SAFETY EVALUATION REPORT
for the Nichols Ranch In Situ Recovery Project in Johnson and Campbell Counties, Wyoming
Materials License No. SUA-1597

Docket No. 040-09067
URANERZ ENERGY CORPORATION

U.S. Nuclear Regulatory Commission

Office of Federal and State Materials and Environmental Management Programs

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Enclosure 2

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INTRODUCTION

By letter dated November 30, 2007, Uranerz Energy Corporation (Uranerz or "the applicant") submitted to the U.S. Nuclear Regulatory Commission (NRC) a license application requesting a source and byproduct material license to allow the operation of a uranium in situ recovery (ISR) facility at its Nichols Ranch ISR Project site in Johnson and Campbell Counties, WY (Uranerz, 2007). Source material licenses are subject to safety requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material."

The application dated November 30, 2007, which consists of a technical report, an environmental report, and several appendices, was received on December 17, 2007. On April 14, 2008, the NRC notified the applicant that it had accepted the application for detailed technical and environmental review (NRC, 2008a). In a letter dated August 21, 2008, Uranerz supplemented its application with change pages and additional information (Uranerz, 2008). On September 11, 2008, the NRC requested additional information from the applicant to allow the staff to complete its safety review (NRC, 2008b). The applicant responded to this request by letter dated March 11, 2009, and supplemented its application with page changes and additional information (Uranerz, 2009a). On October 13, 2009, the NRC staff transmitted to the applicant open issues and confirmatory items that remained before finalization of the safety evaluation report (SER) (NRC, 2009b). By letter dated February 24, 2010, the applicant responded to the open issues and confirmatory items with change pages and additional information (Uranerz, 2010c). Uranerz supplemented the application with letters dated September 15 and 22, 2010, with change pages and additional information (Uranerz, 2010a, 2010b). This SER documents the technical review of the applicant's Nichols Ranch ISR Project technical report and supporting appendices by NRC staff ("the staff"). All references to the application in this SER refer to the Uranerz technical report and supporting appendices and exclude the environmental report unless stated otherwise.

The Atomic Energy Act of 1954, as amended by the Uranium Mill Tailings Radiation Control Act of 1978, authorizes the NRC to issue licenses for the possession and use of source material and byproduct material. The NRC must license facilities, including ISR operations, in accordance with NRC regulatory requirements to protect public health and safety from radiological hazards. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," the NRC is required to make the following safety findings when issuing an ISR license:

- The application is for a purpose authorized by the Atomic Energy Act.

- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property.

- The applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property.

- The issuance of the license amendment will not be inimical to the common defense and security or to the health and safety of the public.

This SER documents the safety portion of the staff's review of the November 20, 2007, application, as amended by subsequent change pages and additional information, and includes an analysis to determine Uranerz's compliance with these and other applicable 10 CFR Part 40 requirements, and applicable requirements set forth in Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content," to 10 CFR Part 40. This SER also evaluates Uranerz's compliance with applicable requirements in 10 CFR Part 20, "Standards for Protection against Radiation."

The staff performed its safety review of the proposed Nichols Ranch ISR Project using NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications" (NRC, 2003) (referred to hereafter as the SRP). The review is a comprehensive assessment of the applicant's proposed ISR project. The regulations at 10 CFR Part 20 and Part 40, and those in Appendix A to 10 CFR Part 40, contain the technical requirements for licensing an ISR project. This SER is presented according to the organization of the SRP, except that sections addressing environmental aspects are not included in the SER as they are addressed in NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities"(referred to here as the GEIS) (NRC, 2009c), and the site's supplemental environmental impact statement (SEIS) (NRC, 2011b). The staff prepared the SEIS in parallel with this SER to address the environmental impacts of the proposed action.

The staff's review of the application for the proposed Nichols Ranch ISR Project identified a number of facility-specific issues that require license conditions to ensure that the operation of the facility will be adequately protective of public health and safety. Table 1 includes the license condition language as well as the section of this SER where the need for the license condition is identified. Appendix A to this SER contains standard license conditions that are applied to all ISR facilities. The staff concludes that the findings described in succeeding sections of this SER, including the necessary license conditions, support the issuance of a license authorizing the construction and operation of the facility. The staff supports the issuance of a license authorizing the construction and operation of the facility, provided that the conditions identified below are included in the license.

Table 1 License Conditions

SER Section	License Condition
2.2.4	The licensee shall install a meteorological station within the license area and collect meteorological data for a period of 1 year at a data recovery rate of 90 percent prior to commencement of operations. The collection of meteorological data will continue until data are determined to be representative of long-term conditions at the Nichols Ranch ISR Project. The data collected shall include, at a minimum, temperature, windspeed, and wind direction. Data submitted shall include an annual wind rose and a summary of the stability classification.
2.6.4	Prior to the preoperational inspection, the licensee will submit monitoring results to the NRC for review that include sampling of domestic and livestock wells that are located within 2 kilometers of the proposed production area monitoring ring wells (MR-wells) of the Nichols Ranch and Hank Units. Samples shall be collected, at a minimum, semiannually. Samples shall be analyzed for the UCL parameters in Section 5.7.8.9 of the approved license application and for natural uranium and radium-226.

Table 1 License Conditions	
3.1.4	Prior to lixiviant injection at the Hank Unit, the licensee will conduct a hydrologic test. The hydrologic test must be scaled and designed to simulate proposed injection and extraction operational conditions at the Hank Unit to demonstrate that an inward hydraulic gradient can be maintained that prevents excursions beyond the perimeter production zone monitoring well ring. The licensee will report the results of the hydrologic test to the NRC for review and approval prior to lixiviant injection into the production area.
3.1.4	The licensee will install “trend” monitoring wells on the upgradient (eastern) side of Hank Units #1 and #2 approximately every 500 feet apart and approximately 300 feet from the injection wells. The licensee will collect water level measurements twice monthly and at least 10 days apart from the trend wells and monthly water level measurements from the production zone monitoring well ring. If water level measurements indicate that an outward gradient exists, the licensee will inform the NRC within 7 days and adjust operations until the outward gradient is eliminated. The licensee shall maintain an inward hydraulic gradient in each individual production area, starting when lixiviant is first injected into the production zone and continuing until the restoration target values (RTVs) have been reached.
3.1.4	The licensee will update or confirm the restoration schedule for the Nichols Ranch Unit Production Area (PA) #2 and provide a basis to the NRC for review and approval for any alternate schedule request that meets the requirements of 10 CFR 40.42. The licensee will update or confirm the restoration schedule for Hank Unit PA #1 and #2 at the completion of the hydrologic test in the Hank Unit as required by this license. The licensee will provide a basis to the NRC for review and approval for any alternate schedule request that meets the requirements of 10 CFR 40.42.
3.1.4	The licensee will notify the NRC within 24 hours if “gas locking,” as discussed in the approved license application, has occurred in the “F sand” at the Hank Unit during operations. The licensee will submit a report within 30 days to the NRC documenting corrective actions taken to ensure that operation of the production zone is proceeding as provided in the application.
4.1.4	Prior to the preoperational inspection, the licensee shall provide for the following information for the airborne effluent and environmental monitoring program in which it shall develop procedures to: (a) Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring. (b) Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302. (c) Discuss and identify how radon (radon-222) progeny will be factored into

Table 1 License Conditions	
	analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2. (d) Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire license area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.
4.2.4	All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit or disposed of as allowed by NRC regulations. Additionally, the licensee is authorized to dispose of process solutions, injection bleed, and restoration brine using deep well injection, as permitted by WDEQ and described in the approved license application. The licensee will obtain the necessary permits and construct a minimum of two Class I Underground Injection Control (UIC) deep disposal wells prior to the commencement of operations of the Nichols Ranch ISR Project. The licensee shall ensure the deep disposal wells shall have enough capacity to handle the disposal of the total liquid effluent generation as stated in Section 3.2.6 of the license application. The licensee will ensure adequate deep well disposal capacity exists at each unit to dispose of liquids from each unit under normal operating conditions during production, production and restoration, and restoration phases as stated in Section 3.2.6 of the license application. The licensee will notify the NRC within 24 hours if a disposal well is shut down and becomes inoperable, with the exception of routine maintenance or required testing that is completed within 48 hours of shutdown. If necessary, the licensee will use additional deep well capacity, surge tanks or cease injection activities until the disposal well is restored to use as written in Section 3.2.6 of the application. The licensee will notify the NRC when the disposal well is placed back into service and report any repairs or service completed on the well that is not associated with routine maintenance. The licensee shall maintain a record of the volumes of solution disposed in each disposal well and submit this information in the annual monitoring report. Prior to the preoperational inspection, the licensee shall develop written procedures to control production fluids and maintain inward hydraulic gradient as required in License Condition (LC) 10.9 if a disposal well becomes inoperable as discussed in LC 10.11.
5.7.2.4	Any areas with exposure rates that exceed 2 millirem in any 1 hour must be immediately treated as either a controlled area or restricted area in accordance with 10 CFR Part 20.
5.7.3.4	The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first

Table 1 License Conditions	
	2 years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g). The licensee shall determine if surface contamination limits are warranted for Th-230, Ra-226, Po-210, and Pb-210 identified in airborne sample analyses. Within 1 year of commencement of operations, the licensee shall provide for NRC review and written verification a technical basis for surface contamination limits for the applicable radionuclides of concern.
5.7.3.4	Lists of Instruments. At least 30 days prior to the preoperational inspection, the licensee shall provide the following: A. A list of radiation measurement instrumentation that will be used to measure or quantify the radioactivity on air sampling media. The list will provide the manufacturer, model number and/or a description of the instrument, range, instrument sensitivity (LLD), and its planned use to measure radioactivity. B. A list of radiation survey instrumentation available for radiation contamination surveys. The licensee will also provide adequate information to show the capability of each instrument such as the type of instrument, range, sensitivity (lowest range limits), and planned use.
5.7.6.4	Prior to the preoperational inspection, the licensee shall develop a survey program for beta/gamma contamination for personnel contamination from restricted areas, and beta/gamma contamination in unrestricted and restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.
5.7.7.4	Radiological monitoring will be conducted for airborne particulate radioactivity and radon-222 at appropriate environmental monitoring locations in accordance with the criteria in Regulatory Guide 4.14 (as revised) during operations to demonstrate compliance with 10 CFR 20.1301, 10 CFR 20.1501, and 10 CFR Part 40, Appendix A, Criterion 7.
5.7.7.4	Consistent with Regulatory Guide 4.14 (as revised), the licensee shall establish air particulate sampling stations in the three sectors with the highest predicted radioactivity concentrations resultant from operations and co-locate radon air samplers and direct radiation and soil sampling with the air particulate sampling stations.
5.7.8.4	The licensee will provide the Production Area Pump Test (PAPT) document for the first production areas at the Nichols Ranch and Hank Units for NRC review and approval prior to lixiviant injection into the production area. The licensee will provide PAPT documents for each additional production area for NRC review. The PAPT document will provide all background ground water data, restoration target values, upper control limits at each monitoring well, as well as the information outlined in Section 5.7.8.4 of the license application.

Table 1 License Conditions	
5.7.9.4	At least 30 days prior to the preoperational inspection, the licensee will submit a Quality Assurance Program (QAP) to the NRC for review to verify the license application statement that the QAP will be consistent with Regulatory Guide 4.15.
6.2.4	At least 12 months prior to initiation of any planned final site decommissioning, the licensee shall submit a detailed decommissioning plan for NRC review and approval. The plan shall represent as-built conditions at the Nichols Ranch ISR Project.
6.2.4	Prior to the preoperational inspection, the applicant will provide a survey plan for postreclamation and decommissioning verification surveys that demonstrates that residual radioactivity in soil meets the criteria in 10 CFR Part 40, Appendix A, Criterion 6(6). The applicable cleanup criteria will be identified for radium-226, and soil cleanup criteria will be developed for natural uranium using the radium benchmark dose approach. Applicable criteria for thorium-230 will also be addressed in the plan.

The NRC finds that the application for the Nichols Ranch materials license complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations. Based on its review, as documented in this SER, the staff concludes that the application meets the applicable requirements in 10 CFR Parts 20 and 40. More specifically, in accordance with 10 CFR 40.32(b-c), the staff finds that Uranerz is qualified by reason of training and experience to use source material for the purpose it requested; and that Uranerz's proposed equipment and procedures for use at its Nichols Ranch facility are adequate to protect public health and minimize danger to life or property. Therefore, in accordance with 10 CFR 40.32(d), the staff finds that issuance of a license to Uranerz will not be inimical to the common defense and security or to the health and safety of the public.

References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

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Uranerz, 2009a. Letter from Uranerz Energy Corporation with Responses to Request for Additional Information for Nichols Ranch ISR Project License Application, March 11, 2009, ADAMS Package No. ML090820568.

Uranerz, 2008. Letter from Uranerz Enclosing Responses to Wyoming Department of Environmental Quality's First Consolidated Completeness and Technical Review for Nichols Ranch, file date November 18, 2008, ADAMS Package No. ML083230892.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

1.0 PROPOSED ACTIVITIES

1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its summary of the proposed activities at the Nichols Ranch facility is in compliance with the applicable requirements in 10 CFR 40.31, "Application for Specific Licenses."

1.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR 40.31 using the acceptance criteria presented in SRP Section 1.3 (NRC, 2003).

1.3 Staff Review and Analysis

The Nichols Ranch ISR Project application, dated November 30, 2007, was submitted by the Uranerz Energy Corporation on December 17, 2007 (Uranerz, 2007). The application consists of a technical report, environmental report, and several appendices. In a letter dated August 21, 2008, Uranerz supplemented its application with change pages and additional information (Uranerz, 2008). The applicant again supplemented the application with page changes and additional information on March 11, 2009 (Uranerz, 2009a). By letter dated February 24, 2010, the applicant responded in writing to NRC open issues and confirmatory items (Uranerz, 2010c). Uranerz supplemented the application with change pages and additional information by letters dated September 15 and 22, 2010 (Uranerz, 2010a, 2010b). Together, these submittals comprise the technical report and form the basis for the staff's review. This SER documents the staff's safety review of the technical report. A SEIS has been prepared in parallel with this SER to address the environmental impacts of the proposed action (NRC, 2011b).

The Nichols Ranch ISR Project is located in the Pumpkin Buttes Uranium Mining District in the Powder River Basin (PRB) in Johnson and Campbell Counties, WY. The project is divided into two units, the Nichols Ranch Unit and the Hank Unit. The applicant proposes to produce uranium at both its Nichols and Hank Units using the solution extraction process, commonly known as in situ recovery. This process involves dissolving water-soluble uranium compounds from the mineralized host sandstone rock commonly referred to as the ore zone. Uranium in the ore zone is dissolved when the uranium is oxidized from the tetravalent to the hexavalent state with an oxidant such as oxygen or hydrogen peroxide that is pumped into the ore zone through a network of injection wells. A chemical compound, such as a sodium bicarbonate ($NaHCO_3$), is added to complex the uranium in the solution, if needed.

The solution used to dissolve the uranium is called lixiviant, which is native ground water fortified with oxidants and sodium bicarbonate as a complexing agent. Once the lixiviant has circulated through the ore zone and dissolved the uranium into solution, the uranium-laden solution, known as pregnant lixiviant, is withdrawn from the ore zone through a network of production wells and transferred to a central processing plant (CPP). Uranium is removed from the lixiviant at a processing facility using the ion exchange (IX) process, whereby the uranium chemically bonds to the IX resins. Once uranium is removed from the lixiviant, the barren lixiviant solution is then refortified with the oxidant and complexing agent and re-injected to recover more uranium. This process is repeated throughout the uranium production process until it is no longer economical to recover the remaining uranium.

The CPP will be located at the Nichols Ranch Unit, and a satellite facility will be located at the Hank Unit. The CPP will produce the final product that is commonly known as yellowcake uranium and contains a combination of uranium oxides and uranyl peroxides. The Nichols Ranch Unit operation would include injection of barren lixiviant and recovery of pregnant lixiviant from the ore zone, as well as IX, elution, precipitation, yellowcake drying, and yellowcake packing operations. The Hank Unit satellite facility is approximately 9.7 kilometers (km) (6 miles [mi]) northeast of the CPP at the Nichols Ranch Unit. Hank Unit operations would include the injection, recovery, and IX portions of the ISR process and will produce uranium that is chemically bound to IX resins. Uranium-laden resins will be transported to the Nichols Ranch CPP for processing to yellowcake.

Current land surface ownership of the Nichols Ranch ISR Project includes approximately 1,251 hectares (ha) (3,091 acres [ac]) of private ownership and approximately 113 ha (280 ac) of U.S. Government ownership administered by the Bureau of Land Management (BLM). The Nichols Ranch Unit encompasses approximately 453 ha (1,120 ac) of land located in Township 43 North Range 76 West, Sections 7, 8, 17, 18, and 20. The Hank Unit encompasses approximately 911 ha (2,250 ac) of land located in Township 44 North Range 75 West, Sections 30 and 31, and Township 43 North Range 75 West, Sections 5, 6, 7, and 8.

The applicant estimates the uranium content for the Nichols Ranch and Hank Units to be 1,145,909 kilograms (kg) (2,521,000 pounds [lb]) and 841,818 kg (1,852,000 lb), respectively. Initially, the Nichols Ranch Unit is designed to operate at a flow rate of 13,248 liters per minute (Lpm) (3,500 gallons per minute [gpm]) and an annual production of 227,273 kg (500,000 lb). The satellite facility at the Hank Unit will have a designed flow rate of 9,463 Lpm (2,500 gpm) and an annual production of 136,364 kg (300,000 lb). The CPP at the Nichols Ranch Unit will have the capacity to produce 909,092 kg (2,000,000 lb) of yellowcake annually.

The Nichols Ranch Unit ore zone is located in the Eocene Wasatch Formation approximately 12.9 km (8 mi) west of the South Pumpkin Butte and straddles the Johnson and Campbell County lines. Mineralized sand horizons occur in the lower part of the Wasatch Formation at an average depth of 168 meters (m) (550 feet [ft]). The Hank Unit ore zone is also located in the Wasatch Formation approximately 8 km (5 mi) east-northeast of the Nichols Ranch Unit CPP in Campbell County. Mineralized sand horizons occur in the lower part of the Wasatch Formation, at an approximate average depth of 111 m (365 ft).

The applicant has estimated its schedules for construction, startup, and duration of operations. Construction for the two units is estimated at approximately 1 year. The Nichols Ranch Unit is expected to require a 6-month ramp up to the full annual production, after which the Hank Unit will start a 6-month ramp-up phase to the full annual production. Uranium extraction in the Nichols Ranch Unit will require 3 to 4 years; extraction at the Hank Unit is estimated to require 4 to 5 years.

Before operations begin, the applicant will install monitoring wells within the production zone and collect four rounds of samples to determine background water quality and calculate restoration standards. To monitor the production zone for hydraulic control of lixiviant solution during operations, the applicant will install monitoring wells adjacent to the production zone and in aquifers immediately above and below the production zone and sample them twice monthly for chemical constituents to ensure that no lixiviant solution is migrating from the production zone. After operations, the applicant will restore the production zone to background water quality or other acceptable alternate standards.

Operation of the Nichols Ranch facility will result in the generation of “byproduct material,” as defined in Section 11e.(2) of the Atomic Energy Act of 1954, as amended, and as codified in 10 CFR 40.4, “Definitions.” Both liquid and solid forms of byproduct material will be generated during operations. The applicant plans to install deep disposal wells, as authorized by the State of Wyoming Department of Environmental Quality (WDEQ) at both the Nichols Ranch Unit and at the Hank Unit. The deep disposal wells will receive liquid byproduct material waste generated during production and restoration. Solid byproduct material (e.g., spent ion exchange resin, pumps, pipes, and building materials used during operations that cannot be decontaminated) will be disposed of at a licensed mill tailings facility or other licensed facility not yet identified. The applicant will also have an agreement with an approved waste disposal facility for solid byproduct material waste.

To ensure that the operations can be restored and the site returned to its preproduction use, a financial surety will be required consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 9. The surety will include estimated costs for ground water restoration and decommissioning of surface features at the Nichols Ranch facility. The financial surety arrangement must be in place before startup of operations and will be held by an approved State agency or the NRC.

The applicant has discussed historical ISR pilot projects at Collins Draw and North Rolling Pin, which are located in the PRB within several kilometers of the Nichols Ranch ISR Project. Both pilot projects successfully produced small amounts of uranium and successfully restored ground water to applicable standards. The applicant also documented the Irigaray and Christensen Ranch commercial ISR project in the PRB near the Nichols Ranch ISR Project. This project demonstrated the ability to produce uranium on a commercial scale and restore ground water at the Irigaray site on a commercial scale.

1.4 Evaluation Findings

The staff reviewed the summary of proposed activities at the Nichols Ranch ISR Project in accordance with review procedures in SRP Section 1.2 and acceptance criteria outlined in Section 1.3. Information contained in the Uranerz application acceptably described the proposed activities at the Nichols Ranch facility, including: (1) the corporate entities involved, (2) the location of the facility, (3) land ownership, (4) ore-body locations, (5) the proposed recovery process, (6) operating plans and design throughput, (7) schedules for construction, startup, and duration of operations, (8) waste management and disposal plans, (9) ground water quality restoration, decommissioning, and land reclamation plans, and (10) financial assurance.

Based on the review described above, the NRC staff concludes that the information in the application meets the applicable acceptance criteria of SRP Section 1.3 and the requirements of 10 CFR 40.31, which describes the general requirements for the issuance of a specific license.

1.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

Atomic Energy Act of 1954, 42 U.S.C. § 2011, Pub. L. 83-703.

NRC, 2011b. NUREG-1910, Supplement 2, "Environmental Impact Statement for the Nichols Ranch ISR Project in Campbell and Johnson Counties, Wyoming—Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," Washington, DC, January 2011.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2010a. "Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application, file date September 23, 2010 (ADAMS Accession Package No. ML102650554).

Uranerz, 2010b. Transmittal of Revised Uranerz Energy Corp Nichols Ranch ISR Project Technical Report Table of Contents, September 22, 2010, ADAMS Accession No. ML102730116.

Uranerz, 2010c. Response to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application, file date March 15, 2010 (ADAMS Accession Package No. ML100740143).

Uranerz, 2009a. Letter from Uranerz Energy Corporation with Responses to Request for Additional Information for Nichols Ranch ISR Project License Application, March 11, 2009, ADAMS Package No. ML090820568.

Uranerz, 2008. Letter from Uranerz Enclosing Responses to Wyoming Department of Environmental Quality's First Consolidated Completeness and Technical Review for Nichols Ranch, file date November 18, 2008, ADAMS Package No. ML083230892.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

2.0 SITE CHARACTERIZATION

2.1 Site Location and Layout

2.1.1 Regulatory Requirements

The staff determines if the applicant has adequately identified the site location in accordance with the requirements of 10 CFR 40.31(g)(2).

2.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in SRP Section 2.1.3 (NRC, 2003).

2.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff visited the site on several occasions during this review to confirm information presented in the application.

The proposed Nichols Ranch ISR Project is located in the PRB in Johnson and Campbell Counties, WY (SER Figure 2.1-1). The Nichols Ranch ISR Project is located generally between Casper, Gillette, and Buffalo, WY. The applicant has divided the project into two project units, the Nichols Ranch Unit and the Hank Unit. Uranium extraction is planned to occur first at the Nichols Ranch Unit and then move to the Hank Unit. Locations of both units are shown in application Figures 1-1, 1-2, 1-3, and 1-4 (Uranerz, 2007).

The Nichols Ranch Unit lies approximately 12.9 km (8 mi) west of South Pumpkin Butte, the southernmost butte of a series of buttes known as the Pumpkin Buttes, which rise approximately 305 m (1,000 ft) above the surrounding terrain (SER Figure 2.1-2). The Nichols Ranch Unit encompasses approximately 453 ha (1,120 ac) of land located in Township 43 North Range 76 West, Sections 7, 8, 17, 18, and 20. The applicant proposes to construct the main processing facility consisting of the CPP, main office building, and a maintenance building at the Nichols Ranch Unit.

The Hank Unit lies to the west and directly at the base of North Middle Butte and South Middle Butte of the Pumpkin Buttes (SER Figure 2.1-3). It encompasses approximately 911 ha (2,251 ac) of land located in Township 44 North Range 75 West, Sections 30 and 31, and Township 43 North Range 75 West, Sections 5, 6, 7, and 8. A satellite operation consisting of a satellite IX plant, an office building, and a maintenance building will be constructed at the Hank Unit.

No residential structures are located within either the Nichols Ranch or Hank Unit proposed license areas. Seven residences exist with 16 inhabitants located within 9.8 km (6.1 mi) of both proposed license areas. Application Table 2-1 lists these residences. The closest residence to the Nichols Ranch Unit is the Dry Fork Ranch, which lies approximately 1.4 km (0.9 mi) to the west, and the closest residence to the Hank Unit is the Pfister Ranch, which is approximately 0.97 km (0.6 mi) to the north. Wright, WY, the closest town to the project, is located

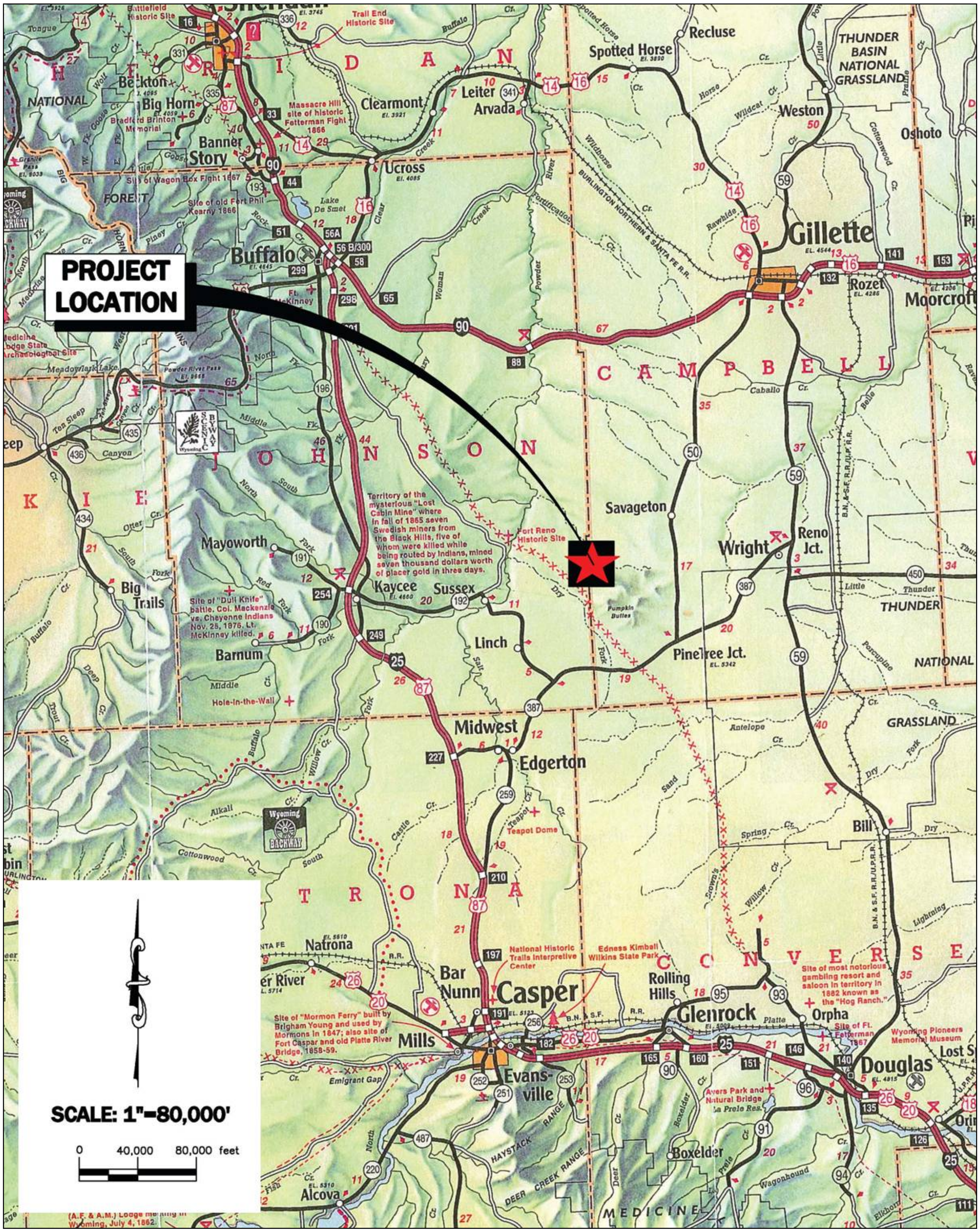

Figure 2.1-1 Location of Nichols Ranch ISR Project, modified from Uranerz, 2007

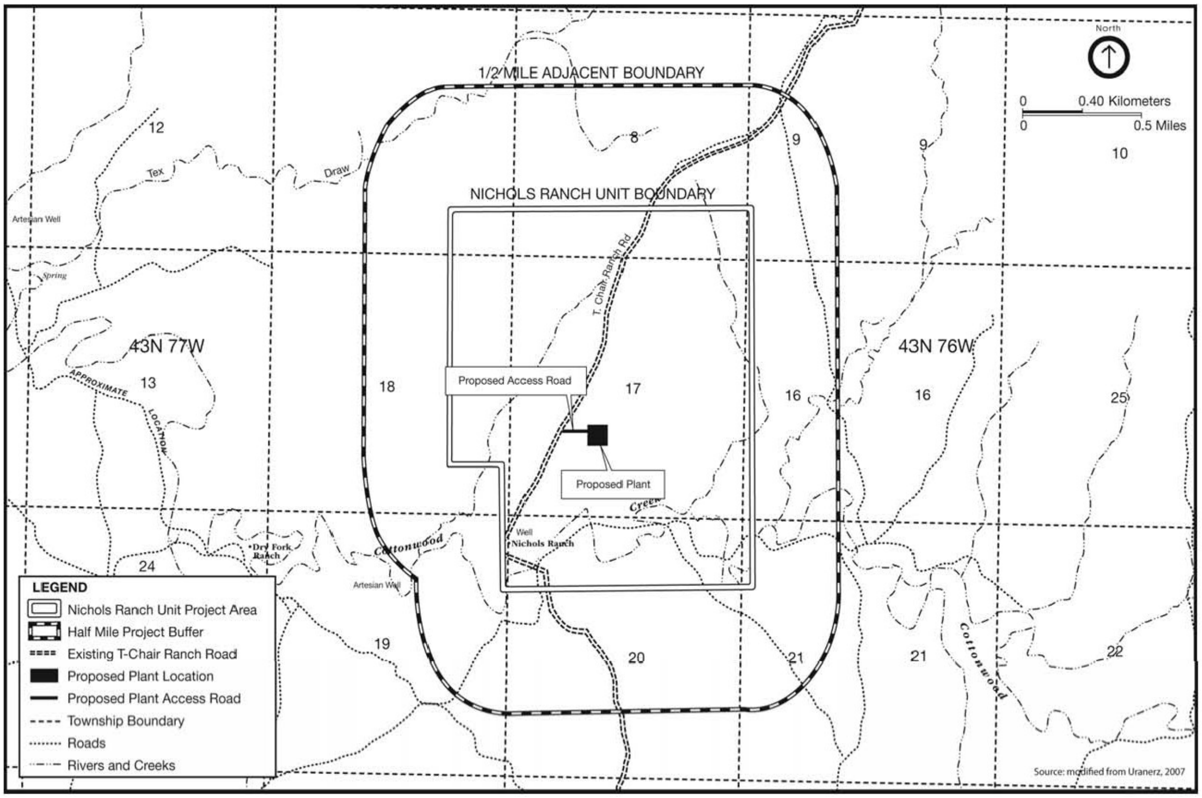

Figure 2.1-2 Location of Nichols Unit

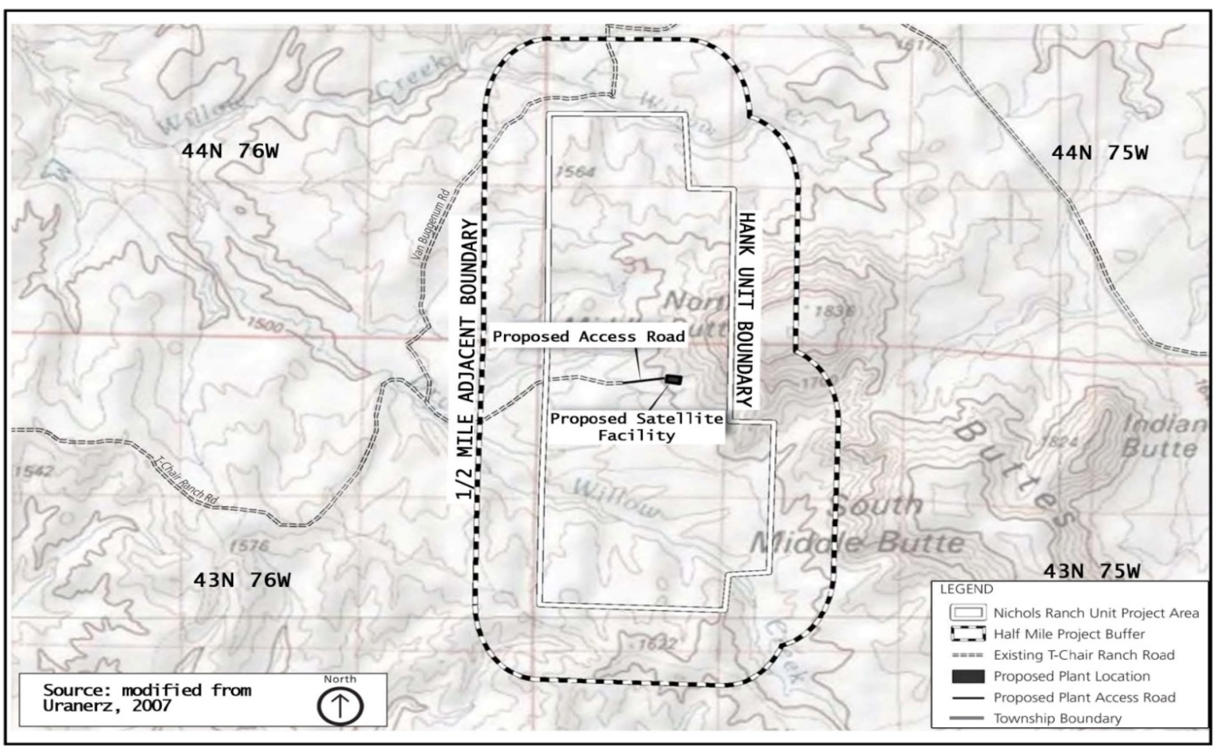

Figure 2.1-3 Location of Hank Unit

approximately 35 km (22 mi) to the east with a population of approximately 1,450. Gillette, WY, the closest major urban area, is approximately 74 km (46 mi) to the northeast and has a population of approximately 22,700. The site descriptions provided by Uranerz are accurate based on staff site visits conducted during the review and staff review of area maps provided in the application.

Two NRC-licensed ISR projects are located near the Nichols Ranch ISR Project. Uranium One's Christensen Ranch ISR satellite facility (formally owned by COGEMA Mining, Inc.) is located approximately 9.7 km (6.0 mi) north of the Nichols Ranch Unit and approximately 6.4 km (4.0 mi) to the northwest of the Hank Unit. The North Butte area licensed by Power Resources Inc., is approximately 3.2 km (2.0 mi) to the north of the Hank Unit and 8.1 km (5.0 mi) to the northeast of the Nichols Ranch Unit. Additional information related to these projects is publicly available in the NRC public document room.

Current surface ownership of the Nichols Ranch ISR Project includes approximately 1251 ha (3,091 ac) of private ownership and 113 ha (280 ac) of Federal Government ownership administered by BLM. All BLM surface ownership is located at the Hank Unit. Uranium mineral ownership includes both private mineral and Federal unpatented mining claims administered by the BLM. Application Appendices A and B list the name and addresses of the surface and mineral ownership within the licensed boundary and within ½ mile of the licensed boundary.

2.1.4 Evaluation Findings

The staff has reviewed the site location and layout of the Nichols Ranch ISR Project in accordance with the review procedures in SRP Section 2.1.2 and the acceptance criteria in Section 2.1.3. The NRC staff finds that the applicant has described the site location and layout with appropriately scaled and labeled maps showing the site layout, principal facilities and structures, boundaries, and topography. Based on the review described above, the NRC staff concludes that the information in the application meets the applicable acceptance criteria of SRP Section 2.1.3 and the requirements of 10 CFR 40.31(g)(2).

2.1.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2007. Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming, ADAMS Accession Package No. ML080080594, November 30, 2007.

2.2 Meteorology

This section discusses the meteorological conditions of the region surrounding and including the applicant's proposed facility. Meteorological data are used for the selection of environmental monitoring locations, assessing the impact of operations on the environment, and determining the radiological dose assessments.

2.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the meteorology program—which is part of the site monitoring programs required by 10 CFR Part 40, Appendix A, Criterion 7—is sufficiently complete to allow for estimating doses to workers and members of the public.

2.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria in SRP Section 2.5.3 (NRC, 2003).

2.2.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the meteorological conditions at the Nichols Ranch ISR Project. Aspects reviewed in the following sections include general site conditions, meteorological data acquisition, wind, and atmospheric dispersion. The information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff also visited the site on several occasions during this review.

2.2.3.1 General Site Conditions

The Nichols Ranch ISR Project is located in a semiarid environment with monthly average temperatures that range from a minimum of between -12.2 and -7.8 degrees Celsius (C) (10 and 18 degrees Fahrenheit [F]) in January to a maximum between 29.4 and 32.2 degrees C (85 and 90 degrees F) in July. The region has an average annual temperature between 7.2 and 10 degrees C (45 and 50 degrees F). Annual precipitation ranges between 28 and 38 centimeters (cm) (11 and 15 inches [in]) with the most precipitation occurring in late spring to early summer and the least occurring in the winter months. Annual average relative humidity is between 52 and 60 percent, but can be as low as 25 to 30 percent. Diurnal variations up to 45 percent occur in the summer months with the increased humidity from rainfall. The most common severe storms consist of thunderstorms, hailstorms, and tornadoes. Uranerz provided the sources of this information in its license application.

The Nichols Ranch and Hank Units are described as two noncontiguous units whose boundaries are located approximately 6.4 km (4 mi) apart west and southwest of the North Middle Butte of the Pumpkin Buttes with CPP and satellite facilities located at elevations of 1,453 and 1,585 m (4,767 and 5,200 ft) above mean sea level, respectively. Nichols Ranch Unit topography is described as relatively flat where the CPP is planned, with gently rolling hills and low ridges that drain toward the southern part of the unit. Hank Unit topography is described as gently rolling hills and low ridges with steep terrain adjacent to the North Middle Butte. Based on staff observations during site visits, these descriptions are accurate.

2.2.3.2 Meteorological Data Acquisition

Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting" (NRC, 1988b), identifies the minimum amount of meteorological data needed for a siting evaluation. According to Regulatory Guide 3.63, applicants should collect data on a continuous basis for a consecutive 12-month period that is representative of long-term (e.g., 30 years) meteorological conditions in the site vicinity. To verify whether the period of record is demonstrative of long-term meteorological conditions, the regulatory guide suggests comparing a concurrent period of meteorological data from a National Weather Service (NWS) station with the long-term meteorological data from that NWS station. The NWS station selected for this comparison should be in a similar geographical and topographical location and be within 80 km (50 mi) of the site.

The SRP lists data to be reviewed by the staff to include the following:

- all NWS data within an 80-km (50-mi) radius
- onsite data if nearby NWS data representative of the site are not available
- miscellaneous data, such as location of instruments, description of general climatology, and occurrences of severe weather

The applicant did not collect onsite meteorological data at the Nichols Ranch ISR Project. Instead, the applicant used the station operated by the Intermountain Laboratory (IML) at the Antelope Coal Company Mine (ACC) located 78 km (48.5 mi) east-southeast of the Nichols Ranch ISR Project area. The applicant selected the ACC station meteorological data as representative of the site because (1) the station was within 80 km (50 mi) of the site, (2) wind data were available, (3) the two sites had similar topography, and (4) the applicant assumed that the staff had approved Energy Metals Corporation's use of the ACC station for the Moore Ranch Uranium Project (NRC, 2009a). This last assumption is erroneous as the staff did not agree that the ACC meteorological data would be representative of the Moore Ranch facility and added a license condition to require onsite data collection to meet the requirements in 10 CFR Part 40, Appendix A, Criterion 7. Except for wind data collected between 1987 and 2006, the applicant did not provide the dates of collection for the ACC station meteorological data presented in application Section 2.5.3.

The applicant provided data collected from seven meteorological stations located northwest, north-northeast, east-southeast, south-southwest, and southwest of the Nichols Ranch ISR Project at distances ranging between 40 and 100 km (25 and 62 mi), as presented in application Figure 2-7 and application Table 2-7 and summarized in SER Table 2.2. Six of the seven meteorological stations are NWS stations. The applicant reviewed temperature and precipitation data from all seven stations, but wind data were available only at the Casper Natrona Airport, ACC, Gillette, and Buffalo stations. Humidity and evaporation data were available only at the ACC station; mixing height data were available only for the meteorological station at Lander, WY. The applicant did not provide the dates of collection for the meteorological data presented in application Section 2.5.2 (Uranerz, 2007) describing the regional characteristics, except for the mixing height data, which were collected from 1987 to 1991. A footnote in application Table 2-7 described the period of record as the start and end dates for which the stations were open, not the data review period. The staff's assessment of the meteorological data collection is discussed in SER Section 2.2.3.6.

Table 2.2 Meteorological Data Summary (adapted from Uranerz, 2007)				
Weather Station	Data Collected by	Periods of Records	Distance from Nichols Ranch (mi)	Wind Direction
ACC	IML	1987–2007	48.5	Yes
Buffalo	NWS	1899–2007	58	Yes
Casper Natrona Airport	NWS	1948–2007	60	Yes
Dull Center	MWS	1926–2007	54	No
Gillette	NWS	1902–2006	46.5	Yes
Glenrock	NWS	1946–2006	62	No
Midwest	NWS	1939–2006	25	No

Regulatory Guide 3.63 recommends that precipitation and evaporation data be used to design evaporation impoundments and that these parameters should be measured near the ground surface. Since evaporation ponds will not be constructed, staff agrees there is no need for precipitation or evaporation data. Additionally, because the applicant does not plan to construct or use evaporation impoundments, the applicant did not consider precipitation and evaporation data essential to evaluate dose or radioactivity transport calculations. Staff finds that precipitation data are not needed because evaporation ponds are not being used.

The regulatory guide recommends that the meteorology parameters needed to calculate transport of airborne effluents should be measured approximately 10 m (32.8 ft) above ground elevation and away from obstructions, such as buildings, and in the prevailing downwind direction of an obstruction. Application Table 2-7 presents the location and description of the meteorological instruments used to collect temperature and wind data at the ACC station. The staff finds the height and location of ACC instruments away from obstructions used for temperature, windspeed, and wind direction consistent with Regulatory Guide 3.63.

2.2.3.3 Wind

The staff reviewed all meteorological data presented in the application to ensure completeness of the review. The following documents the NRC staff's review of wind data. The applicant's data from four select stations (Buffalo, Gillette, ACC, and Casper) show that regional wind directions are highly variable and strongly influenced by local topography. The applicant provided Figure 2-10a in the application for the annual wind rose for the Antelope station. Windspeed and wind direction data were collected from 1987 to 2007. Application Figures 2-10, 2-10a, and 2-10b, respectively, illustrate the average annual windspeed and the annual and monthly wind rose data. Average windspeed at the ACC station was 18 kilometers per hour (kph) (11 miles per hour [mph]) with maximum windspeed averaging 76 kph (47 mph), and the wind direction from the ACC station showed a generally westerly pattern with a stronger west-southwest component. Winds are the weakest in the predawn hours and strongest in the midafternoons, tapering off again at dusk. Seasonal variations indicated maximum windspeeds in the spring and minimum in the fall.

The applicant stated in application Section 2.2.3 that winds are highly variable and are influenced by local topography. The Pumpkin Buttes can produce variable and diverse microclimatic effects on the local precipitation pattern, but the applicant concluded that the effects of local topography were negligible without explaining the criteria used to make this conclusion. The applicant stated in application Section 2.5.1 that the physical setting of both the ACC Mine Station and Nichols Ranch ISR Project are similar, and therefore, the ACC site meteorological data can be used as a surrogate for the Nichols Ranch ISR Project. Application Figure 2-7 shows the location of the ACC station 48.5 miles to the east-southeast of Nichols Ranch. Although the applicant stated that the ACC station and the proposed Nichols Ranch Unit CPP share similar topography, similar vegetation, and proximity, the staff notes that Regulatory Guide 3.63, Regulatory Position C. 2., suggests that differences in topography can cause meteorological data differences within the same site. The staff cannot agree that a meteorological station 48.5 miles from the Nichols Ranch Project is representative of the site meteorological conditions. Local topography at the Nichols Range ISR Project warrants collecting onsite meteorological measurements. Therefore, the staff will include a license condition requiring collection of onsite meteorological data. This condition can be found in Section 2.2.4 of this SER.

2.2.3.4 Atmospheric Dispersion

Mixing height is the height to which the air near the earth is well mixed because of turbulence caused by the interaction between the surface and the atmosphere. Average morning and afternoon mixing heights (also known as inversion) and the joint frequency distribution (JFD) are meteorological characteristics needed as input parameters in atmospheric dispersion and transport computer codes, such as MILDOS-AREA (Yuan, et al., 1989), to calculate the average annual airborne concentration of the contaminant and the radiation dose commitments to human receptors near a facility.

The JFD is a set of meteorological data presented in graphs and tables that represents a summary of observed meteorological conditions over a period of time. The JFD is developed from the occurrence of 6 classes of windspeed, 16 divisions of wind direction, and 6 Pasquill stability classes. Stability classes describe atmospheric turbulence and are characterized by the letters A through F, with A as the most turbulent or unstable, D as neutral, and F as the least turbulent or most stable.

The applicant stated in application Section 2.5.3.3 that the mixing height data were collected at the Lander Station in Lander, WY, between 1987 and 1991. Average morning and afternoon mixing heights were 659 and 4,074 m (2,162 and 13,363 ft), respectively. Wind direction and speed collected from the ACC station between 1987 and 2006 were used as input parameters to calculate the JFDs presented by the applicant in application Addendum 7C. The applicant concluded in application Section 2.5.3.3 that more than 55 percent of winds at the ACC station fell into Stability Class D, near neutral to slightly unstable conditions. The staff agrees with this assessment. However, as previously stated, the applicant has not demonstrated that the ACC station data are representative of the meteorological conditions at the Nichols Ranch ISR Project. Because the stability class was based on ACC data, the applicant will need to recalculate these classes using site-specific data once they are collected per the license condition in Section 2.2.4 of this SER.

2.2.3.5 Meteorological Data Quality

The purpose of instrument calibration and maintenance is to ensure that readings or measurements are consistent with a standard and accurate source of data. The applicant did not provide any information on the calibration, maintenance, inspection, or service of the instrumentation used by the meteorological stations. The staff, therefore, cannot determine the validity of the meteorological data provided by the applicant for the period from 1987 to 2006.

The applicant did not provide the period of record for any of the data except for the mixing height and wind data collected from the Lander and Antelope stations, respectively. Furthermore, the applicant did not compare data collected from an NWS station during a concurrent period with long-term data collected from that NWS station to determine if the period of record of the onsite data was representative of meteorological conditions at the Nichols Ranch ISR Project site. The minimum amount of data required for a siting evaluation is that amount of data collected on site on a continuous basis for a consecutive 12-month period that is representative of long-term (e.g., 30 years) meteorological conditions in the site vicinity. Onsite data must be compared to data collected from an NWS or other credible station during the same period to ensure that the period of record is consistent. Consequently, the other station data must be compared to long-term data to determine if the data during the period sampled are typical of long-term conditions.

The staff finds the lack of (1) onsite or local meteorological station data and (2) the comparative data to determine if the data are representative of long-term conditions at the proposed site to be insufficient to allow an independent evaluation and assessment of the meteorological conditions at the Nichols Ranch ISR Project site. This data deficiency will be addressed by the same license condition to require onsite data collection discussed in Section 2.2.4 of this SER.

2.2.4 Evaluation Findings

The NRC has completed its review of the meteorology of the Nichols Ranch ISR Project in accordance with SRP Section 2.5.3. The applicant used data from offsite NWS meteorological stations to represent conditions at the Nichols Ranch ISR Project; however, such representativeness has not been satisfactorily demonstrated as discussed in the staffs meteorological review and analysis presented above in SER 2.2.3. Because the applicant has not provided representative meteorological data in the application, the staff is imposing the following license condition to ensure that representative data are collected prior to commencement of operations:

> The licensee shall install a meteorological station within the license area and collect meteorological data for a period of 1 year at a data recovery rate of 90 percent prior to commencement of operations. The collection of meteorological data will continue until data are determined to be representative of long-term conditions at the Nichols Ranch ISR Project. The data collected shall include, at a minimum, temperature, windspeed, and wind direction. Data submitted shall include an annual wind rose and a summary of the stability classification.

The license condition provides an exemption to the 10 CFR Part 40, Appendix A, Criterion 7, requirement that the baseline data be provided on a mill site and its environs 12 months prior to major construction activities at the site. The NRC staff has determined that providing the meteorological data for the NRC’s review and written verification before the commencement of operations at the site is adequately protective of public health and safety because no radiological material will be stored or produced at the site until the facility begins operations. Based on its review (described above) of the information provided in the application, as supplemented by information to be collected in accordance with the noted license condition, the staff concludes that this information meets the applicable acceptance criteria of SRP Section 2.5.3 to allow evaluation of the spread of airborne contamination at the site and development of monitoring programs to meet requirements of 10 CFR Part 40, Appendix A, Criterion 7 prior to the facility's operation.

2.2.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2009a. NUREG-1910, Supplement 1, "Environmental Impact Statement for the Moore Ranch ISR Project in Campbell County, Wyoming; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," Washington, DC, November 2009.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 1988b. Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting," Washington, DC, March 1988.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

Yuan, Y.C., J.H.C. Wang, and A.J. Zielen, 1989. ANL/ES-161, "MILDOS-AREA: an Enhanced Version of MILDOS for Large-Area Sources," Argonne National Laboratory, Argonne, IL, June 1989.

2.3 Geology and Seismology

2.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the characterization of geology and seismology at the Nichols Ranch ISR Project is sufficient to document the applicant's ability to maintain control over production fluids containing source and byproduct materials, as required in 10 CFR 40.41(c).

2.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed using the acceptance criteria presented in SRP Section 2.6.3 (NRC, 2003).

2.3.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the geology and seismology of the Nichols Ranch ISR Project. Aspects reviewed in the following sections include regional geology, site geology, soils, mineralogy, exploration boreholes, and seismology. The information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff also visited the site on several occasions during this review.

2.3.3.1 Regional Geology

Both units in the Nichols Ranch ISR Project lie within the PRB in north-central Wyoming. The PRB is an asymmetrical syncline filled with marine and nonmarine and continental sediments that are approximately 4,573 m (15,000 ft) thick in the deepest part of the basin. The PRB covers approximately 56,980 square km (km^2) (22,000 square mi [mi^2]). The applicant provided the entire regional stratigraphic column of the PRB in application Figure 2-13, of which the general upper stratigraphy is of interest to this review (see SER Figure 2.3-1).

The applicant reported that in the license area, the White River Formation has been eroded away except at the top of the Pumpkin Buttes, which are on the east side of the Hank Unit. In the rest of the license area, the surficial unit is the Wasatch Formation, which is composed of interbedded mudstones, carbonaceous shales, silty sandstones, and clean sandstones. Near the Pumpkin Buttes, the applicant reported that the Wasatch is approximately 488 m (1,600 ft) thick and contains the uranium resources of interest. Below the Wasatch is the Fort Union Formation. The applicant reported that the Fort Union Formation is composed of a series of interbedded silty claystones, sandy siltstones, and relatively clean sandstones, claystones, and coals. Total thickness of the Fort Union Formation is approximately 915 m (3,000 ft) in the area. The Fort Union Formation contains uranium mineralization throughout the basin and also coal seams that are a source of methane gas. The applicant reported that the regional coal bed methane (CBM) deposits in the region are located approximately 305 m (1,000 ft) below ground surface (bgs) at the Nichols Ranch Unit and 366 m (1,200 ft) bgs at the Hank Unit. This description is consistent with the staff's knowledge of the geology of the PRB from site visits and reviews of geological and technical reports provided from other ISR licensees and projects that have occurred over more than 40 years in the PRB.

2.3.3.2 Site Geology

The applicant described the geology of the site in detail in application Appendix D5.0. It provided geological cross sections that display the stratigraphy and isopach maps that show the thickness of each layer in the license areas. These maps were developed using well logs from historical and recent exploratory borings. Figure 2.3-2 shows a generalized local stratigraphic section that describes the sequence of sands and aquitards for the Nichols Ranch license area. This sequence is essentially the same for the Hank Unit, with the exception that several additional overlying sands and some discontinuous sands are described. The following sections present in detail the NRC staff's review of the descriptions of the site geology provided by the applicant.

2.3.3.2.1 Nichols Ranch Unit License Area

The applicant provided the local geology for the Nichols Ranch Unit in six different cross sections (A-A', B-B', E-E', K-K', L-L', and M-M') and isopachs in Figures D5-13 through D5-17 in Appendix D5 to the technical report. Cross section A-A' transects north to south along the length of the east limb ore zone. Cross section K-K' transects north to south along the length of the west limb. The other cross sections (M-M', B-B', and L-L') transect west to east across the license area at different points. The staff reviewed the geology of the license area from an evaluation of the cross sections and isopachs provided by the applicant as shown in Table 2.3-1. No faults or fracturing were observed on the cross sections or noted in any descriptions at the Nichols Ranch Unit. No underground mine works were identified. The alternating sand, silt, siltstone, clay layercake geology and lack of faulting and underground mine works is consistent with the NRC staff's historical knowledge of the geology of the PRB associated with historical and current uranium ISR projects. Based on this evaluation and the criteria in SRP Section 2.6.3(5), the staff finds the geological characterization of the Nichols Ranch Unit to be acceptable.

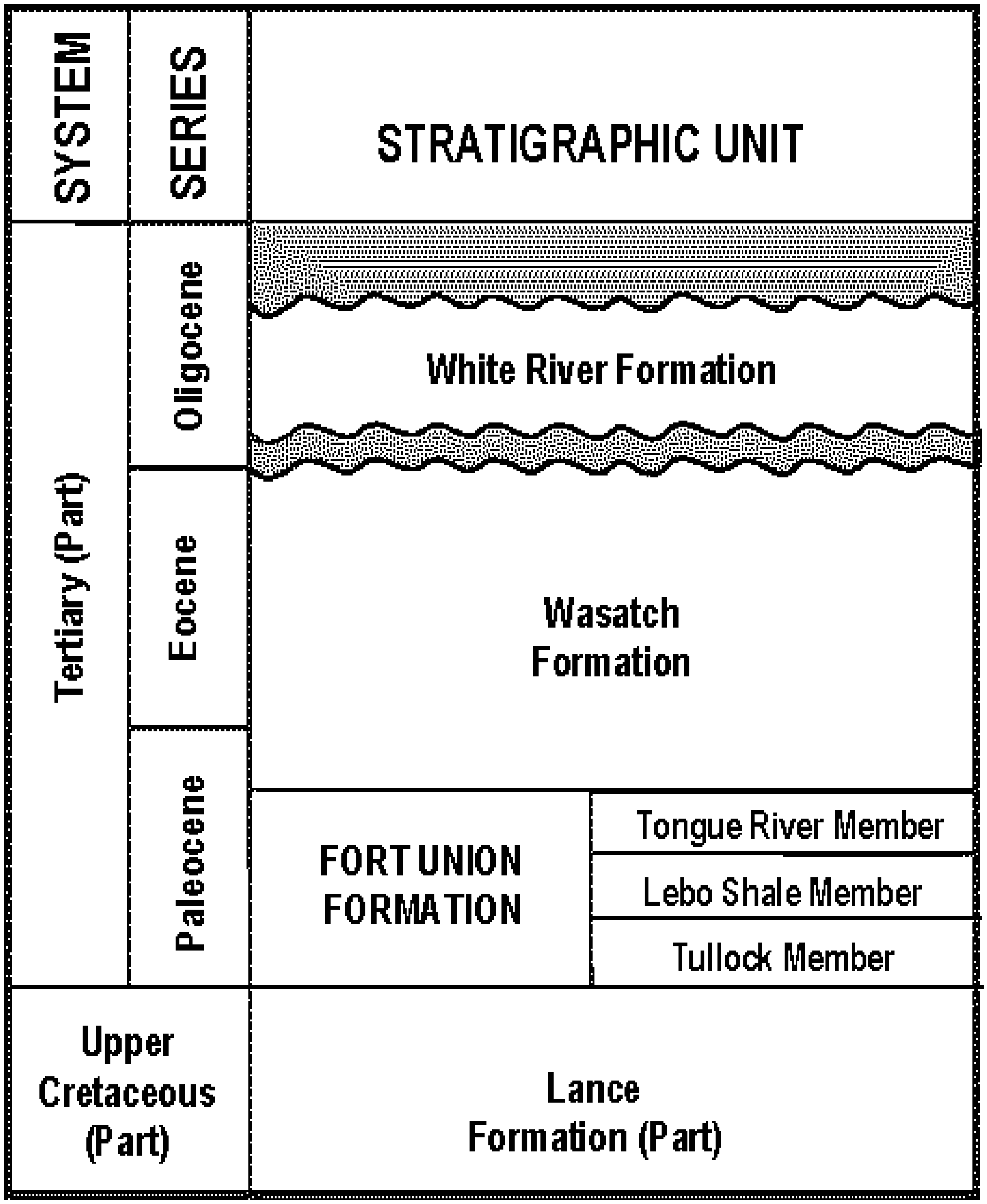

Figure 2.3-1 Powder River Basin regional shallow stratigraphy (DOE, 2002)

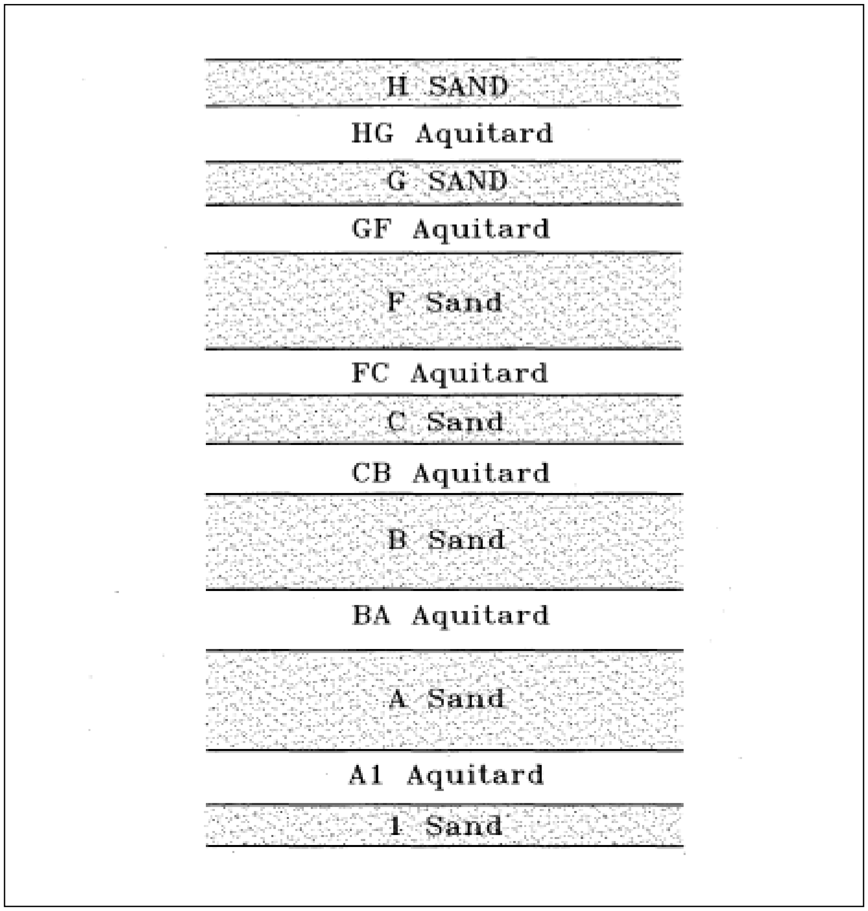

Figure 2.3-2 Nichols Ranch Unit generalized local stratigraphic column (adapted from Uranerz, 2007; not to scale)

Geological Section	Typical Thickness	Description
H Sand	20 feet	The first sand encountered at the site. It is not continuous and only exists in the northern part of the unit where it is exposed on the surface.
H-G Aquitard	20 feet	This layer is composed of a silt and mudstone. It is exposed on the surface where the “H sand” unit is absent.
G Sand	<100 feet	This sand is composed of three individual coarse grained sands which are discontinuous across license area and absent over large distances.
G-F Aquitard	20-185 feet	This layer is composed of siltstones and mudstones. It varies in thickness depending on the presence or absence of the “G sand.”
F Sand	15-50 feet	This sand is composed of three distinct sands which are fine to medium grained. It varies in thickness depending on the presence of these sands. It pinches out in the northern portion of the Nichols Ranch Unit.
F-C Aquitard	45-110 feet	This layer is composed of mudstones, siltstones, carbonaceous shales and coal.
C Sand	Variable (<20 ft)	This sand is described as a fine to very fine grained. It is discontinuous and was only present over a short distance on the east limb cross section A-A’ and not at all on the west limb shown on cross section K-K’. It did not appear on cross sections L-L’ and M-M’ and was only present on a small part of cross section B-B’.
C-B Aquitard	Variable (depends on C sand presence)	This layer is composed of mudstones, thin siltstones and sandstones and carbonaceous shales.
B Sand	40-180 feet (Exhibit D5-13)	This is the first continuous sand above the ore zone shown on all of the cross sections. It is occasionally separated by lenses of mudstone, siltstone and carbonaceous shales which may extend horizontally for thousands of feet.
B-A Aquitard	10-130 feet (Exhibit D5-14)	Composed of mudstones and thin discontinuous siltstones. The shale is typically greater than 40 ft and thins to 10 ft in small areas in the southern tips of the east/west limbs of the ore body.
A Sand	40 -100 feet (Exhibit D5-15)	The ore zone sand which is continuous across the entire license area and is shown on all cross sections. The trend is thicker in the northern portions of the license area and thins to the south. The sand is described as fine to coarse grained. It is occasionally separated by lenses of siltstones and mudstones.
A-1 Aquitard	20-80 feet (Exhibit D5-16)	Below the “A sand” is the lower mining zone aquitard or 1- A shale. It consists of mudstones and carbonaceous shales and typically greater than 40 ft thick.
1 Sand	< 5 feet (Exhibit D5-17)	The sand is very fine to coarse grained. It is missing or less than 5 ft thick over the majority of the license area.

Table 2.3-1 Geological Characterization of the Nichols Ranch Unit (prepared by NRC staff from information provided in the application)

2.3.3.2.2 Hank Unit License Area

The applicant provided the local geology for the Hank Unit in six different application cross sections (C-C’, D-D’, F-F’, G-G’, H-H’, and J-J’) in Exhibits D5-3 through D5-9 and isopachs in Exhibits D5-17A through D5-24. Cross section C-C’ transects the entire length of the license area north to south along the axis of the ore body. Cross sections D-D’, G-G’, and H-H’ transect west-east in various locations. Cross section F-F’ transects north to south to the west of the ore body. The staff evaluated the geology of the proposed license area and the cross sections and isopachs provided by the applicant, as shown in Table 2.3-2. No faults or fracturing were observed on the cross sections or noted in any descriptions at the Hank Unit. No underground mine works were identified. The alternating sand, silt, siltstone, clay layercake geology and lack of faulting and underground mine works are consistent with the NRC staff's historical knowledge of the geology of the PRB associated with historical and current uranium ISR projects. The staff finds the assessment of regional and site geology to be acceptable, as the information provided in the application is consistent with the acceptance review criteria in SRP Section 2.6.3.

Geological Section	**Typical Thickness**	**Description**
J Sand	10–30 feet	The sand is composed of two thin sands. It is located only in the central portion and the southern tip of the ore body as shown in cross sections C-C' and D-D'.
J-H Aquitard	25–90 feet	This layer is composed of mudstones. It is exposed on the surface over much of the Hank Unit license area.
H Sand	50–170 feet	This sand is continuous and composed of up to four individual sands. It is exposed on the surface over large portions of the license area.
H-G Aquitard	30–125 feet (Exhibit D5-17A)	This layer is composed of mudstones and siltstones.
G Sand	10–50 feet (Exhibit D5-18)	This is the first sand overlying the ore zone. The cross sections for the Hank Unit show that it is composed of three thin sands which join and separate and are not continuous across the license area.
G-F Aquitard	10–130 feet (Exhibit D5-19)	This layer is composed of mudstones and is typically about 50 ft in thickness.
F sand	20–120 feet (Exhibit D5-20)	This sand hosts the uranium ore zone. It is shown as being continuous across all cross sections. The uranium mineralization occurs in two stacked roll fronts, the upper and the lower front.
F-C Aquitard	30–100 feet (F to C shale in Exhibit D5-21)	This shale is present in the northern half of the license area where the C sand is present. It separates the F sand ore zone from the underlying C sand. It is composed of mudstones, siltstones, carbonaceous shales, and coal.
C sand	10–60 feet (Exhibit D5-22)	The C sand is discontinuous. It is present in the northern half of the license area. It is absent in the southern half of the license area.
C-B Aquitard	30–90 feet (B to C shale in Exhibit D5-23)	When the C sand is present in the northern half of the license area, this shale separates the C sand from the underlying B sand.
F-B Aquitard	30–170 feet (B to F shale in Exhibit D5-23)	When the C sand is absent in the southern half of the license area, the B to F shale separates the F sand ore zone from the underlying B sand.
B sand	70–180 feet (Exhibit D5-24)	The B sand is very thick and continuous across the entire license area.

Table 2.3-2 Geological Characterization of the Hank Unit (prepared by NRC staff from information provided in the application)

2.3.3.3 Mineralogy

The applicant reported that the ore bodies in the “A sand” at the Nichols Ranch Unit and “F sand” at the Hank Unit are typical roll front deposits. The Nichols Ranch Unit is composed of an east limb and a west limb connected at a northern point, forming a wishbone shape, while the Hank Unit is a long, single unit that stretches north to south. Both deposits have at least two vertically stacked roll fronts that formed as the result of small differences in sandstone conductivity. The lateral distances between the stacked roll fronts are highly variable and range from 0 to 61 m (0 to 200 ft) (Uranerz, 2007).

The applicant described the mineralization of the ore bodies at both units as amorphous uranium oxide, sooty pitchblende, and coffinite. Uranium is deposited on individual sand grains, within minor authigenic clays in the void spaces. Authigenic clays are those formed in situ by precipitation or recrystallization instead of being transported from elsewhere by water or wind. Host sandstones are composed of quartz, feldspar, biotite, mica, and carbon fragments, and the sandstones are weakly consolidated and friable. Minerals contained in the sandstones include pyrite, calcite, and the clay minerals montmorillonite and kaolinite. The NRC staff finds this description consistent with general scientific and uranium industry knowledge of the formation and occurrence of uranium roll front deposits in the PRB.

2.3.3.4 Exploration Boreholes

The applicant reported that a total of 546 abandoned drill holes were located within the Nichols Ranch ISR Project boundaries. In the Nichols Ranch Unit and Hank Unit, 103 and 218 boreholes were abandoned by companies other than the applicant, respectively. The applicant stated that holes drilled from 1997–2007 were plugged in accordance with current State of Wyoming regulations, and, to the best of its knowledge, boreholes drilled before 1997 were also plugged in accordance with regulations in effect at that time. The applicant provided the locations of all known abandoned drill holes in four tables in Volume VI, Appendix D6, and in application Exhibits D6-7 and D6-8 and cited the information used to identify the locations of the exploratory drill holes.

The applicant stated that in its experience drilling holes in the license area in 2006, 2007, and 2008, it had found that the exploration drill holes tended to seal themselves with the natural swelling of the subsurface clays. The staff does not dispute the applicant’s experience with natural swelling of subsurface clays and notes that clays with high swelling capacity have been reported in the PRB (USGS, 2006). However, the applicant committed in application Sections 2.7.5 and 7.5.7 to reenter, plug, and abandon any improperly plugged boreholes it discovers by pumping tests or other methods. The staff finds the assessment of the location and plugging of exploratory boreholes and the commitment to take corrective action if any improperly plugged holes are located to be acceptable.

2.3.3.5 Seismology

The applicant provided the basic seismologic characterization of both Campbell and Johnson Counties in two separate reports prepared by Case et al. (2002) for the Wyoming State Geological Survey. Application Addendum 2D includes these reports. Reports provided the historical seismology for Campbell and Johnson Counties and the magnitude, date, and location of all known seismic events. Five magnitude 2.5 and greater earthquakes have been recorded in Campbell County. The largest earthquake occurred on May 29, 1984, and was a magnitude 5.0, intensity V earthquake. In Johnson County, eight magnitude 2.5 or greater earthquakes have occurred, with the largest occurring on September 7, 1984; this measured magnitude 5.1, intensity V.

No active faults with surface expression are known to be in Campbell County where the Nichols Ranch ISR Project is located, so no fault-specific analysis was possible (Case et al., 2002). An active fault system called the Cedar Ridge/Dry Fault system is present on the southwestern border of Johnson County. The report stated that there is no compelling evidence that the Dry Fork fault is active, but if it became active, it is estimated it could produce a magnitude 6.7 earthquake (Case et al., 2002). This could create an acceleration of up 0.12g (acceleration due to gravity) at the southwestern corner of Johnson County. Minor damage would occur in the southwestern portion of the county. The Cedar Ridge fault is also thought to be inactive. Because of the fault's distance from Johnson County, Uranerz stated that an earthquake of this intensity is unlikely to cause any damage if it were to occur. Staff agrees with this assessment.

Floating or random earthquakes were analyzed in the report (Case et al., 2002), which indicated that the largest random flowing earthquake for the province where Campbell and Johnson Counties are located would have an average magnitude of 6.25. If this earthquake occurred within 15 km (9.3 mi) of any structure in Campbell or Johnson County, it could create an acceleration of 0.15 g, which is an intensity VI earthquake. Such earthquakes cause light to moderate damage.

Wyoming Geological Survey reports, provided by the applicant, show recent U.S. Geological Survey (USGS) probabilistic acceleration maps for Wyoming published in 2000, which display the 500-, 1,000-, and 2,500-year probabilistic accelerations for Wyoming. According to these maps, damage expected from earthquakes using these probabilities in the Nichols Ranch ISR Project area would be in the range of intensity V–VII. These intensity levels would result in light to moderate damage in either license area. The staff finds the applicant's assessment of the seismology to be acceptable as its analysis is supported by published studies and the information provided in the application is consistent with the acceptance criteria in SRP Section 2.6.3.

2.3.3.5 Soils

The applicant described soils occurring in the Hank and Nichols Ranch Units as generally fine-textured throughout, with patches of sandy loam on upland areas and fine-textured soils occurring in or near drainages. The project area contains deep soils on lower toe slopes and flat areas near drainages with shallow and moderately deep soils located on upland ridges and shoulder slopes (Uranerz, 2007).

In application Appendix D-7, the applicant presented detailed soils information including a literature review, results and interpretations of the soil surveys, analytical results of soil sampling, and an evaluation of soil suitability as a plant growth medium. Application Appendix D-7 also includes references to Natural Resources Conservation Service (NRCS) farmland surveys and includes soil maps of the proposed project area. The staff finds the applicant's assessment of soils acceptable as it is supported by published studies and maps produced by NRCS.

2.3.4 Evaluation Findings

The staff has completed its review of the site characterization information addressing geology and seismology at the Nichols Ranch ISR Project in accordance with SRP Section 2.6.3. The applicant has adequately described the geology and seismology by providing: (1) a description of the local and regional stratigraphy, (2) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy, (3) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone, (4) a description of the local and regional geologic structure, (5) a discussion of the seismicity and seismic history of the region, (6) a generalized stratigraphic column that includes the thickness of rock units, a representation of lithologies, and a definition of mineralized horizon, and (7) a description and map of the soils.

Based on the review conducted by the staff as indicated above, the information provided in the application meets the applicable acceptance criteria of SRP Section 2.6.3 and 10 CFR 40.41(c).

2.3.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

Case, J.C., R.N. Toner, and R. Kirkwood, 2002. "Basic Seismological Characterization for Campbell County, Wyoming," September 2002.

DOE, 2002. "Powder River Basin Coalbed Methane Development and Produced Water Management Study," DOE Report No. DOE/NETL-2003/1184, Washington, DC, November 2002.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," June 2003.

Uranerz, 2007. Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming, ADAMS Accession Package No. ML080080594, November 30, 2007.

USGS, 2006. Fact Sheet 2006-3137, "Coalbed Methane Extraction and Soil Suitability Concerns in the Powder River Basin, Montana and Wyoming," November 2006.

2.4 Hydrology

2.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the characterization of surface and ground water hydrology at the Nichols Ranch ISR Project is sufficient to document the applicant's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.4.2 Regulatory Acceptance Criteria

Unless stated otherwise, the application was reviewed for consistency with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in SRP Section 2.7.3 (NRC, 2003).

2.4.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the surface water and ground water hydrology for the Nichols Ranch ISR Project. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff visited the site on several occasions during this review to confirm information presented in the application.

2.4.3.1 Surface Water

2.4.3.1.1 Nichols Ranch Unit

The applicant described the surface water hydrology for the proposed Nichols Ranch Unit. The majority of the Nichols Ranch Unit license area lies within the Cottonwood Creek drainage, which covers 208 km^2 (80.2 mi^2) (SER Figure 2.4.1-1). Cottonwood Creek is a tributary to the Dry Fork of the Powder River and flows from east to west through the southern portion of the license area and enters the Dry Fork about 0.81 km (0.5 mi) downstream of the project area. The northwestern corner of the license area lies within the Tex Draw drainage, which occupies 13.5 km^2 (5.2 mi^2). Tex Draw flows from the northeast to the southwest, north of the license area. Tex Draw is also a tributary to the Dry Fork of the Powder River and enters Dry Fork about 3.2 km (2.0 mi) downstream of the license area. Powder River is a tributary of the Yellowstone River (Uranerz, 2007).

The applicant defined six smaller drainage basins numbered by the applicant as NDA1 through NDA6 (presumably NDA is an acronym for Nichols Drainage Area, but this term is not defined by the applicant) in the Nichols Ranch Unit license area as shown in application Figure 2-15. Each of these drainage areas has an ephemeral stream that is a tributary of Cottonwood Creek. Tributaries in NDA2, NDA3, and NDA4 cross the planned well fields flowing from northeast to the southwest.

The applicant reported that Cottonwood Creek, Tex Draw, and the smaller tributaries in the license area are all classified as ephemeral streams that flow only in response to heavy snowmelt and large rainfall events. Peak flows were estimated for recurrence intervals of 5, 10, 25, 50, and 100 years for the Cottonwood Creek and Tex Draw using the methods of Lowham (1976), which were developed for and are suited to drainages of this size. The peak flows were also estimated for all of the smaller drainage areas using the method of Craig and Rankl (1978). This method was devised using field data from small drainages in Wyoming to develop empirical relationships to assess peak flow rates. The NRC staff finds methods developed from empirical data measured in similar drainages to provide the best estimate for these types of small drainages. SER Table 2.4.1-1 shows the peak rate values from these calculations. Staff reviewed the values provided by the applicant and agrees with the calculations and the methodology used.

The applicant estimated peak velocities in the drainages for the Nichols Ranch Unit license area based on the 25-year peak flow rate. It reported these values in application Table D6-1 in Appendix D6; the values ranged from 2.2 to 3.7 meters per second (mps) (7.2 to 12.1 ft per second [fps]). In application Figure 2-15a, the applicant provided a map of the areas anticipated to be flooded in the Nichols Ranch Unit license area for a 25-year event. This figure shows floodwater covering the lower tip of the west limb of the ore body. This floodwater may inundate any well field in the lower portion of the license area. The applicant predicted that flow in the smaller tributaries within the license area will be confined to the channels, which are incised.

The CPP, also shown in application Figure 2-15a, is located in the middle of the license area north of the region that is anticipated to be flooded by Cottonwood Creek. Although the CPP is not within the flood zone, the staff notes that it could be subjected to surface sheet flow, which is surface water flow not in a defined channel. The applicant committed in application Section 2.4.1.2 to installing a ditch and berm on the upgradient side of the CPP, which will be able to convey waters from a 25-year event away from the plant. Staff agrees that installation of a ditch and berm will stop or minimize potential sheet flow flooding and water damage to the CPP. The staff finds that the applicant has sufficiently described the potential for flooding at the Nichols Ranch Unit by using the appropriate methods.

The applicant recognized that the magnitude of the peak flows and velocities for the tributaries that cross the well fields in the Nichols Ranch Unit license area may present an erosion risk to the site and damage the well field infrastructure. The applicant committed in application Section 2.7.1.2 to minimizing damage from erosion and to well field infrastructure from peak flow events by avoiding well installation in the ephemeral drainages. If such wells must be installed, appropriate erosion protection controls will be applied to minimize damage to the drainage. Controls include grading and contouring, culvert installation, low-water crossing constructed of stone, water contour bars, and designated traffic routes. If wells are to be placed near a stream, appropriate well and wellhead protection will be used. The protective measures will include barriers surrounding the well, such as cement blocks, protective steel casings, and other measures. The applicant committed in application Section 2.7.1.2 to using these practices for any wells or infrastructure to be located in the 25-year flood plain of Cottonwood Creek shown in application Figure 2-15a. Additionally, the applicant committed to protecting embankments, culverts, and drainage crossings with best management practices such as rip rap and rock, in accordance with of WDEQ, Land Quality Division (LQD), Chapter 3 Rules and Regulations (2006). Staff finds the application of erosion control best management practices using WDEQ regulations acceptable.

The applicant stated that CBM production has occurred and will continue in the Nichols Ranch Unit license area. It provided the location of permitted CBM outfalls and impoundments within the Nichols Ranch Unit license area within a 1.6-km (1-mi) radius in application Exhibit 2-3 and Table 12-2 b. Application Table 12-2d provides effluent water quality limits for each of these permits. The staff notes that CBM-produced water may contain chemical constituents similar to those found in uranium production processes.

The CBM outfall and impoundment location map in application Exhibit 2-3 shows five active permits with multiple CBM-produced water outfalls located in this area. The applicant stated that discharge to surface water drainages has occurred at only 5 of the 17 permitted outfalls. The staff reviewed application Exhibit 2-3 and noted that all of these active outfalls are currently located outside and hydrologically downgradient of the Nichols Ranch Unit license area. Therefore, these CBM outfalls are unlikely to have affected the surface water quality at the site.

All the remaining CBM outfalls are associated with impoundments that are designed to infiltrate to ground water and prohibited from direct discharge to surface water drainage. Two impoundment outfalls, identified under permit WY 0056502 as 002 and 003, which have not received discharge, are located upgradient of the site on the NDA6 surface water drainage. As NDA6 is a tributary to Cottonwood Creek, these impoundments may have an impact on surface water quality in Cottonwood Creek if they overflow during significant runoff events.

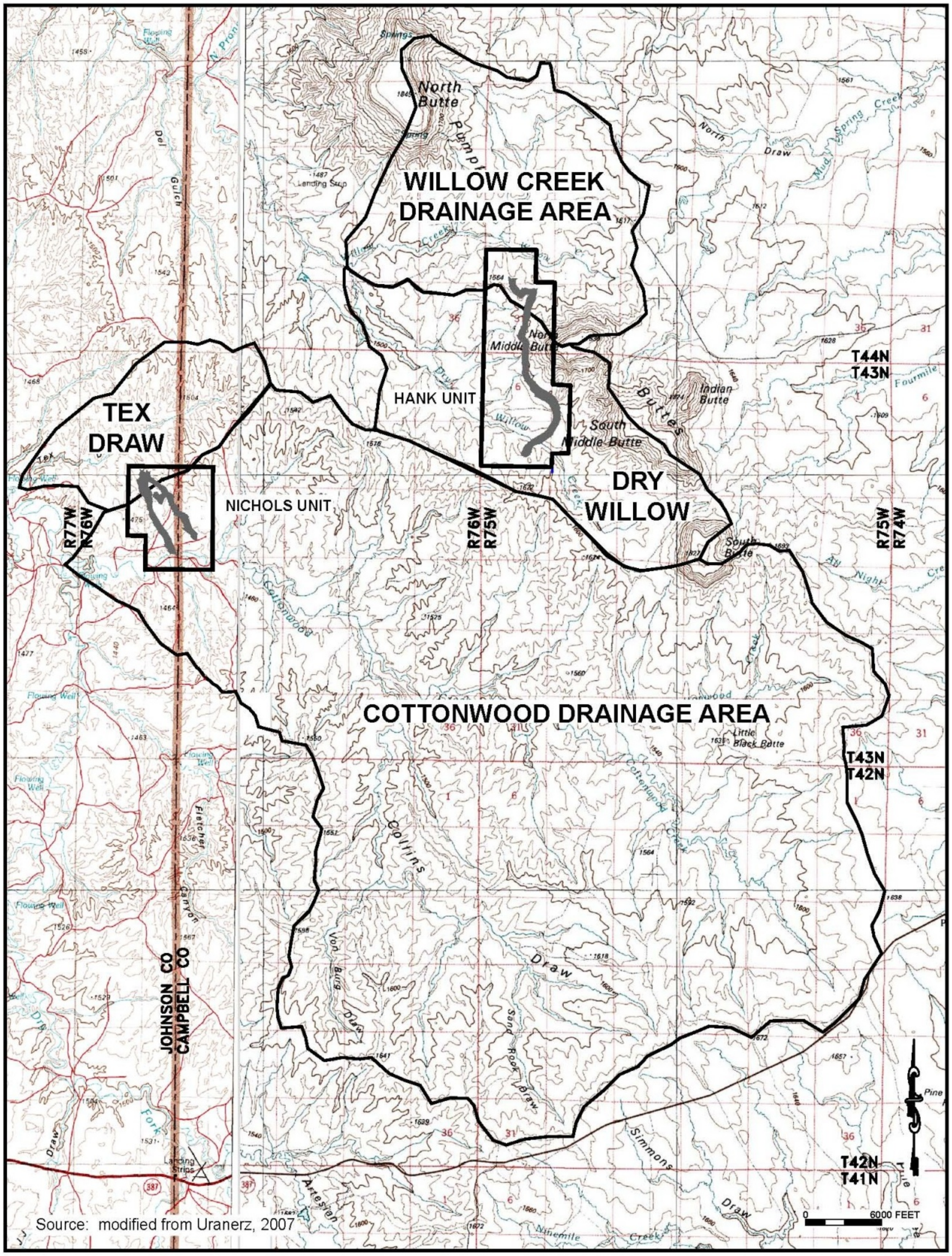

Figure 2.4.1-1 Nichols Ranch Unit and Hank Unit drainage areas

Table 2.4.1-1 Peak Flood Discharge Estimates for Specific Recurrence Intervals for Nichols Ranch Unit Drainages (adapted from application Table D6.1)

Drainage	Drainage Area (mi^2)	Craig and Rankl's Method (cubic feet per second [cfs])					Lowham (cfs)				
		5-year	10-year	25-year	50-year	100-year	5-year	10-year	25-year	50-year	100-year
Cotton-wood Creek	80.2						1,220	2,150	3,760	5,420	7,500
Tex Draw	5.2						456	782	1,370	1,970	2,720
NDA1	0.25	85	122	177	224	277					
NDA2	0.33	101	145	212	271	337					
NDA3	0.24	83	119	172	218	270					
NDA4	0.3	96	137	199	254	315					
NDA5	0.65	153	223	332	429	541					
NDA6	3.2	407	611	950	1,268	1,648					

Impoundment Outfalls 004 and 006, also under permit WY0056502, and Outfall 024 under WY0055824 are also total containment impoundments. These CBM outfalls are located on drainages that discharge to Cottonwood Creek between the two surface water sampling points for Nichols Ranch Unit, which are located upgradient and downgradient of the license area. The staff observes that water may also enter Cottonwood Creek during significant rainfall events. However, impacts on surface water quality from the CBM outfalls should be unlikely because of the dilution from runoff. The applicant stated that the WDEQ permit and freeboard requirements for the impoundments should prevent any impacts on surface water quality in the license area or on Cottonwood Creek. The staff agrees with the applicant's statement about impacts on surface water quality in the license area and Cottonwood Creek because the surface water discharges from the CBM outfalls are regulated by the WDEQ and must meet the State's regulatory requirements.

2.4.3.1.2 Hank Unit

The Hank Unit lies within the Dry Willow and Dry Willow Creek drainages, as shown in SER Figure 2.4.1-1. The Dry Willow drainage occupies 31.6 km^2 (12.2 mi^2) and discharges to Dry Willow Creek, which flows from the southeast to northwest, traversing the southern portion of the license area. It enters Willow Creek approximately 3.2 km (2 mi) west of the license area. The northern portion of the Hank Unit lies within the Willow Creek drainage which covers 34.2 km^2 (13.2 mi^2). It drains directly into Willow Creek, which flows from east to west through the northern portion of the license area. Willow Creek is a tributary of the Powder River and enters the Powder River approximately 26 km (16 mi) downstream of the Hank Unit (Uranerz, 2007).

The applicant described eight smaller drainage basins numbered HDA1 through HDA8 (presumably HDA is an acronym for Hank Drainage Area, but this term is not defined by the applicant) in the Hank Unit license area as shown in application Figure 2-15. Each of these drainages contains an ephemeral stream, which is a tributary to Dry Willow Creek in the south of the license area. Tributaries in HDA3, HDA4, HDA6, HDA7, and HDA8 cross the planned well fields flowing from east to west.

Willow Creek, Dry Willow Creek, and the smaller tributaries in the license area are all classified as ephemeral streams that flow only in response to heavy snowmelt and large rainfall events (Uranerz, 2007). The applicant estimated the peak flows for recurrence intervals of 5, 10, 25, 50, and 100 years for Willow Creek and Dry Willow Creek using the methods of Lowham (1976), which were developed for and are suited to drainages of this size. The peak flows were also estimated for all of the smaller drainage areas using the method of Craig and Rankl (1978). This method was developed using field data from small drainages in Wyoming to develop empirical relationships to assess peak flow rates. The NRC staff finds methods developed from empirical data measured in similar drainages to provide the best estimate for these types of small drainages. SER Table 2.4.1-2 shows these values. Staff reviewed the peak flow values provided by the applicant and finds that they have been acceptably described based on the acceptance criteria in SRP Section 2.7.3.

Peak velocities were estimated for the Hank Unit license area based on the 25-year peak flow rate. The applicant reported these values in application Table D6-1 in Appendix D6 for all of the streams, which ranged from 2.2 to 4.2 mps (7.2 to 13.8 fps). In application Figure 2-15b, the applicant provided a map of the regions anticipated to be flooded in the Hank Unit license area for a 25-year event. In Dry Willow Creek, Willow Creek, and all of the smaller tributaries within the license area, flow was predicted to be confined to the channels that are incised. Staff agrees with the applicant's assessment. The satellite facility, also shown in application Figure 2-15b, is located in the middle of the license area and is not shown to be flooded by any streams. The applicant committed to protecting the satellite facility from sheet flow by constructing a ditch and berm on the upside slope of the facility to allow sheet flow to drain around the structure.

The applicant recognized that the magnitude of the peak flows and velocities for the tributaries that cross the well fields in the Hank Unit license may present an erosion risk to the site. The forces resulting from these peak flows and velocities may damage well field infrastructure. The applicant committed to minimizing damage from erosion and to well field infrastructure from peak flow events by avoiding well installation in the ephemeral drainages. The applicant also stated that if it is necessary to install such wells, appropriate erosion protection controls will be applied to minimize damage to the drainage. These controls are the same as those discussed for the Nichols Ranch Unit in SER Section 2.4.3.1.1.

The applicant provided the location of permitted CBM facilities within the Hank Unit license area and within a 1.6-km (1-mi) radius of the license area in Exhibit 2-2 and Table 12-2a of the technical report. Application Table 12-2c provides effluent water quality limits for each of these permits. The applicant reported that discharge monitoring reports submitted to WDEQ showed no discharge at any of the outfalls through June 2008. Furthermore, according to application Section 2.7.2.4.1, the CBM operator at Hank Unit will not discharge any CBM water in the license area, but is instead pumping it off site for reinjection into a different underground formation at a site 56 km (35 mi) to the west of the site. The applicant could not provide assurance that this or any additional CBM operator will continue this practice for the lifetime of the Hank Unit; however, it stated in application Section 2.7.2.4.1 that it would notify the NRC

Table 2.4.1-2 Peak Flood Discharge Estimates for Specific Recurrence Intervals for Hank Unit Drainages (adapted from application Table D6.1)

Drainage	Drainage Area (mi^2)	Craig and Rankl's Method (cfs)					Lowham (cfs)				
		5-year	10-year	25-year	50-year	100-year	5-year	10-year	25-year	50-year	100-year
Dry Willow Creek	12.2						620	1,070	1,870	2,700	3,730
Willow Creek	13.2						638	1,100	1,930	2,780	3,840
HDA1	0.12	55	77	109	136	166					
HDA2	0.4	114	164	241	309	385					
HDA3	0.25	85	122	177	224	277					
HDA4	0.48	127	184	272	350	438					
HDA5	0.34	103	148	216	277	344					
HDA6	0.81	175	256	384	499	631					
HDA7	0.49	129	187	275	354	444					
HDA8	0.2	75	106	152	193	237					

if any new CBM ponds or basins are installed in, or within 0.4 km (0.25 mi) of, the Hank Unit. The staff finds the applicant's description of surface water acceptable, as it addresses the issue of potential flooding in the Hank Unit and is consistent with acceptance criteria found in SRP Section 2.7.3.

2.4.3.2 Ground Water

2.4.3.2.1 Regional Hydrogeology

The Nichols Ranch Unit license area is located in the south-central PRB. General stratigraphy is described and shown in SER Section 2.3. Regional geologic structure is marked by the Pumpkin Buttes to the east and a gentle dip of interbedded sedimentary units to the southwest toward the basin axis. The highest regional aquifers are found in the Wasatch Formation, which is also the host formation for the uranium deposits. Ground water in the Wasatch flows to the north and northwest. Underlying the Wasatch are aquifers in the sandstones and coal seams of the Fort Union Formation, and flow in these aquifers is also generally to the north and northwest. Underlying the Fort Union is the Lance Formation, which is composed of very fine to fine-grained sandstone, shale, and coal beds. Ground water flow direction in the Lance Formation is to the north. The Fox Hills sandstone is located below the Lance and is composed of fine- to medium-grained sandstone.

2.4.3.2.2 Nichols Ranch Unit Site Hydrogeology

The applicant conducted a site investigation at the Nichols Unit to develop an understanding of the hydrogeology. The investigation included drilling of exploration borings, installation of monitoring wells, and measurement of hydrogeologic properties within the different aquifers.

The results of the site investigation formed the basis of the applicant's understanding of the Nichols Unit.

The applicant reported, based on its field investigations, that the surficial aquifer in the Nichols Ranch Unit license area varies with location as defined by the shallow well water levels shown in application Figure D6-7a. In the northern portion of the license area, the applicant estimated that the surficial aquifer is located in the "G sand" at a depth of 15 to 30.5 m (50 to 100 ft) bgs. In the middle portion of the license area, the surficial aquifer is located in the "F sand," at 15 to 30.5 m (50 to 100 ft) bgs. In the southern portion of the license area, the surficial aquifer is the Cottonwood Alluvial Aquifer, located around 3 m (10.0 ft) bgs, which is hydraulically connected to Cottonwood Creek.

The applicant reported that the next aquifer encountered in the license area is the "C sand," which is missing or very thin over most of the license area. Below the "C" sand is the "B sand," which the applicant identified as the overlying aquifer to the ore zone. Only one well, URZNB-1, is located in the "B sand" within the Nichols Ranch Unit license area. The applicant provided the temporal variation in water level in this well in Figure D6D.1-1 in the application. The staff reviewed application Figure D6D.1-1 and notes that the water level was shown to be steady over numerous measurements collected from the end of 2006 till the beginning of 2010.

The applicant provided a potentiometric surface for the "B sand" for the entire Nichols Ranch ISR Project area in Figure D6-6c in the application. The potentiometric surface is equivalent to the ground water hydraulic head. The ground water hydraulic head is the water level that is measured in a well. The staff observes that this potentiometric surface is of limited value in determining the ground water flow direction and magnitude in the "B sand" in the Nichols Ranch Unit. This is because Figure D6-6c is based on only one measured value. The NRC requires at least three measured values to map out a potentiometric water-level surface which can be used to calculate the ground water flow direction. However, the applicant has committed to providing the first well field production area pump test report for the Nichols Ranch Unit for NRC review and approval as discussed in SER Section 5.7.8.4. This report will include the potentiometric surface of the "B sand" defined after further well installation and testing.

The applicant reported that below the "B sand" aquifer is the "A sand" aquifer, which is the ore zone in the Nichols Ranch Unit license area. The applicant used seven wells (MN-1, MN-2, MN-3, MN-4, MN-5, MN-6, and Nichols 1), shown in SER Figure 2.4.2-1, to measure water levels in the "A sand." Water levels in the "A sand" demonstrate that the aquifer is a confined (saturated) aquifer, with a potentiometric surface rising approximately 122 m (400 ft) above the top of the sand. Based on the potentiometric contours, the applicant reported the ground water flow direction in the "A sand" is to the northwest with a gradient of 0.0033. Application Figures D6D.1-1 and D6D1-2 show the variation in water level over time for these wells. The staff reviewed these figures, which indicate that the water levels were relatively steady over the period from late 2006 to the beginning of 2010.

Below the "A sand" ore zone is a very thick clay confining layer. The applicant described the underlying aquifer below the clay layer at Nichols Ranch Unit as the "1 sand." According to the application, the "1 sand" is very discontinuous, which means the aquifer thins out and disappears in some locations. The applicant reported that it is missing or less than 1.5 m (5 ft) thick over the majority of the license area. The applicant used one well, URZN1-2, to measure water levels in the "1 sand" in the Nichols Ranch Unit license area. Values over time are reported in Table D6D1-1 and shown in application Figure D6D.1-1. The staff reviewed these figures, which demonstrate that the water levels were steady for the period from late 2006 to the beginning of 2010. The applicant provided a regional potentiometric surface for the “1 sand” across the entire Nichols Ranch ISR Project area in application Figure D6-6a. This potentiometric surface was based on measured values from three wells over an area of more than 560 km^2 (216 mi^2), which showed ground water flowing to the northwest with a gradient of 0.0006. Based on the discontinuous nature of the “1 sand” in the license area, the staff concludes that the measurement of one well is not likely to be representative of the ground water flow across the region. However, the applicant has committed to providing the first production area pump test report for the Nichols Ranch Unit for NRC review and approval, as discussed in SER Section 5.7.8.4; the pump test report will include additional wells to describe the ground water flow of the “1 sand” after further well installation and testing.

The applicant did not describe any aquifers underlying the “1 sand.” However, it did provide a deeper cross section in application Exhibit D6-5 to show the relationship of the CBM production zone to the ore zone at the Nichols Ranch Unit. The staff reviewed this deeper cross section, which shows that the next aquifer would be located in the Fort Union sands. Based on a review of the deeper cross section, the staff concludes that the Fort Union Sands appear to be separated from the “1 sand” by a very thick shale layer.

The applicant provided a map of water wells within 0.81 km (0.5 mi) of the Nichols Ranch Unit license area, as shown in SER Figure 2.4.2-2. Application Table D6-2 provides completion data for these wells, including the aquifers in which they are screened. Based on a search of the water permit database of the Wyoming State Engineers Office for this area, the staff found that the majority of wells are stock wells or monitoring wells. No water wells permitted for domestic use are located within this 0.81-km (0.5-mi) boundary. The applicant also presented a map of all permitted wells within a 4.8-km (3-mi) radius in application Exhibit D6-1 and the associated ground water permits in application Table D6G.1-2. According to the table, the majority of wells are stock or monitoring wells. Two domestic wells, Doughstick #3 and Garden Well, are located approximately 3.2 km (2 mi) southeast of the license area. One other domestic well, Dry Fork #1, associated with a residence at Dry Fork Ranch, is located approximately 1.6 km (1 mi) to the west of the license boundary. The depth of this well is unknown.

The applicant conducted nine single-well and three multiwell pumping tests across the Nichols Ranch Unit license area to determine the hydraulic characteristics of the site aquifers. SER Table 2.4.2-1 presents the results from the single-well tests. The applicant also conducted three multiwell pumping tests at MN-1, MN-2, and MN-6 in the Nichols Ranch Unit license area. Results are shown in SER Tables 2.4.2-2, 2.4.2-3, and 2.4.2-4, respectively. The applicant later conducted two multiwell pumping tests at wells URNZA-7 and URNZA-9 in 2010; Table 2-15 of the revised application shows the results of these tests.

The first test was conducted at pumping well MN-1 for 3 days, with three “A sand” observation wells and one underlying “1 sand” and one overlying “B sand” monitoring well. Observation wells in the “A sand” responded at distances of 579 to 732 m (1,900 to 2,400 ft) from the pumping wells; however, overlying and underlying monitoring wells located near the same location showed no response. A second test was conducted at MN-2 for 3 days, with one “A sand” observation well and one underlying “1 sand” well and one overlying “B sand” well. No response was noted at either the underlying or overlying monitoring wells. A third test occurred at MN-6, with three observation wells in the “A sand.” Transmissivity ranged from 4,184 to 4,769 Lpd/m (Liter per day/m) (337 to 384 gpd/ft (gallon per day/ft) and the storage coefficient from 2.8×10^{-5} to 1.5×10^{-4}. The results of the latest 2010 pumping tests provided similar values for transmissivity and storage coefficient of the “A sand.” Based on these initial pumping test results, the staff concludes that sufficient communication exists across the “A sand” ore zone, and no communication with the underlying or overlying aquifers exists in the Nichols Ranch Unit license area.

The applicant evaluated the potential for vertical flow between the ore zone “A sand” and the overlying and underlying aquifers in the Nichols Ranch Unit license area using field data it collected on water levels, pumping tests, and measurements of permeability from cores. It reported that the potentiometric head in the “A sand” is 4.3 m (14 ft) higher than in the overlying “B sand” at well MN-1. This head difference creates an upward gradient of 0.06 across 21.3 m (70 ft) of the overlying B-A aquitard at this location. Head in the underlying “1 sand” is 4.6 m (15 ft) less than in the “A sand” at this location. This creates a downward gradient of 0.09 across the underling A1 aquitard. The applicant reported that measured and estimated vertical permeabilities of the aquitards in and near the license area ranged from 6.9 $\times 10^{-8}$ centimeters per second (cm/s) (2.3 $\times 10^{-9}$ feet per second [ft/s]) to 3.8$\times 10^{-8}$ cm/s (1.2 $\times 10^{-9}$ ft/s) which are sufficient to minimize vertical movement of water. The staff concludes that the presence of the vertical gradient across the overlying and underlying aquitards, the low vertical permeabilities, and lack of response of the overlying and underlying aquifers during pumping tests demonstrate confinement of the ore zone by the overlying and underlying aquitards in the Nichols Ranch Unit license area.

The applicant also used its knowledge of the site to evaluate the impact of CBM water production from a deeper coal seam aquifer in the license area on the vertical gradients in the proposed ore zone. The top of the CBM production zone in the Nichols Ranch Unit is located approximately 233 m (765 ft) below the base of the “A sand” ore zone. In the Hank Unit, the base of the “F sand” to the top of the coal is 354 m (1,160 ft). Based on the applicant’s comprehensive analysis of BLM-measured drawdowns in overlying sands to the CBM zone near the license area and using a widely accepted USGS MODFLOW model (Harbaugh, 2005) of the site using 13 layers stressed with CBM production over 20 years, the applicant demonstrated to the staff’s satisfaction that the drawdown in the CBM zone will not impact water levels in the overlying ore zone unless there are artificial hydraulic connections, such as old improperly abandoned wells that may allow water to move from one unit to another.

The applicant has investigated the potential for the presence of artificial hydraulic connections between aquifers. It identified several exploratory borings and permitted wells which extended to depths great enough to penetrate the coal seams in and around the Nichols Ranch Unit as shown on application Figure D6-8a. The applicant reported that no open historic drill holes have been found during drilling and drilling reclamation in the Nichols Ranch Unit license area. Additionally, the applicant stated that there has not been any evidence of a hydraulic connection between aquifers during pumping tests or in reviews of historic versus current water levels. The applicant noted that historic drill holes were abandoned and released by the WDEQ, so it can be assumed that they were properly abandoned according to the rules and regulations in place at the time. Staff agrees with the applicant’s assessment.

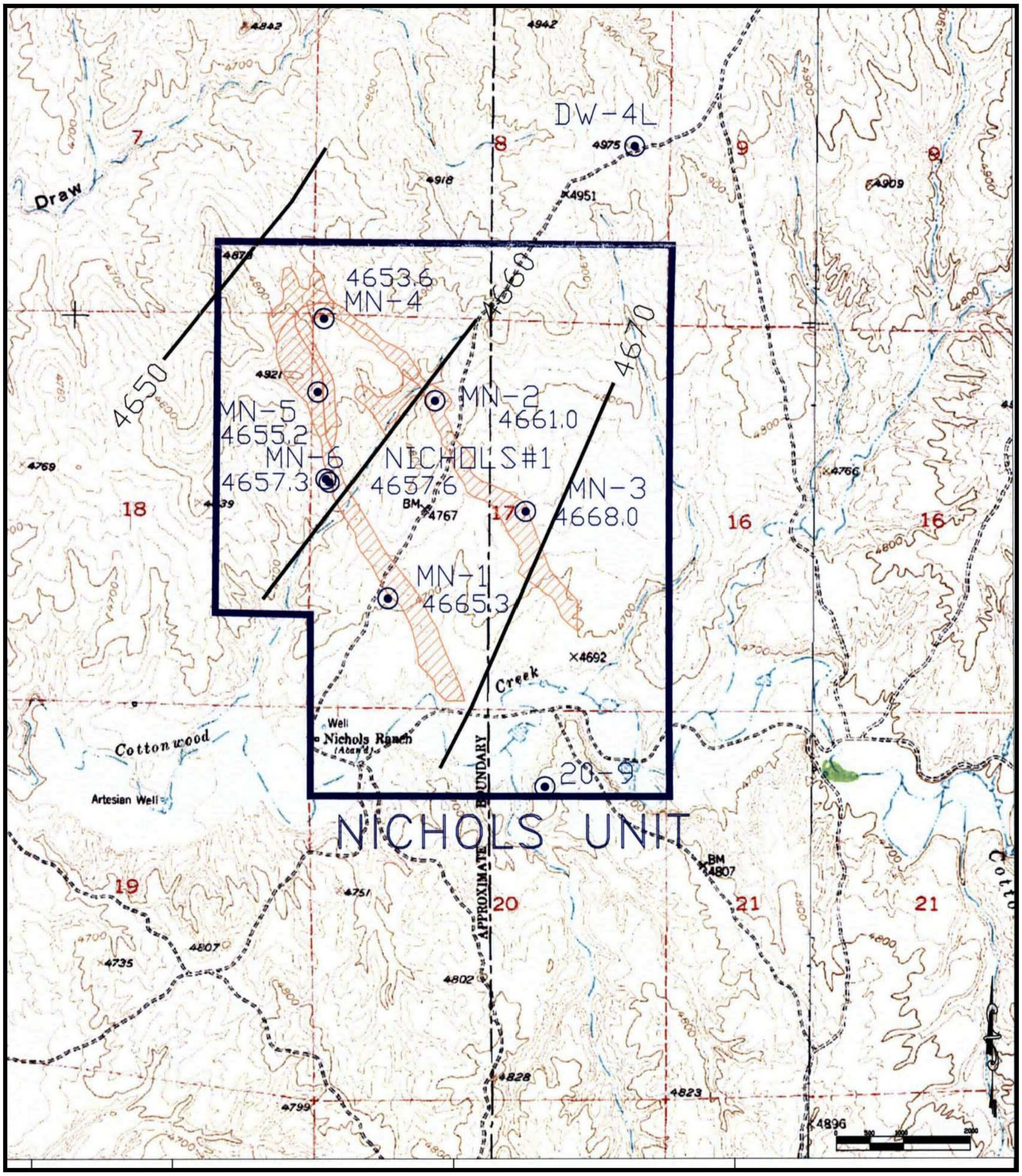

Figure 2.4.2-1 Potentiometric surface in the Nichols Ranch Unit "A sand" aquifer in 2008 (modified from application Figure D6-5)

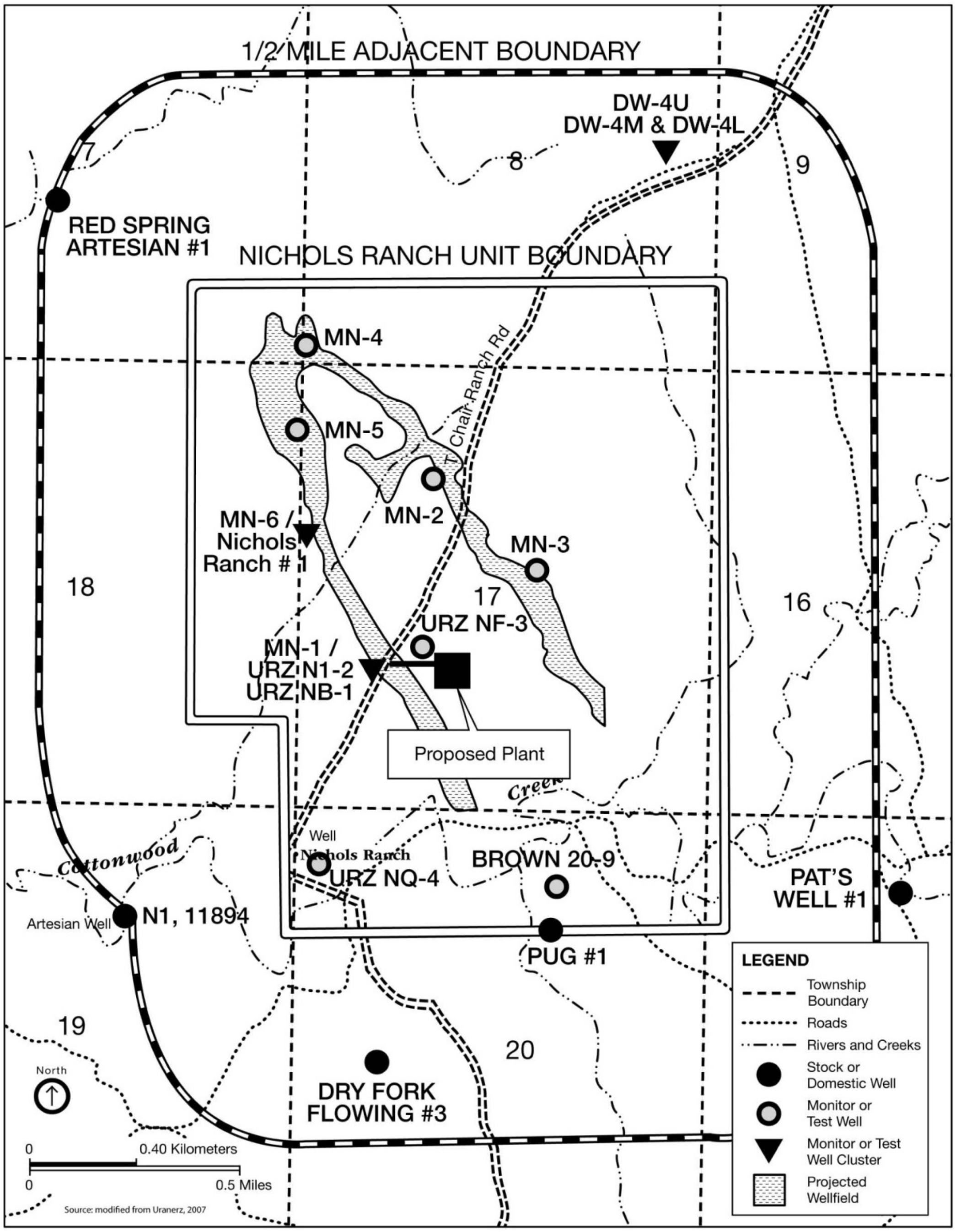

Figure 2.4.2-2 Water wells within a 0.81-km (0.5-mi) boundary of the Nichols Ranch Unit (modified from application Figure 2-17)

Table 2.4.2-1 Uranerz Nichols Ranch Unit Single-Well Pumping Tests

Test No.	Start Date	Well	Aquifer	Time (days:hr:min)	Flow (gpm)	Well Drawdown (ft)	T (gpd/ft)	K (ft/day)
1A	3/27/07	MN-1	A	0:20:21	14.5	87.34	453	No Response (NR)
1B	5/2/07	MN-1	A	0:3:47	11.1	NR	276	0.65
2	4/18/07	MN-3	A	0:2:40	11.0	23.63	465	0.57
3	7/10/07	MN-4	A	0:2:49	6.3	34.18	308	0.65
4A	5/14/07	MN-5	A	0:2:58	2.8	17.04	747	NR
4B	5/30/07	MN-5	A	0:3:36	5	33.69	357	0.41
5A	5/14/07	DW-4U	F	0:0:52	7.2	8.31	1360	3.6
5B	5/17/07	DW-4U	F	0:4:45	10.0	13.15	1470	NR
6	5/17/07	DW-4M	C	0:3:43	1.3	44.7	45	0.099
7	11/2/78	DW-4L	A/1	0:3:18	4.2	61.49	101	0.18
8A	3/21/07	URZNB-1	B	0:4:47	5.1	69.55	306	NR
8B	5/30/07	URZNB-1	B	0:3:36	NR	71.56	174	0.18
9A	3/23/07	URZN1-2	1	0:8:03	3	82.59	105	NR
9B	6/04/07	URZN1-2	1	0:10:45	2.8	81.11	73	0.26

Table 2.4.2-2 Uranerz Nichols Ranch Unit Multiwell Pumping Test at MN-1

Well	Type	Aquifer	Time (days:hr: min)	Flow (gpm)	T (gpd/ft)	S	Well Draw-down (ft)	Distance to Pumping Well (ft)
MN-1	Pumping	A	3:4:51	4.9	355	Not applicable (NA)	92.72	0
Nichols 1	Observation (OBS)	A	3:4:51	NA	631	$1.7x10^{-4}$	3.31	1,920
MN-2	OBS	A	3:4:51	NA	1,034	$1.4x10^{-4}$	1.77	2,400
MN-3	OBS	A	3:4:51	NA	1,095	$1.2x10^{-4}$	3.19	2,401
URZN1-2	Underlying OBS	1	3:4:51	NA	NA	NA	NR	NR
URZNB-1	Overlying OBS	B	3:4:51	NA	NA	NA	NR	NR

Table 2.4.2-3 Uranerz Nichols Ranch Unit Multiwell Pumping Test at MN-2

Well	Type	Aquifer	Time (days:hr:min)	Flow (gpm)	T (ft^2/d)	S	Well Drawdown (ft)	Distance to Pumping Well (ft)
MN-2	Pumping	A	3:0:15	4.9	196	NA	91.5	0
MN-1	OBS	A	3:0:15	NA	588	$1x10^{-4}$	1.02	2,400
URZN1-2	Underlying OBS	1	3:0:15	NA	NA	NA	NR	NR
URZNB-1	Overlying OBS	B	3:0:15	NA	NA	NA	NR	NR

Table 2.4.2-4 Uranerz Nichols Ranch Unit Multiwell Pumping Test at MN-6

Well	Type	Aquifer	Time (days:hrs:min)	Flow (gpm)	T (gpd/ft)	S	Well Draw-down (ft)	Distance to Pumping Well (ft)
MN-6	pumping	A	3:3:28	14.1	346	NA	73.33	0
Nichols1	OBS	A	3:3:28	NA	384	$3.1x10^{-5}$	30.78	65.6
MN-5	OBS	A	3:3:28	NA	620	$1.5x10^{-4}$	3.83	1,150
MN-2	OBS	A	3:3:28	NA	688	$3.8x10^{-4}$	2.18	1,250

2.4.3.2.3 Hank Unit Site Hydrogeology

The applicant conducted a site investigation at the Hank Unit to develop an understanding of the hydrogeology. The investigation included the drilling of exploration borings, installation of monitoring wells, and measurement of hydrogeologic properties within the different aquifers. The results of the site investigation formed the basis of the applicant's understanding of the Hank Unit.

The applicant reported that the surficial aquifer in the Hank Unit license area is located in the "H sand," a map of which was provided in application Figure 6-7b showing the depth to water to the "H sand" surficial aquifer. Water levels range from 15 to 61 m (50 to 200 ft) bgs, based on four wells, and generally follow the topographic surface. The applicant noted that the depth to water was less than 15 m (50 ft) south of the Hank Unit in the Dry Willow drainage and also to the north of the Hank Unit in the Willow Creek drainage north of the license area. The applicant reported that BLM monitors the wells in the alluvium in the Dry Willow Creek drainage to the west of the license area. These wells have been dry recently. An alluvial well in Willow Creek to the north of the license area was also dry. Based on the applicant's information, the staff finds that the applicant has demonstrated that the surficial aquifer is located in the “H sand” and no surficial aquifer is currently present in the alluvium at the Hank Unit.

The applicant stated that the next underlying aquifer is in the “G sand,” which is composed of three individual coarse-grained sands that are discontinuous across the Hank Unit license area and absent over large areas. The combined thickness of the sands is typically less than 30.5 m (100 ft) where they exist. The “G sand” aquifer is the overlying aquifer to the ore zone, except when absent. Two wells, URZHG-3 and URHZG-4, are completed in the “G sand” within the license area boundary. Two other “G sand” wells, BR-F and BR–H, are located north and northwest of the license area boundary. The applicant provided a map of water level contours for the “G sand” in the license area in application Figure D6-7c. The ground water direction is to the west in this aquifer, with a gradient of approximately 0.014.

Underlying the “G sand” is the “F sand,” which is the ore zone in the Hank Unit. The applicant measured water levels in 11 wells over time in the “F-sand.” Time series plots of some of the wells are shown in Figures D6D2-1 through D6D2-4 in the application from late 2006 to late 2009. The staff reviewed these figures, which demonstrate that water levels have remained steady. The applicant provided the water-level contours for the “F sand,” as shown in SER Figure 2.4.2-3. Based on the contours, the applicant estimated the gradient in the “F sand” to be 0.005 to the west. Water levels in the “F sand” fall below the base of the overlying G-F aquitard in the northern portion of the license area and are slightly above in the southern portion. The applicant stated that the “F sand” is both an unconfined (unsaturated) and confined (saturated) aquifer across the Hank Unit license area, and staff agrees with this assessment.

The applicant has shown that the underlying aquifer to the “F sand” ore zone is in the “C sand,” which is separated from the “F sand” by siltstones and mudstones and is thin and missing over large areas. Where the “C sand” does not exist, the “B sand” aquifer is the underlying aquifer. One well is completed in the “C sand,” and seven wells are completed in the “B sand.” Water levels measured in both aquifers are presented in Figures D6D2-1 through D6D2-4 in the application, which indicate that water levels have remained steady from late 2006 through late 2009. The applicant presented potentiometric contours for the B and C sands in application Figure D6-7. The applicant’s contours indicate ground water flow to the west and northwest across the Hank Unit at a gradient of approximately 0.005. Staff finds the applicant’s assessment acceptable.

The applicant did not provide a description of any underlying aquifers to the “B sand” in the Hank Unit license area. However, cross section E-E’, which traverses from west to east from the Nichols Ranch Unit to the Hank Unit, shows that the “B sand” at Hank Unit is underlain by the “A sand” aquifer, which is continuous across the region. The staff observes in cross section E-E’ that the “A sand’ aquifer is separated from the “B sand” by 38 m (125 ft) of siltstones and mudstones.

The applicant provided a map of water wells within 0.81 m (0.5 mi) of the Hank Unit license area, as shown in SER Figure 2.4.2-4. Application Table D6-3 provides completion data for these wells, including the aquifers in which they are screened. Based on a search of the database of ground water permits and well descriptions for this area in the Wyoming State Engineers Office, the staff found that the majority of wells are stock wells or monitoring wells. No water wells permitted for domestic use are located in this 0.81-km (0.5-mi) boundary area. The applicant also presented a map of all permitted wells within a 4.8-km (3-mi) radius in application Exhibit D6-2 and the associated ground water permits in application Table D6G.2-2. According to this table, the majority of wells are stock or monitoring wells.

Two domestic wells, Doughstick #3 and Garden Well, are located approximately 4.8 km (3 mi) southwest of the license area. The depth of these wells is 168 and 159 m (550 and 520 ft), respectively. The applicant stated that a domestic well is associated with a residence at Pfister Ranch, approximately 1 km (0.6 mi) north of the Hank Unit northern boundary. The well, identified as BR-T, is shown on application Exhibit D6-2. The only well shown on application Exhibit D6-2 in this location is BR-T. The applicant stated that this well is located at a depth stratigraphically below the “F sand” ore zone in the “B sand” underlying aquifer. Application Table D6-3 provided completion information for BR-T, but did not identify a permit for this well in application Table D6G2-2. The staff was unable to locate BR-T or any other domestic wells associated with this ranch from the water permit database of the Wyoming State Engineers Office. However, the staff accepts that the applicant has located and assessed this well location, well completion, and its use as a domestic well.

The applicant conducted numerous pumping tests across the Hank Unit license area to determine the hydraulic characteristics of the site aquifers. It performed 11 single-well tests and 3 multiwell tests. SER Table 2.4.2-5 presents the results of the single-well tests. Five different wells, Hank 1, Dry Willow 1, BR-B, BR-G, and OW43756, in the “F sand” ore zone aquifer were tested.

The applicant also conducted three multiwell pumping tests at URZHF-5, URZHF-1, and SS1-F in the Hank Unit license area; SER Tables 2.4.2-6, 2.4.2-7, and 2.4.2-8, respectively, show the results. The first test was conducted at pumping well URZHF-5 for 4 days and 19 hours with two “F sand” observation wells, one underlying “B sand,” and one overlying “G sand” monitoring well, as shown in Table 2.4.2-6. The applicant calculated the transmissivity in the “F sand” from the drawdown response at the URZHF-5 pumping well to be 5,836 Lpd/m (470 gpd/ft). The observation wells, which were located 152 m (500 ft) to the south and 305 m (1,000 ft) to the northeast, respectively, showed no drawdown response and therefore could not be used to calculate transmissivity. The staff notes that observation wells must be placed closer to the pumping well in an unconfined (unsaturated aquifer) such as the “F sand” to show a drawdown response. The applicant committed to performing additional multiwell pumping tests with observation wells in the appropriate locations to detect drawdown in the unconfined “F sand” aquifer so that transmissivity and specific yield may be calculated (Uranerz, 2009a).

A second test was conducted at URZHF-1 for 2 days and 20 hours, with one observation well each in the underlying “C sand” and overlying “G sand.” No response was noted at either the underlying or overlying monitoring well, as shown in Table 2.4.2-7. A third test was conducted at SS1-F with one observation well located 46 m (150 ft) away to the northwest in the “F sand.” Table 2.4.2-8 presents the transmissivities and storage coefficients calculated from this test.

Based on these initial pumping test results, the staff concludes that the shales above and below the “F sand” appear to have sufficient integrity to act as aquitards to prevent ISR fluids from moving to aquifers either above or below the ore zone. The staff, however, finds that the Hank Unit pumping tests and analysis have not accounted for the unconfined (unsaturated) nature of the “F sand” aquifer. Observation wells were not properly placed to demonstrate communication across the “F sand.” To date, the pumping tests conducted and analyzed have not produced a specific yield value for the unconfined aquifer. The staff observes that the behavior of the unconfined (unsaturated) “F sand” aquifer at the Hank Unit is still in question based on the lack of adequate pumping test data. Therefore, a license condition will be included in the license that requires the applicant to submit the Hank Unit well field hydrologic data package for review and approval as discussed in SER Section 5.7.8.4.

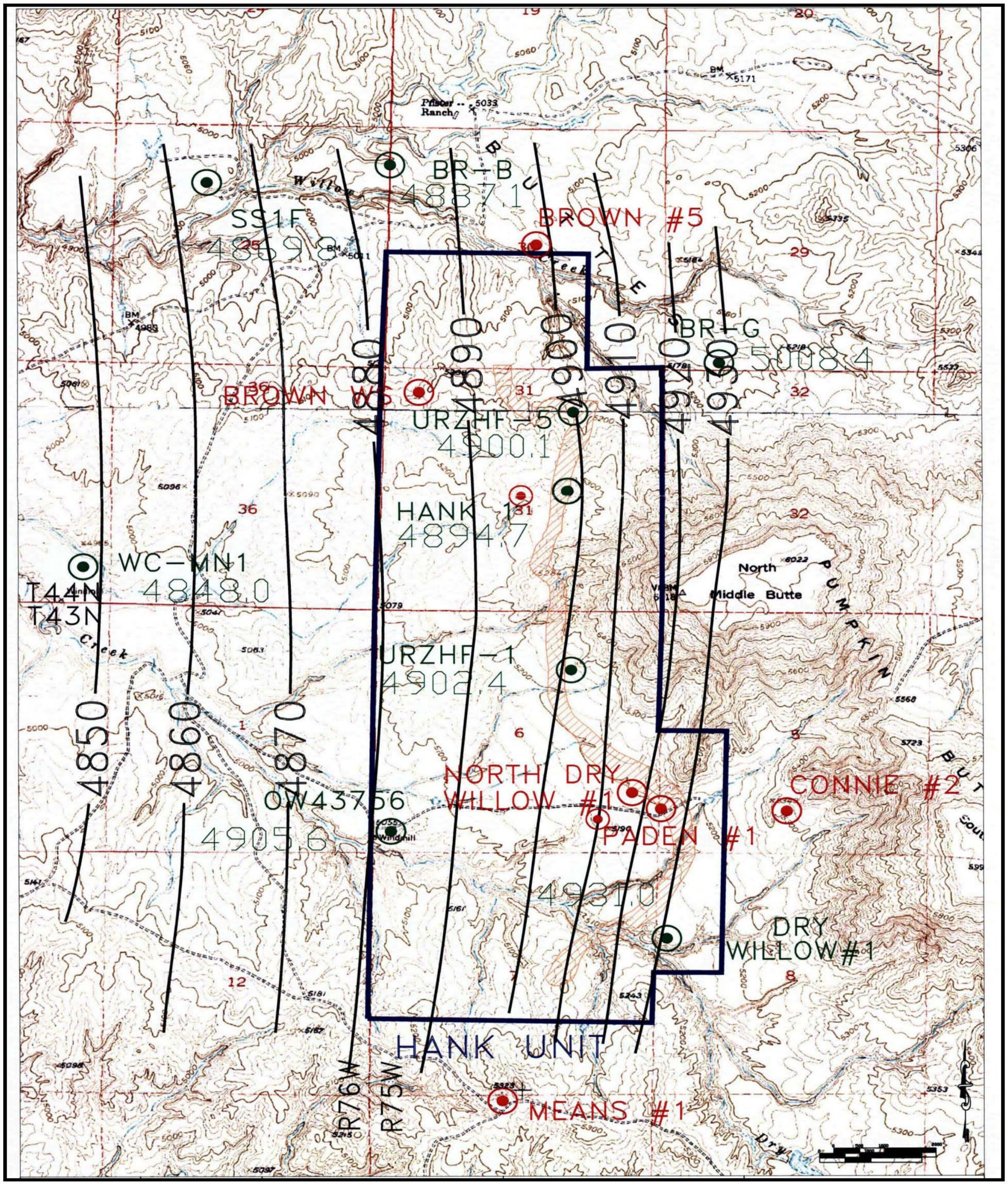

Figure 2.4.2-3 Water levels in the "F sand" ore zone in the Hank Unit (application Figure 2-20b)

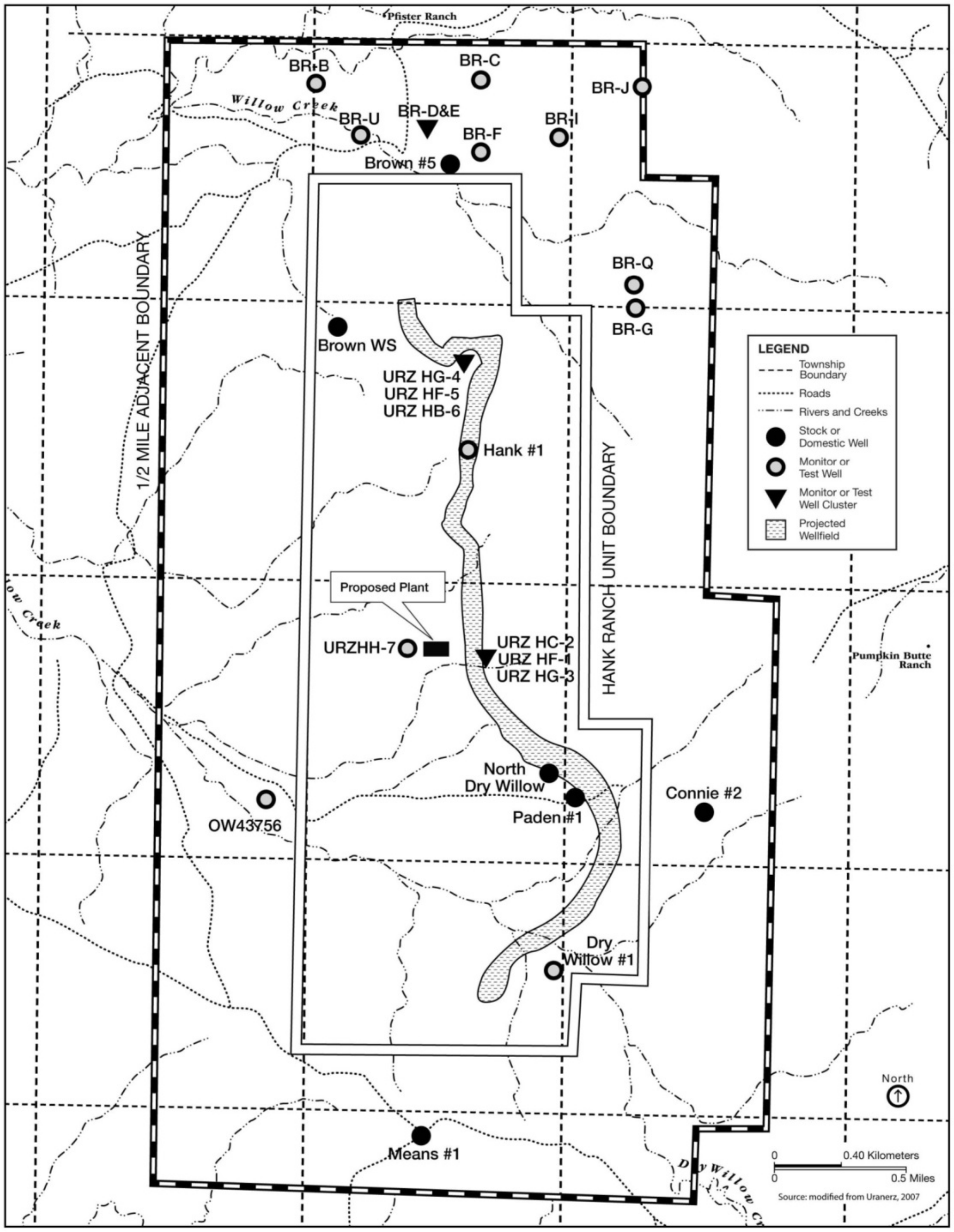

Figure 2.4.2-4 Water wells within a ½-mile boundary of the Hank Unit

Table 2.4.2-5 Uranerz Hank Unit Single-Well Pumping Tests

Test No.	Start Date	Well	Aquifer	Time (days:hr:min)	Flow (gpm)	Well Drawdown (ft)	T (gpd/ft)	K (ft/d)
1	7/11/07	Hank 1	F	0:1:05	9.2	12.45	2,210	3.5
2	5/2/07	Dry Willow 1	F	0:3:42	10.1	4.03	6,670	9.4
3A	10/10/79	BR-B	F	0:19:43	14.5	15.17	2,530	NR
3B	4/25/07	BR-B	F	0:1:04	12.7	13.87	1,970	3.4
4	8/8/07	BR-G	F	0:2:29	2.0	56.97	19	0.14
5	6/21/07	OW43756	F/G	0:2:25	3.1	84.37	18	NR
6A	10/24/79	BR-F	G	0:2:43	0.62	56.65	0.62	NR
6B	6/15/07	BR-F	G	0:2:09	0.11	9.03	2.3	0.005
7A	10/12/79	BR-H	G	0:3:05	1.0	78.38	2.7	NR
7B	5/24/07	BR-H	G	0:2:18	0.5	32.18	2.9	0.022
8	6/28/07	URZHC-2	C	0:3:08	0.3	50.12	1.9	0.025
9	8/08/07	BR-Q	B	0:4:25	2.2	30.86	176	0.38
10	5/16/07	NBHW-13	B	0:2:28	6.0	5.87	1,300	2.2
11A	10/12/78	SS1-L	A	0:5:00	NR	59.5	1,100	1.1
11B	4/27/07	SS1-L	A	0:2:48	9.8	21.66	843	0.89

Table 2.4.2-6 Uranerz Hank Unit Multiwell Pumping Test at URZHF-5

Well	Type	Aquifer	Time (days:hr:min)	Flow (gpm)	T (gpd/ft)	S	Well Drawdown (ft)	Distance to Pumping Well (ft)
URZHF-5	Pumping	F	4:19:26	4.0	470	NA	40.29	0
Hank 1	OBS	F	4:19:26	NA	NA	NA	0.2	500
BR-G	OBS	F	4:19:26	NA	NA	NA	0.2	1000
URZHG-4	Overlying OBS	G	4:19:26	NA	NA	NA	NR	Directly above
URZHB-6	Underlying OBS	B	4:19:26	NA	NA	NA	NR	Directly below

Table 2.4.2-7 Uranerz Hank Unit Multiwell Pumping Test at URZHF-1

Well	Type	Aquifer	Time (days:hr:min)	Flow (gpm)	T (gpd/ft)	S	Well Drawdown (ft)	Distance to Pumping Well (ft)
URZHF-1	Pumping	F	2:20:23	1.3	149	NA	19.1	0
URZHG-3	Overlying OBS	G	2:20:23	NA	NA	NA	NR	Directly above
URZHC-2	Underlying OBS	C	2:20:23	NA	NA	NA	NR	Directly below

Table 2.4.2-8 Uranerz Hank Unit Multiwell Pumping Test at SS1-F

Well	Type	Aquifer	Time (days:hr:min)	Flow (gpm)	T (gpd/ft)	S	Well Drawdown (ft)	Distance to Pumping Well (ft)
SS1-F	Pumping	F	0:1:29	11	1,530	NA	12.84	0
SS1-FPU	OBS	F	0:1:29	NA	1,530	6.8×10^{-5}	2.24	150

The applicant evaluated the potential for vertical flow between the ore zone "F sand" and the overlying and underlying aquifers in the Hank Unit license area using field data it collected on water levels, pumping tests, and measurements of permeability from cores. It reported that the water-level elevation in the "H sand" surficial aquifer is 46 m (150 ft) higher than in the overlying "G sand" at well URZHH-7. The "G sand" water level elevation is 15 m (50 ft) higher than the water level in the "F sand" at monitoring well URZHF-1. This head difference creates a downward gradient greater than 1 across the overlying G-F aquitard at this location.

The water level in the underlying "C sand" is 3.4 m (11 ft) less than the "F sand" water level at monitoring well location URZHF-1, creating a downward gradient of 0.3 across the underlying F-C aquitard. The applicant reported that measured and estimated vertical permeabilities of the aquitards in and near the license area ranged from 6.9×10^{-8} to 3.8×10^{-8} cm/s (2.3×10^{-9} to 1.2×10^{-9} ft/s), which are sufficient to minimize the vertical movement of water. The staff concludes that the presence of the vertical gradient across the overlying and underlying aquitards, their low vertical permeabilities, and lack of response of the overlying and underlying aquifers during pumping tests support confinement of the ore zone by the overlying and underlying shales in the Hank Unit license area.

The applicant also evaluated the impact of CBM water production from a deeper coal seam aquifer in the license area on the vertical gradients in the proposed ore zone. The top of the CBM production zone in the Hank Unit is located 354 m (1,160 ft) below the base of the "F sand" ore zone. Based on a comprehensive analysis of BLM-measured drawdowns in overlying sands to the CBM zone near the license area using a widely accepted USGS MODFLOW model of the site using 13 layers stressed with CBM production over 20 years, the applicant concluded that the drawdown in the CBM zone will not have an impact on water levels in the overlying ore zone unless artificial hydraulic connections exist. The staff reviewed the information, modeling, and evaluation provided and finds them acceptable.

The applicant has investigated the potential for the presence of such artificial hydraulic connections. It identified several exploratory borings and permitted wells which extend to depths sufficient to penetrate the coal seams in and around the Hank Unit as shown on application Figure D6-8a. One permitted well, North Dry Willow #1, and eight exploratory borings were located in the Hank Unit, with depths ranging from 259 to 610 m (850 to 2,000 ft). The applicant committed in application Section 2.7.2.3.3 to isolate the ore zone in the North Dry Willow #1 well or completely plug and abandon the well. The applicant also committed in application Section 2.7.5 to assessing the condition of the exploratory borings in the Nichols and Hank Units. Based on this analysis and commitment, the staff notes that CBM production at depth has not affected, and is unlikely to affect, the "F sand" ore zone aquifer in the Hank Unit.

2.4.4 Evaluation Findings

The staff has completed its review of the hydrologic site characterization information for the proposed Nichols Ranch ISR Project. During the review, the staff determined that the applicant has acceptably described the surface water hydrology by providing the following:

- the location of the drainages in and around the license area
- peak flood estimates for appropriate recurrence intervals for all drainages
- a flood potential analysis for the facilities
- a description of historical and current CBM-produced water discharges in and around the license area
- acceptable erosion protection against the effects of flooding from all drainages in and around the license area

The applicant has acceptably described the ground water hydrology by providing the following:

- a description of the regional hydrogeology
- a description of the overlying aquifer, extraction zone, and underlying aquifer hydrogeology using potentiometric surfaces maps with acceptable contour intervals based on an appropriate number of monitoring wells with exceptions noted below
- vertical gradients and pumping test data to evaluate the integrity of the confining layers and initially assess hydraulic parameters with exceptions noted below

However, the applicant has not provided sufficient data for the staff to draw conclusions regarding the hydrogeology of the "F Sand" at the Hank Unit and "1 sand" at the Nichols Unit. Because the applicant did not provide this information in the application, the staff is imposing the license conditions in SER Sections 3.1.4 and 5.7.8.4. Based on its review of the information provided by the applicant, as supplemented by information to be collected in accordance with the noted license conditions, the staff concludes that the information meets the applicable acceptance criteria of SRP Section 2.7.3 and the requirements of 10 CFR 40.41(c).

2.4.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

Craig, G.S., and J.G. Rankl, 1978. "Analysis of Runoff from Small Drainage Basins in Wyoming," U.S. Geological Survey, Water Supply Paper 2056, Reston, VA.

Harbaugh, A.W., 2005. "MODFLOW-2005, U.S. Geological Survey Modular Ground-water Model—the Ground-Water Flow Process," U.S. Geological Survey Techniques and Methods 6-A16, Reston, VA.

Lowham, H.W., 1976. "Techniques for Estimating Flow Characteristics of Wyoming Streams," U.S. Geological Survey, Water Resources Investigation Report 76-112, Reston, VA.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2009a. Letter from Uranerz Energy Corporation with Responses to Request for Additional Information for Nichols Ranch ISR Project License Application, March 11, 2009, ADAMS Accession Package No. ML090820568.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

WDEQ, 2006. Land Quality – Non Coal Rules and Regulations, Chapter 3, "Environmental Protection Performance Standards,'' April 25, 2006.

2.5 Background Surface Water and Ground Water Quality

2.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the characterization of surface and ground water quality at the Nichols Ranch ISR Project has been performed to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria outlined in SRP Section 2.7.3 (NRC, 2003).

2.5.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the surface water and ground water quality of the Nichols Ranch ISR Project. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff visited the site on several occasions during this review to confirm information presented in the application.

2.5.3.1 Surface Water

The applicant reported that the drainages within both the Nichols Ranch and Hank Units were ephemeral so no surface water samples could be collected within either license area. However, the applicant did provide historical and recent surface water samples from locations upstream and downstream of both units on the Cottonwood Creek drainage for the Nichols Ranch Unit and on the Dry Willow Creek drainage for the Hank Unit. The historical samples were collected in 1978 and 1979, and a recent sample was collected in June 2008. Samples were analyzed for all analytes listed in SRP Table 2.7.3-1, except for silver, gross alpha and gross beta.

The applicant provided surface water quality for six surface water sampling locations for the Nichols Ranch Unit in application Table D6A.1-1. The first sampling point was Brown Water Pond, located on a tributary of Cottonwood Creek 3.2 km (2 mi) upstream of the license area. The second sampling point was Cottonwood Creek at Brown Ranch, located approximately 3.2 km (2 mi) upstream of the license area on Cottonwood Creek. A third sampling point was Cottonwood Upstream Nichols, located immediately upstream of the license area on the southern boundary. A fourth sampling point was Cottonwood Downstream Nichols, located immediately downstream of the license area on the southern boundary. Two other locations, Cottonwood Creek and North Cottonwood Creek, were sampled; however, the applicant reported these positions as unknown, and therefore, the staff excluded them from its evaluation.

Table 2.5.1-1 in this SER shows the measured surface water quality parameters for these locations at Nichols Ranch Unit. An analysis by the staff indicated the following:

- Surface water quality measured at the Cottonwood Creek Downstream location in 2008 exceeded the Wyoming Class I (domestic use) and U.S. Environmental Protection Agency (EPA) secondary drinking water standard for iron.

- The Cottonwood Creek Upstream location exceeded Wyoming Class I and EPA primary and secondary drinking water standards for total dissolved solids (TDS), sulfate, uranium, and manganese in 2008.

- The Cottonwood Creek at Brown Ranch location exceeded Wyoming Class I and EPA secondary standards for TDS and sulfate in 1979.

- The Brown Water Pond sample in 1979 did not exceed any drinking water standards.

The applicant provided results for two surface water sample locations for the Hank Unit in application Table D6A.1-1. The first sampling point was on Dry Willow Reservoir, which is located upstream of the project boundary on Dry Willow Creek in the southern portion of the license area. This location was sampled in 1978 and 1979. The second sampling point was on Dry Willow Creek just downstream of the license area in the southern portion of the unit. It was sampled in 1979 and 2008.

Table 2.5.1-2 in this SER shows the measured surface water quality parameters for the Hank Unit. An analysis by the staff indicated the following:

- Surface water quality measured at the Dry Willow Creek location downstream of the Hank Unit in 2008 did not exceed any of the Wyoming Class of Use standards or EPA primary or secondary drinking water standards. It exceeded the Wyoming Class I and EPA secondary standard for TDS, sulfate, and uranium in 1979.

- The Dry Willow Reservoir sample in 1978 did not exceed any drinking water standards.

- The Dry Willow Reservoir sample in 1979 exceeded Wyoming Class I and EPA secondary drinking water standards for pH and iron.

The staff finds the background characterization of the surface water quality at both the Nichols Ranch and Hank Units to be acceptable. The applicant has committed in application Section 5.7.8.11 to continue the sampling of these locations after operations begin if water is present. SER Section 5.7.8 further discusses operational data collection.

2.5.3.2 Ground Water

This section describes the preoperational ground water quality monitoring that was conducted as part of the initial site characterization of the license area. SER Section 5.7.8 discusses an evaluation of the programs for baseline ground water monitoring, which takes place as part of well field development and operational ground water monitoring. SER Section 6.1 addresses restoration monitoring, which is conducted during ground water restoration.

The applicant established the site preoperational ground water quality in the Nichols Ranch ISR Project area from data collected by recent sampling in 2006, 2007, and 2008, and prior sampling completed in the late 1970s and early 1980s. Application Table D6E.1-1 presents information on ground water quality from wells in the Nichols Ranch Unit. Application Table D6-2 presents completion data from these wells. SER Figure 2.4.2-2 shows the locations of the wells.

Application Table D6E.1-2 presents ground water quality data from wells in the Hank Unit. Application Table D6-3 provides completion data for these wells, and SER Figure 2.4.2-4 shows the location of the wells. Ground water quality parameters measured for both license areas include all suggested analytes in SRP Table 2.7.3-1, except silver. The application included data from three to four rounds of water sampling in 2006, 2007, or 2008 for most wells. The applicant provided tables summarizing the ground water quality for wells in the overlying, underlying, and ore zone aquifers at both the Nichols Ranch and Hank Units in application Table D6-6.

SER Table 2.5.2-1, which is based on Table D6-6 of the application, shows the average water quality measured in the Nichols Ranch Unit for the overlying aquifer “B and C sands,” ore zone aquifer “A sand,” and underlying aquifer “1 sand.” The table shows that the average water quality in the overlying aquifer exceeded the Wyoming Class I and EPA primary and secondary drinking water standard for TDS, sulfate, ammonia, uranium, and radium-226 (Ra-226). The “B and C sand” major ion constituents were sodium, bicarbonate, and sulfate. The ore zone “A sand” aquifer exceeded the Class I and EPA drinking water standard for Ra-226. The major “A sand” ions were sodium, sulfate, and bicarbonate. The “1 sand” underlying aquifer did not exceed any drinking water standards. Sodium and bicarbonate were the major ions in the “1 sand.”

SER Table 2.5.2-2, which is based on Table D6-6 of the application, shows the average water quality measured in the Hank Unit for the overlying aquifer “G sand,” ore zone aquifer “F sand,” and underlying aquifer “B and C sand.” The table shows that the average water quality in the “G sand” overlying aquifer exceeded the Wyoming Class I and EPA primary and secondary drinking water standards for TDS, aluminum, iron, lead, and manganese. The major ions in the “G sand” were sodium, sulfate, and bicarbonate. The ore zone “F sand” aquifer exceeded the Class I and EPA primary and secondary drinking water standards for TDS, sulfate, Ra-226, iron, aluminum, manganese, and uranium. The major ions were sodium, calcium, sulfate, and bicarbonate. The “B and C sands” underlying the aquifer exceeded the Class I and EPA primary and secondary drinking water standards for TDS, sulfate, Ra-226, ammonia, and uranium. The major ions were sodium, bicarbonate, and sulfate.

In the original application, the applicant provided the preoperational water quality from monitoring wells in the surficial aquifers at both the Nichols Ranch and Hank Unit proposed license areas to assess preoperational ground water quality. Recently, the applicant drilled two additional monitoring wells (URNZG-5 and URNZG-6) in the surficial aquifer at Nichols Ranch and two additional monitoring wells (URZHH-9 and URZHH-10) in the surficial aquifer at the Hank Unit (Uranerz, 2010a). Revised application Tables D6E1-1 and D6E1-2 provide information on the water quality from these wells. The staff has determined that the original and additional data provide for four surficial wells and are adequate to determine background water quality.

The staff notes that the surficial aquifer water quality may be affected by spills, piping and casing leaks, which routinely occur at ISR operations, and, potentially, artificial connections between the surficial aquifer and other aquifers. Additionally, the applicant reported that CBM-produced water will be discharged at the surface into impoundments that are designed to infiltrate into the surficial aquifer near the Nichols Ranch Unit license area as discussed in SER Section 2.4. This surface discharge would make it possible for CBM discharge water to affect ground water quality in the surficial aquifer during the life of the Nichols Ranch ISR Project. The applicant stated that the CBM-produced water contains high sodium and bicarbonate, while the sulfate concentration is very low. The applicant also stated that the “G sand” surficial aquifer water quality near the wells has relatively low sodium and bicarbonate and higher sulfate concentrations. The applicant concluded that the contrast between these three parameters should enable it to distinguish the impacts of CBM water on the surficial aquifer from those of the ISR operations.

The NRC staff disagrees with the applicant’s conclusion that these three parameters will enable the applicant to distinguish the impacts of CBM water on the surficial aquifer from those of the ISR operations. Given the potential impact on surficial aquifers from CBM water infiltration and spills or leaks from ISR operations, the staff concludes that the applicant should establish the baseline water quality of the “G sand” and “F sand” in the Nichols Ranch Unit license area and the “H sand” surficial aquifer at the Hank Unit before operations begin. This will allow the applicant and the NRC to distinguish between CBM-produced water infiltration to the surficial aquifer and impacts from surface spills, well and pipeline leaks, or excursions from ISR operations. The applicant will be required by a standard license condition, listed in SER Appendix A, to establish the average baseline water quality of the surficial aquifers in the production areas at the Nichols Ranch and Hank Units before operations begin so that impacts to these surficial aquifers from future CBM or ISR operations may be identified.

Table 2.5.1-1 Nichols Ranch Surface Water Quality

Water Quality Parameter	Nichols Ranch Unit License Area			
	Cottonwood Creek Upstream	Cottonwood Creek Downstream	Cottonwood Creek at Brown Ranch	Brown Water Pond
	6/9/2008	6/10/2008	4/20/1979	4/20/1979
Bicarbonates as HCO3(mg/L)	245	148	284	100
Carbonates as CO3(mg/L)	<1	<1	0	5.4
Alkalinity (mg/L)	NR	NR	233	86.5
Chloride (mg/L)	18	<1	7.7	1.6
Conductivity (umhos/cm)	NR	NR	3,300	324
Fluoride (mg/L)	0.2	<0.1	0.2	0.2
pH (s.u.)	NR	NR	7.7	8.5
Total Dissolved Solids (mg/L)	**1,800**	197	**1,300**	163
Total Suspended Solids (mg/L)	NR	NR	6	27
Sulfate (mg/L)	**1,030**	12	**1,178**	48
Radium-226 (pCi/L)	NR	-0.1	0±0.4	0±0.4
Nitrogen, Ammonia as N (mg/L)	0.7	<0.1	<0.1	0.2
Nitrogen, Nitrate+Nitrite as N (mg/L)	0.1	<0.05	0.06	0.03
Aluminum (mg/L)	<0.1	0.2	<0.1	<0.1
Arsenic (mg/L)	0.003	0.004	<0.003	<0.003
Barium (mg/L)	<0.1	<0.1	<0.1	<0.1
Boron (mg/L)	0.1	<0.1	0.1	0.1
Cadmium (mg/L)	<0.005	<0.005	<0.01	<0.01
Calcium (mg/L)	141	12	278	40
Chromium (mg/L)	<0.05	<0.05	<0.01	<0.01
Copper (mg/L)	<0.01	<0.01	<0.01	<0.01
Iron (mg/L)	0.19	**0.57**	0.03	0.03
Lead (mg/L)	<0.001	0.001	<0.01	<0.01
Magnesium (mg/L)	77	5	145	4.9
Manganese (mg/L)	**0.36**	0.05	0.02	<0.01
Mercury (mg/L)	<0.001	<0.001	<0.0005	0.0025
Molybdenum (mg/L)	<0.1	<0.1	<0.1	<0.1
Nickel (mg/L)	<0.05	<0.05	0.02	<0.01
Potassium (mg/L)	27	13	7.5	1.6
Selenium (mg/L)	0.001	0.002	0.001	<0.003
Sodium (mg/L)	288	18	165	5.1
Uranium (mg/L)	**0.137**	0.0009	0.012	<0.001
Vanadium (mg/L)	<0.1	<0.1	<0.1	<0.1
Zinc (mg/L)	0.01	<0.01	<0.01	<0.01

Bold indicates an exceedance of Wyoming Class I or EPA primary or secondary standards.

Table 2.5.1-2 Hank Unit Surface Water Quality

Water Quality Parameter	Hank Unit License Area			
	Dry Willow Reservoir	Dry Willow Reservoir	Dry Willow Creek	Dry Willow Creek
	10/22/1978	4/21/1979	4/18/1979	6/10/2008
Bicarbonates as HCO3 (mg/L)	116	106	316	75
Carbonates as CO3(mg/L)	NR	19	0	<1
Alkalinity (mg/L)	95	103	259	NR
Chloride (mg/L)	2.2	1.5	7.4	<1
Conductivity (umhos/cm)	330	345	1,675	NR
Fluoride (mg/L)	0.17	0.1	0.3	<0.1
pH (s.u.)	8.3	**8.9**	7.8	NR
Total Dissolved Solids (mg/L)	174	174	**1,190**	184
Total Suspended Solids (mg/L)	17	8	206	NR
Sulfate (mg/L)	20	19	**631**	3
Radium-226 (pCi/L)	0.6	0.9	0.4	<0.1
Nitrogen, Ammonia as N (mg/L)	0.5	0.1	0.1	0.1
Nitrogen, Nitrate+Nitrite as N (mg/L)	<0.01	0.31	0.19	0.1
Aluminum (mg/L)	<0.1	<0.1	<0.1	<0.1
Arsenic (mg/L)	<0.003	<0.003	0.002	0.001
Barium (mg/L)	0.1	<0.01	<0.1	<0.1
Boron (mg/L)	0.6	<0.1	<0.1	<0.1
Cadmium (mg/L)	<0.01	<0.01	<0.01	<0.005
Calcium (mg/L)	30	40	242	20
Chromium (mg/L)	<0.01	<0.01	<0.01	<0.05
Copper (mg/L)	0.01	<0.01	<0.01	<0.01
Iron (mg/L)	0.03	**0.57**	<0.24	<0.25
Lead (mg/L)	<0.01	<0.01	<0.01	0.002
Magnesium (mg/L)	5.7	6.6	53	3
Manganese (mg/L)	<0.01	0.01	0.03	0.04
Mercury (mg/L)	<0.0005	<0.0005	<0.0005	<0.001
Molybdenum (mg/L)	<0.1	<0.1	<0.1	<0.1
Nickel (mg/L)	0.02	<0.01	<0.01	<0.05
Potassium (mg/L)	5	4.2	5.4	14
Selenium (mg/L)	<0.003	<0.003	<0.003	0.003
Sodium (mg/L)	5.2	6.3	76	<1
Uranium (mg/L)	0.0086	<0.001	**0.054**	0.001
Vanadium (mg/L)	<0.1	<0.1	<0.1	<0.1
Zinc (mg/L)	0.02	0.01	0.01	<0.01

Bold indicates an exceedance of Wyoming Class I or EPA primary or secondary standards.

Table 2.5.2-1 Nichols Ranch Average Preoperational Background Ground Water

Water Quality Parameter	Nichols Ranch Unit License Area		
	"B and C Sand" Overlying Aquifer	"A Sand" Ore Zone Aquifer	"1 Sand" Underlying Aquifer
Bicarbonates as HCO3 (mg/L)	120.65	138.6	233.75
Carbonates as CO3(mg/L)	3.43	4.41	15.75
Chloride (mg/L)	53.22	8.06	5.00
Conductivity (umhos/cm)	1162.68	564.3	411.5
Fluoride (mg/L)	0.174	0.24	0.65
pH (s.u.)	8.15	8.48	8.63
Total Dissolved Solids (mg/L)	**797.11**	333.1	232.0
Sulfate (mg/L)	**466.24**	135.0	1.5
Radium-226 (pCi/L)	**15.44**	**5.02**	0.1
Nitrogen, Ammonia as N (mg/L)	**0.627**	0.09	0.07
Nitrogen, Nitrate+Nitrite as N (mg/L)	0.069	0.05	0.05
Aluminum (mg/L)	0.095	0.05	0.05
Arsenic (mg/L)	0.002	0.002	0.0005
Barium (mg/L)	0.052	0.05	0.05
Boron (mg/L)	0.110	0.08	0.05
Cadmium (mg/L)	0.004	0.003	0.0025
Calcium (mg/L)	53.22	7.6	3.75
Chromium (mg/L)	0.016	0.02	0.025
Copper (mg/L)	0.012	0.01	0.005
Iron (mg/L)	0.109	0.07	0.015
Lead (mg/L)	0.01	0.01	0.005
Magnesium (mg/L)	10.94	0.57	0.50
Manganese (mg/L)	0.025	0.01	0.005
Mercury (mg/L)	0.001	0.0005	0.0005
Molybdenum (mg/L)	0.069	0.07	0.05
Nickel (mg/L)	0.02	0.02	0.025
Potassium (mg/L)	6.89	2.23	2.25
Selenium (mg/L)	0.001	0.0006	0.0005
Sodium (mg/L)	189.49	113.62	99.5
Uranium (mg/L)	**0.06**	0.01	0.00015
Vanadium (mg/L)	0.05	0.05	0.05
Zinc (mg/L)	0.23	0.01	0.005

Bold indicates an exceedance of Wyoming Class I or EPA maximum contaminant levels (MCLs). (Table D6-6, D6E-1; Uranerz, 2007)

Table 2.5.2-2 Hank Unit Average Preoperational Background Ground Water Quality

Water Quality Parameters	Hank Unit License Area		
	"G Sand" Overlying Aquifer	"F Sand" Ore Zone Aquifer	"B and C Sand" Underlying Aquifer
Bicarbonates as HCO3 (mg/L)	151.1	171.43	120.65
Carbonates as CO3(mg/L)	8.8	0.63	3.43
Chloride (mg/L)	7.6	5.53	53.22
Conductivity (umhos/cm)	804.9	1,426.96	1,162.68
Fluoride (mg/L)	0.2486	0.15	0.174
pH (s.u.)	8.4	7.82	8.15
Total Dissolved Solids (mg/L)	**504.4**	**1,020.95**	**797.11**
Sulfate (mg/L)	243.1	**597.33**	**466.24**
Radium-226 (pCi/L)	0.73	**44.6**	**15.44**
Nitrogen, Ammonia as N (mg/L)	0.103	0.05	**0.627**
Nitrogen, Nitrate+Nitrite as N (mg/L)	0.05	0.05	0.069
Aluminum (mg/L)	**0.425**	**0.05**	0.095
Arsenic (mg/L)	0.0033	0.0068	0.002
Barium (mg/L)	0.055357	0.05	0.052
Boron (mg/L)	0.24643	0.08	0.110
Cadmium (mg/L)	0.00329	0.0034	0.004
Calcium (mg/L)	48.6	99.77	53.22
Chromium (mg/L)	0.0221	0.02	0.016
Copper (mg/L)	0.00714	0.02	0.012
Iron (mg/L)	**0.499**	**0.30**	0.109
Lead (mg/L)	**0.0231**	0.01	0.01
Magnesium (mg/L)	9.8	24.37	10.94
Manganese (mg/L)	**0.051**	**0.07**	0.025
Mercury (mg/L)	0.00047	0.0005	0.001
Molybdenum (mg/L)	0.05	0.05	0.069
Nickel (mg/L)	0.0232	0.02	0.02
Potassium (mg/L)	6.0	7.12	6.89
Selenium (mg/L)	0.0026	0.02	0.001
Sodium (mg/L)	110.9	185.73	189.49
Uranium (mg/L)	0.009475	**0.15**	**0.06**
Vanadium (mg/L)	0.0363	0.05	0.05
Zinc (mg/L)	0.021	0.02	0.23

Bold indicates an exceedance of Wyoming Class I or EPA MCLs.
(Table D6-6; Uranerz, 2007)

2.5.4 Evaluation Findings

The staff reviewed the preoperational surface water quality of the proposed Nichols Ranch facility in accordance with SRP Section 2.7.3. The applicant described the preoperational surface water quality by providing appropriate chemical and radiochemical analyses of water samples from drainages in and near the mineralized zones. The applicant described the preoperational water quality of the surficial aquifer at both units.

Based on the review described above, the staff concludes that the information provided in the application, as supplemented by the information to be collected in accordance with the license condition, meets the applicable acceptance criteria of SRP Section 2.7.3 and the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," June 2003.

Uranerz, 2010a. "Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application," file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

2.6 Background Radiological Characteristics

This section discusses the background radiological characteristics of the surrounding environment. Background radiological characteristics are used to evaluate the potential radiological impact of operations on human health and the environment. Such impacts could result from spills, routine discharges from operations, and other potential releases to the environment. In addition, the data collected are used to identify a radiological baseline for decommissioning, restoration, and reclamation.

2.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the background radiological characteristics or the preoperational environmental monitoring program is in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

2.6.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria presented in SRP Section 2.9.3 (NRC, 2003). Also, as discussed in Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980b), the preoperational monitoring program needs to include at least 12 consecutive months of data, in accordance with 10 CFR Part 40, Appendix A, Criterion 7, including the submittal of complete soil sampling, direct radiation, and radon flux data, prior to any major site construction.

2.6.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the background radiological characteristics of the Nichols Ranch ISR Project. Review areas addressed in this section include: air particulate and radon sampling, radon flux monitoring, vegetation, food and fish sampling, direct radiation measurements, soil sampling, sediment sampling, ground water sampling, and surface water sampling. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The NRC staff visited the site on several occasions during this review to confirm information presented in the application.

2.6.3.1 Air Sampling (Particulate and Radon)

Regulatory Guide 4.14 recommends preoperational air particulate and radon sampling at three locations at or near the site boundaries, one location at or near the nearest residence, and one control location remote from the site. The recommended sampling frequency is weekly (or more frequent) filter changes, as required by dust loading. Frequency of analysis for air particulates is quarterly composites of the weekly samples. Air particulate samples should be analyzed for natural uranium (U), thorium-230 (Th-230), Ra-226, and lead-210 (Pb-210).

The applicant stated that airborne particulate sampling was done at four locations at the Nichols Ranch Unit and the Hank Unit in 2009. The applicant collected airborne particulate samples and compared the compiled data to similar data at three nearby ISR projects that have done background airborne particulate sampling (Uranerz, 2010a). Application Figures 2-25 and 2-26 show airborne particulate sampling locations for upwind, downwind, nearest residence, and plant site locations. Section 2.9.3 of the application presents the baseline radon-222 (Rn-222) exposure rates.

Regulatory Guide 4.14 recommends that Rn-222 samples be collected continuously or, alternatively, at least 1 week for 1 month. Rn-222 sampling locations should be at the same location used for air particulate sampling. The applicant used Landauer Extra Sensitive Outdoor Rn-222 detectors in the 1-year preoperational monitoring program. The Rn-222 detectors were collocated with 10 of the gamma dosimeters discussed in SER Section 2.6.3.4. Application Figures 2-25 and 2-26 show the combined radon and direct radiation (gamma) sampling station locations. Five radon/gamma monitoring stations were placed at the Nichols Ranch Unit and five at the Hank Unit.

The applicant reported the average Nichols Ranch Unit radon results as 1.2 picocuries per liter (pCi/L). These radon levels are higher (as expected) than the U.S. outdoor average of 0.4 pCi/L reported by EPA (EPA, 2007). The applicant reported radon measurements for the North Butte ISR Project, located within 3.2 km (2 mi) of the Hank Unit, measured over a 1-year period in 1988 and 1989, as 0.8 pCi/L (average), which is comparable to the Nichols Ranch average.

Staff finds that the air sampling data collected are consistent with the data in Regulatory Guide 4.14. However, Tables 1 and 2 of Regulatory Guide 4.14 show that monitors should be collocated with air particulate sample locations and that air particulate sample locations should be at or near the site boundary in different sectors that have the highest predicted concentrations of airborne particulate releases. Staff finds that the applicant has not provided enough data to indicate that the locations chosen have the highest predicted concentrations. A license condition in SER Section 5.7.7.4 addresses the issue of the location of radon monitors.

2.6.3.2 Radon Flux Monitoring

Regulatory Guide 4.14 recommends that radon flux measurements be conducted at eight locations within 1.5 km (0.9 mi) of the site. The applicant indicated that, because there are no tailing impoundments or evaporation ponds at the Nichols Ranch ISR Project, radon flux surveys are not applicable for background radiological characterization. The staff agrees that there are no tailing impoundments and evaporation ponds, agrees with the applicant's assessment, and concludes that radon flux measurements are not applicable.

2.6.3.3 Vegetation, Crop, and Fish Sampling

Regulatory Guide 4.14 recommends that forage vegetation be sampled at least three times during the grazing season in the three different sectors with the highest predicted airborne radionuclide concentrations during milling operations. At least three samples should be collected at the time of harvest or slaughter or removal of animals from grazing for each type of crop or livestock raised within 3 km (1.9 mi) of the mill site. Fish samples should be collected semiannually from any bodies of water that may be subject to seepage or surface drainage from potentially contaminated areas or that may be affected by a tailings impoundment failure.

The applicant indicated in application Section 2.9.4.1 that the background sampling program was modified from the guidance in Regulatory Guide 4.14. Vegetation type samples include sagebrush and grasses, which are consistent with the vegetation in the sampling site. These communities are discussed in application Volume VII, Appendix D8, and in Section 2.9.4.2. The applicant stated that no permanent surface water or fish are present at or immediately adjacent to the Nichols Ranch or Hank Units. Agricultural activities are limited to cattle grazing, with no crop-growing areas identified at or near the Nichols Ranch ISR Project. Therefore, no fish or crop samples were collected as part of the background radiological investigation. Staff agrees with the applicant's assessment. During visits to the site, staff did not see any crop land near either project site, and ephemeral streams were dry. Only typical PRB grasses and sagebrush were observed; therefore, staff finds that sampling this vegetation is acceptable. Streams were dry and could not support a fish population for sampling. The applicant stated that cattle grazing is limited in the area. Staff has not observed cattle at or near the Nichols Ranch Unit, but did see cattle near the Hank Unit during site visits.

Application Figures 2-25 and 2-26 show vegetation and grazing sample locations. All samples were analyzed for U, Th-230, Ra-226, Pb-210, polonium-210 (Po-210), arsenic, and selenium. The staff observed that the vegetation and grazing sampling was consistent with Regulatory Guide 4.14 and 10 CFR Part 40, Appendix A, Criterion 7. SER Table 2.6-1 summarizes the vegetation sampling results for the Nichols Ranch Unit, and Table 2.6-2 summarizes the vegetation sampling results for the Hank Unit.

Based on the information provided in the application, the vegetation sampling locations and sample parameters are consistent with the guidance in Regulatory Guide 4.14 and are, therefore, acceptable. The staff agrees with the applicant's determination in application Section 2.9.4.2 that fish and crop sampling is not necessary.

Table 2.6-1 Nichols Ranch Unit Vegetation Sampling Summary

Radionuclide	Maximum (μCi/kg)	Minimum (μCi/kg)
Lead-210	7.5×10^{-4}	4.2×10^{-4}
Polonium-210	1.5×10^{-4}	7.2×10^{-5}
Radium-226	3.7×10^{-4}	6.7×10^{-5}
Thorium-230	1.4×10^{-4}	3.6×10^{-6}
Uranium	2.4×10^{-4}	6.6×10^{-5}

Table 2.6-2 Hank Unit Vegetation Sampling Summary

Radionuclide	Maximum (μCi/kg)	Minimum (μCi/kg)
Lead-210	5.9×10^{-4}	2.5×10^{-4}
Polonium-210	1.5×10^{-4}	2.9×10^{-5}
Radium-226	9.6×10^{-5}	4.6×10^{-5}
Thorium-230	3.5×10^{-5}	2.3×10^{-6}
Uranium	4.9×10^{-5}	7.1×10^{-7}

2.6.3.4 Direct Radiation Monitoring

The applicant used Landauer X-9 gamma dosimeters for the 1-year preoperational monitoring program. Application Figure 2-25 shows four gamma dosimeter locations for the Nichols Ranch Unit, and application Figure 2-26 shows five gamma dosimeter locations for the Hank Unit. These are collocated with the Rn-222 monitors, but, as discussed in SER Section 2.6.3.1, the NRC staff has concluded that the measurement locations may not be located where the highest predicted airborne particulate concentrations are expected. This is because no onsite meteorological data were collected; instead, meteorological data from stations located at some distance from the site were used. This is not consistent with the recommendations in Regulatory Guide 4.14. Therefore, the applicant will be required to provide additional information supporting the environmental monitoring locations to demonstrate that data were collected where the highest predicted airborne particulate concentrations are expected. This is addressed with a license condition, discussed in SER Section 5.7.7.4.

2.6.3.5 Background Gamma Survey

Regulatory Guide 4.14 recommends a total of 80 direct radiation measurements at 150-m (492-ft) intervals up to a distance of 1,500 m (4,920 ft) in eight directions from the center of the site and at air particulate sampling locations. Gamma exposure measurements may be made with thermoluminescent dosimeters (TLDs), pressurized ion chambers, or properly calibrated portable survey instruments.

The applicant did not follow this regulatory guidance, but instead used a modified approach. The applicant measured gamma radiation while collecting soil and sediment samples using a Ludlum Model 19 MicroR survey meter that utilized an internal sodium iodide scintillation detector, which was calibrated in June 2007 before use. Gamma measurements were recorded at waist level over the area near each soil sample location; application Tables 2-26 and 2-27 present the gamma survey results. A total of 57 gamma measurements were collected at the Nichols Ranch Unit or one survey per 0.81 ha (2 ac). A total of 86 gamma measurements were made at the Hank Unit or one survey per 0.81 ha (2 ac).

The applicant reported that gamma exposures ranged between 11 and 15 microRoentgen per hour (μR/hr) at the Nichols Ranch Unit and between 11 and 18 μR/hr at the Hank Unit. Gamma exposures averaged 13 ± 1 μR/hr in soils at both sites and in sediments at the Nichols Ranch Unit, and gamma exposures in sediment samples at the Hank Unit averaged 15 ± 2 μR/hr. The applicant noted that gamma exposure measurements did not indicate a strong correlation with increased soil and sediment concentrations. Although the gamma exposure measurements (15 μR/hr) were higher at the SD-8 and SD-9 sampling locations, gamma exposure measurements (13 μR/hr) were not elevated at the LAS-5 soil sample and the SD-1 and SD-10 sediment sample locations at the Nichols Ranch Unit. These samples contained the most elevated U and Ra-226 concentrations (U < .4.7 mg/kg, Ra-226 < 26 pCi/g) measured in the soils and sediments in the Nichols Ranch Unit.

By contrast, higher gamma exposure measurements (18 μR/hr) were detected in the Hank Unit than in the Nichols Ranch Unit, but Ra-226 concentrations were much lower. The higher exposure measurements, 17 and 18 μR/hr, were collected at the LAS-2 soil sample location, which contained the highest U concentration (8.40 mg/kg), and the SD-15 and SD-18 sediment sample locations, which measured higher than average U concentrations (2.9 and 3.5 mg/kg, respectively). However, 16 μR/hr was measured at the SD-2 and SD-22 sediment sample locations which measured U concentrations of 3.5 and 3.7 mg/kg, respectively.

The applicant stated in application Sections 2.9.1.3 and 2.9.1.4 that background soil and sediment concentrations at the Nichols Ranch ISR Project are, for the most part, similar to the average concentrations observed in typical soils (1 pCi/g). In addition, the applicant stated in application Section 2.9.2.3 that background gamma exposure measurements are similar to regional and national background measurements. Regional gamma measurements were defined from measurements collected at the nearby North Butte area, which ranged between 11 and 13 μR/hr (an average of 11.7 μR/hr). The applicant described average national gamma exposure readings between 8 to 15 μR/hr. The applicant concluded in this section that although gamma exposure measurements made with a general survey-type meter do not have a high degree of correspondence with chemically measured radium content, a measurement with the survey meter 2.5 to 3 times higher than background can serve as a first-level screening test for areas with elevated concentrations of radionuclides. The staff disagrees with the applicant's conclusion because the analytical and survey results as described above showed exposure measurements within the national background range at locations that contain U and Ra-226 concentrations far in excess of typical background soil concentrations. No exposure readings were 2.5 to 3 times the national background exposure readings (e.g., 20-45 μR/hr), although the concentrations were as much as 8 to 26 times the background concentrations for U and Ra-226. Therefore, the staff concludes that the applicant has demonstrated that the gamma exposure measurements using a survey meter cannot be used to confirm the presence or absence of contamination in soils.

The staff concludes that the direct radiation survey was consistent with Regulatory Guide 4.14. The staff also agrees with the applicant's conclusions in application Section 2.9.1.1 that the soil and sediment sampling efforts provide a representative radiological background against which its operational activities can be measured. The results should also be used to determine that decommissioning requirements are in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6). However, the staff concludes that the applicant cannot rely solely on gamma exposure measurements to determine if soils and sediments are not contaminated because of the following: (1) there was no direct or consistent correlation between gamma exposure measurements and soil concentrations, and (2) the applicant measured background exposure readings in areas that contain Ra-226 concentrations in excess of decommissioning concentrations required in 10 CFR Part 40, Appendix A, Criterion 6(6). Although the staff disagreed with the applicant's conclusion on gamma surveys and their correlation with direct radiation measurements, this has no impact on the staff's conclusion that direct radiation surveying was adequate. The gamma survey was in addition to direct radiation guidance in Regulatory Guide 4.14. Because the direct radiation survey was consistent with Regulatory Guide 4.14, the applicant has provided the information necessary.

2.6.3.6 Soil Sampling

Regulatory Guide 4.14 recommends that up to 40 surface soil samples be collected at 300-m (984-ft) intervals to a distance of 1,500 m (4,920 ft) in eight meteorological sectors, as well as five or more surface soil samples collected at air particulate stations. In addition, at least five subsurface soil samples in four meteorological sectors should be collected. Streambed sediment samples should be collected upstream and downstream in each stream and one in each water impoundment. These samples should be collected at the same location where surface water samples are collected from the streams following extended periods of heavy and low flows, such as those occurring during spring runoff and late summer. Additionally, a composite sample should be prepared from several sediment samples collected in a traverse across each stream sampled to obtain a representative sample of the streambed.

The applicant stated that Regulatory Guide 4.14 was dated and intended for conventional mills. Therefore, the applicant proposed a modified background sampling program designed for "a modern ISR facility." The applicant stated that contemporary ISR operations have minor impact on soils in comparison to the impact of a conventional mill because of the following three major differences between ISR and conventional milling:

(1) ISR recovery methods do not require removal of the overburden, the material overlying the U deposit, nor require physical removal of the ore zone.

(2) ISR recovery process is wet up to the stage of yellowcake drying and packaging, and is contained for the most part, in a closed system of pipes, hoses, and tanks.

(3) Modern dryers and packaging systems are maintained under vacuum with a series of filters to prevent discharging large amounts of airborne particulates to the atmosphere.

Additionally, the applicant stated that potential radiological effects resulting from accidental spills and leaks from pipes within the well fields, between the well fields and the process facility, and within or from the process facility are reduced by engineering controls and management programs based on as low as reasonably achievable (ALARA) principles. Any break in the system resulting in a leak or spill would be detected by a drop in the pipe pressure and reported promptly by onsite personnel. Thus, any spill or break in the system would receive a quick response, and the affected area would be surveyed, sampled, and recorded on a spill map. Soils with significantly elevated levels of uranium and Ra-226 would be removed and disposed of at a licensed byproduct material site. The curbed pad and/or sump system would be expected to contain any spills within the processing facility. Therefore, the applicant designed the preoperational sampling program to characterize radiological background conditions in areas that are most likely to experience potential impacts from the ISR process.

Application Exhibits D11-1 and D11-2 illustrate the surface and subsurface soil and sediment samples collected at the Nichols Ranch and Hank units, respectively. Soils were collected with a 7.62 cm (3-in.) diameter auger, placed in 3.79 L (1-gallon [gal]) plastic freezer bags, and stored in coolers before shipment to the laboratory for analysis. Sampling tools were cleaned after use with de-ionized water and wiped dry with paper towels to avoid cross-contamination.

Regulatory Guide 4.14 recommends subsurface soil sampling up to 1 m (3.3 ft) in depth. Regulations in 10 CFR Part 40, Appendix A, Criterion 6(6), require Ra-226 soil concentrations to be averaged over 15-cm (6-in.) depths. In application Tables 2-22 and 2-24, respectively, the applicant identified 42 locations at the Nichols Ranch Unit and 53 locations at the Hank Unit where soil samples were collected on the surface to a depth of 15 cm (6 in.) in June 2007.

The applicant collected subsurface samples at three layer depths of 30 cm (12 in.) to a total depth of 91 cm (36 in.) at six locations at both the Nichols Ranch and Hank Units, as illustrated in application Exhibits D11-1 and D11-2, respectively. All soil samples were analyzed for Ra-226 (pCi/g). All of the subsurface samples and the surface soil samples collected near residences (labeled R) and in the licensed area (labeled LAS) at both units were analyzed for U (mg/kg), Pb-210 (pCi/g), and Th-230 (pCi/g), as well. Only four of the surface samples (labeled SS) collected at each of the units were also analyzed for the additional isotopes.

Ra-226 concentrations in the surface and subsurface soils ranged from 0.3 to 26.4 pCi/g and 0.6 to 1.6 pCi/g, respectively, at the Nichols Ranch Unit, and ranged from 0.3 to 2.1 pCi/g and 0.8 to 1.6 pCi/g, respectively, at the Hank Unit. Excluding one sample collected in the licensed area, LAS-5, at the Nichols Ranch Unit, the average Ra-226 concentrations measured in the surface soil samples at the Nichols and Hank Units were 0.9 ± 0.4 pCi/g and 1.0 ± 0.3 pCi/g, respectively. The unusually elevated soil Ra-226 concentration, 26.4 pCi/g, was attributed to contamination from past well exploration activities.

The staff agrees with the applicant’s assessment that a soil sampling program for an ISR may be different than that for a conventional mill, for which Regulatory Guide 4.14 was intended. The staff observes that the soil sampling program was consistent with the intent of Regulatory Guide 4.14 and meets the requirements of 10 CFR Part 40, Appendix A, Criterion 7, with the exception of soils collected at the same location as air particulate samples. Once the applicant demonstrates, as required by license condition, the locations of the highest predicted concentrations of airborne particulate releases, these samples will be obtained.

2.6.3.7 Sediment Sampling

Regulatory Guide 4.14 recommends sediment sampling at two locations in each stream and one sampling location in each water impoundment. The applicant collected streambed sediment samples using the same methodology as used to collect the soil samples, except that a composite of several samples rather than a single sample was collected at each location. Application Exhibits D11-1 and D11-2 show sample locations, and application Tables 2-23 and 2-25 present analytical results for the Nichols Ranch and Hank units, respectively. Samples were collected upstream at the license boundary, at various locations downstream, and at the downstream license boundary. Ten samples were collected at the Nichols Ranch Unit and 26 at the Hank Unit. All samples were analyzed for Ra-226 (pCi/g), U (mg/kg), Pb-210 (pCi/g), and Th-230 (pCi/g). SER Table 2.6-3 summarizes the data.

Table 2.6-3 Summary of Analytical Results of Sediments at the Nichols Ranch ISR Project

Unit	Analyte	Concentration			
		Minimum	Maximum	Average	Standard Deviation
Nichols Ranch	U (mg/kg)	1.0	4.0	2.3	0.9
	Pb-210 (pCi/g)	not detected	2.0	1.3	0.8
	Ra-226 (pCi/g)	0.5	32.2	9.6	12.1
	Th-230 (pCi/g)	0.2	1.0	0.6	0.2
Hank	U (mg/kg)	1.2	3.7	2.4	0.6
	Pb-210 (pCi/g)	not detected	2.5	1.0	0.7
	Ra-226 (pCi/g)	0.8	2.2	1.2	0.3
	Th-230 (pCi/g)	0.2	1.1	0.6	0.2

The staff finds that most samples indicate typical background concentrations of the uranium series isotopes in soils (1–2 pCi/g) except for three Nichols Ranch Unit sediment samples that contained elevated concentrations of Ra-226 and U and one Hank Unit sediment sample that contained an elevated U concentration (8.40 mg/kg). The applicant did not include the highest U concentration in the statistical analysis of the Hank Unit sediment samples (Table 2.6) because of an anomalous result. This is acceptable as the single result was reported, but was not used in that statistical analysis and was considered an outlier. The four Nichols Ranch Unit sediment samples with elevated concentrations of Ra-226 were collected near the site's boundary. SD-1 (16.2 +/- 3.0 pCi/g) was collected at the northern boundary, and samples SD-8 (32.2 +/- 4.2 pCi/g), SD-9 (23.5 +/- 3.6 pCi/g), and SD-10 (19.4 +/- 3.3 pCi/g) were collected downstream of Cottonwood Creek, near the southern boundary. The applicant stated that earlier exploration could have left zone cuttings on the surface. The staff finds this explanation plausible; however, the possible reasons for the high sample values are not critical to this review as the values are used only for the determination of background levels at the site. The staff concludes that the sediment sampling and analysis program was consistent with Regulatory Guide 4.14 and, therefore, the staff finds the preoperational sediment sampling and analysis acceptable.

2.6.3.8 Ground Water Sampling

Regulatory Guide 4.14 recommends that ground water samples should be collected quarterly from each well within 2 km (1.2 mi) of a proposed tailings area that is or could be used for drinking water, watering of livestock, or crop irrigation. As stated earlier in the SER, the applicant does not plan to have any features, such as a tailings impoundment or evaporation ponds, that could be considered a disposal area. Therefore, the applicant stated that this portion of Regulatory Guide 4.14 does not apply. However, the SRP recommends that information on current uses of ground water must be sufficient to evaluate potential risks to ground water users in the vicinity of the ISR facility. While an ISR does not have a tailings impoundment, the ore zone will contain elevated levels of radionuclides and other constituents during production and byproduct material after lixiviant injection has ended. For the purposes of domestic and livestock well radiological monitoring, staff will treat preoperational ISR monitoring outside the ore zone monitoring well ring in a manner similar to that suggested for impoundments in Regulatory Guide 4.14. Therefore, the staff is including a license condition, which is presented in SER Section 2.6.4, that requires semiannual ground water sampling within 2 km (1.2 mi) of the proposed monitoring well ring boundary. Semiannual monitoring will provide adequate data to determine background characteristics for nearby domestic and livestock wells. The license condition will require that samples be analyzed for the upper control limit (UCL) parameters in Section 5.7.8.9 of the licensee's approved application and for natural uranium and Ra-226. Staff notes that UCL parameters are used for excursion sampling in the MR-wells, and sampling for natural uranium and Ra-226 is consistent with environmental ground water sampling required of other ISR licensees.

Regulatory Guide 4.14 recommends continued quarterly sampling after operations begin; however, the staff will require annual monitoring after operations commence and within 1 km (0.6 mi) of the monitoring well ring. ISR operations differ from a conventional tailings impoundment in that each production area is surrounded by a monitoring well ring, which consists of monitoring wells above and below the ore zone aquifer that are sampled twice monthly to detect excursions that give early warning that contaminants have the potential to move outside of the ore zone or to water supplies. By standard license condition, an excursion that is not corrected within 60 days of confirmation requires a written 60-day excursion report identifying the corrective actions the licensee is taking. Staff notes that this may involve increased domestic and livestock well sampling or other actions consistent with a performance-based license to protect public health and safety. After operations commence, a standard license condition will require that the applicant perform annual monitoring at domestic and livestock wells within 1 km (0.6 mi) of the monitoring well ring at both the Nichols Ranch and Hank Units. The license condition will require that samples be analyzed for the UCL parameters in Section 5.7.8.9 of the licensee's approved application and for natural uranium and Ra-226. Appendix A of this SER includes this license condition.

The applicant provided the following information in application Sections 2.2.1 and 2.2.4 and Table 2-1. Table 2-1 shows three ranches—Pfister Ranch, Dry Fork Ranch, and Pumpkin Buttes Ranch—located within 2 km (1.2 mi) of the Nichols Ranch ISR Project area. The Pfister Ranch is located approximately 0.97 km (0.6 mi) north of the Hank Unit, Pumpkin Buttes Ranch is located approximately 1.77 km (1.1 mi) east of the Hank Unit, and Dry Fork Ranch is located approximately 1.45 km (0.9 mi) southwest of the Nichols Ranch Unit. Application Table 2-1 lists other residential sites near the Nichols Ranch ISR Project, but these are located greater than 2 km (1.2 mi) outside the licensed boundary. No wells within the Nichols Ranch ISR Project will be used for domestic water supplies. The applicant stated in application Section 2.2.4 that it will provide its staff with bottled water for drinking.

Wells in the area available for agricultural uses—primarily livestock watering—are uniformly located over the Nichols Ranch ISR Project at depths of 55 m to 305 m (180 ft to 1,000 ft). The applicant stated in application Section 2.2.4 that those wells installed in the ore zone will either be abandoned using acceptable WDEQ procedures with the ore zone interval isolated or will be used as monitoring wells—if not completed in multiple sands.

2.6.3.9 Surface Water Sampling

Regulatory Guide 4.14 recommends surface water sampling for several types of areas. The locations can include large permanent onsite water impoundments such as ponds or lakes, offsite impoundments that may be subject to direct surface drainage from potentially contaminated areas, surface waters or drainage systems crossing the site boundary, and surface waters that may be subject to drainage from potentially contaminated areas. These surface water samples are to be collected as a grab sample on a monthly and quarterly basis for water impoundments and drainage systems, respectively.

The applicant stated that surface water self-samplers were set up at three locations—two samplers in Cottonwood Creek and one sampler in Dry Willow Creek. Both creeks are ephemeral streams that may contain water only during runoff or major storm events. In June 2008, surface water samples were collected, and the results are presented in application Volume VI, Appendix D6, Addendum D6A in Table D6A.1-1. Constituents analyzed included basic water quality parameters such as pH, conductivity, and total dissolved solids, as well as uranium, selenium, and Ra-226. Based on the information provided in the application, the staff concludes that the surface water sampling is consistent with Regulatory Guide 4.14, and the staff finds the preoperational surface water sampling and analysis acceptable.

2.6.4 Evaluation Findings

The staff reviewed the background radiological characteristics of the Nichols Ranch ISR Project in accordance with SRP Section 2.9.3. The applicant has established the background radiological characteristics by providing monitoring programs that include sampling frequency and methods, sampling locations, and types of analyses for soil and sediment sampling, ground water sampling, air sampling, and flora and fauna sampling. However, the staff determined that the applicant has not provided background radiological ground water sampling for domestic or livestock wells in the vicinity of the Nichols Ranch ISR Project. Because the applicant has not provided the required information, the staff is imposing the following license condition to ensure that the data are collected:

> Prior to the preoperational inspection, the licensee will submit monitoring results to the NRC for review that include sampling of domestic and livestock wells that are located within two kilometers of the proposed production area monitoring ring wells (MR-wells) of the Nichols Ranch and Hank Units. Samples shall be collected, at a minimum, semi-annually. Samples shall be analyzed for the UCL parameters in Section 5.7.8.9 of the approved license application and for natural uranium and radium-226.

The applicant has provided adequate justification for not conducting radon flux monitoring, crop sampling, and fish sampling during preoperational monitoring. The applicant stated that no permanent surface water or fish existed at or immediately adjacent to the Nichols Ranch or Hank Units. Agricultural activities are limited to cattle grazing, and no crop-growing areas were identified. The applicant provided background direct radiation, radon, and particulate monitoring; however, the applicant did not provide sufficient justification for the monitoring locations because of the lack of onsite meteorological data. This information will be required in accordance with license conditions in SER Sections 2.2.4 and 5.7.7.4.

Based on the review described above, the NRC staff concludes that the information provided in the application, as supplemented by information to be collected in accordance with the noted license conditions, meets the applicable acceptance criteria of SRP Section 2.9.3 and the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.6.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

EPA, 2007. http://epa.gov/radon/zonemap.html, EPA Map of Radon Zones, Washington, DC.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 1980b. Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills," Washington, DC, April 1980.

Uranerz, 2010a. "Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application," file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

3.0 DESCRIPTION OF PROPOSED FACILITY

3.1 In Situ Recovery Process and Equipment

3.1.1 Regulatory Requirements

The staff determines if the applicant demonstrated that the equipment and processes used in the well fields during operation at the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, the application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 3.1.3 (NRC, 2003).

3.1.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the ISR processes and equipment proposed for the Nichols Ranch facility. Review areas addressed in this section include: well field infrastructure, operations in the production area aquifers and the proposed schedule for operations. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

3.1.3.1 Introduction

The applicant described the ISR process and equipment to be used at the Nichols Ranch ISR Project. Major production facilities include a CPP at the Nichols Ranch Unit and a satellite IX facility at the Hank Unit. The Nichols Ranch Unit will occupy 453 ha (1,120 ac), with the proposed well fields and disturbance occurring on 45.6 ha (113 ac). The Hank Unit will be composed of 911 ha (2,250 ac), with the well fields and disturbed area occupying 62.6 ha (155 ac).

The applicant stated that uranium at Nichols Ranch Unit will be extracted from an ore body in the “A sand” at depths of 92.5–215 m (300–700 ft) bgs. This ore zone is shaped in two long narrow trends which join at a “nose” in the northern portion of the license area. Uranium at the Hank Unit will be extracted from a long, thin ore body in the “F sand” at depths of 62–185 m (200–600 ft) bgs. The average thickness of ore at the two units is 2.15 m (7 ft), and the average uranium grade is above 0.1 percent.

The applicant has reported that the aquifer in the “A sand” ore zone at Nichols Ranch Unit is completely saturated and hydraulically confined, meaning that the “A sand” water level, or hydraulic head, is higher than the bottom of the overlying shale. At the Hank Unit, however, the applicant has reported that the “F sand” ore zone aquifer is unconfined, meaning that the “F sand” water level, or hydraulic head, is lower than the bottom of the overlying shale. The sand is, therefore, not completely saturated and can be described as unsaturated over part of its thickness. While the Hank Unit is hydraulically unconfined (unsaturated over part of its thickness), aquitards such as shale or clay units that have lower hydraulic conductivity than the “F sand” exist both above and below the “F sand” at the Hank Unit.

To evaluate the ISR process and equipment at the Nichols Ranch ISR Project, the staff reviewed the well field infrastructure at both the Nichols Ranch and Hank Units, including such features as well installation, well completion, mechanical integrity testing, well field piping, header house design and water balances, and disposal well capacity. The staff then reviewed the ISR operations process separately for the two units to address the Nichols Ranch Unit confined aquifer and Hank Unit unconfined aquifer hydrogeology aspects to ensure that the applicant will be able to conduct its ISR operations at both units in a way that protects public health and safety.

3.1.3.2 Nichols Ranch Unit and Hank Unit Well Field Infrastructure

For well field infrastructure, the applicant stated that the ore zones at the Nichols Ranch and Hank Units would be divided into separate production areas where the injection and extraction wells would be installed. Wells would be arranged in four-spot, five-spot, seven-spot, or line-drive patterns. Injection wells are anticipated to be spaced between 15–36 m (50–150 ft) apart.

The applicant described in detail the well installation and cementing procedures to protect overlying and underling aquifers and prevent cross-contamination. After completion, wells would be developed by airlifting and tested for mechanical integrity. Application Figure 3-13 provided a typical well completion schematic for an injection/recovery well. Application Figure 3-14 provided a schematic of a typical monitoring well. The applicant stated that the well casing would be 10.2 to 12.7 cm (4 to 6 in.) in diameter equivalent to SDR-17 to SDR-26. Casing for the well connections will be joined using an O-ring and spline locking system.

The applicant stated that well field piping will be constructed of high-density polyethylene, PVC, and/or stainless steel. Piping will have an operating pressure of 1.034 megapascal (MPa) (150 pounds per square inch [psi]). All equipment in the well fields will be operated at pressures less than or equal to the designed piping ratings. Individual well lines and trunk lines will be buried to prevent freezing.

The applicant presented the mechanical integrity test (MIT) procedures for all injection and extraction wells in application Section 3.4.6. MITs will be performed when wells are brought into service initially and every 5 years after. Wells will also be tested after any repair or work is done on the well. MITs will be performed at a pressure which is 125 percent of the maximum operating wellhead casing pressure. A well will pass the MIT if a pressure drop of less than 10 percent occurs over a 60-minute period. A well will also pass if it experiences a pressure drop of less than 5 percent over a 30-minute period. All MITs will be documented, and the records will be maintained on site for NRC review. The staff finds the mechanical integrity testing procedures acceptable as they reflect accepted industry practice for ISR operations and are consistent with the criteria in SRP Section 3.1.3(2)(b).

The applicant stated that during operations, the maximum injection head pressure at either license area would not exceed 90 percent of the MIT pressures. Based on a review of published fracture gradient information, the applicant estimated that the fracture gradient for the license area was 5.5 kilopascals (kPa)/ft (0.80 psi/ft). The staff accepts this estimate for the fracture gradient as it is based on published information. Based on this gradient, the staff estimated the maximum bottomhole injection pressure that could be maintained without fracturing at the Nichols Ranch Unit and Hank Unit. The staff estimated the pressure to be 3.86 MPa and 3.31 MPa (560 and 480 psi), respectively, for the maximum well depths of 213 m (700 ft) at Nichols Ranch Unit and 183 m (600 ft) at Hank Unit. Using a hydrostatic pressure gradient of 9.794 kPa/m (0.433 psi/ft), the NRC staff estimated that the maximum wellhead pressure for these bottomhole pressure constraints would be 2.482 MPa (360 psi) and 1.378 MPa (200 psi) for the Nichols Ranch and Hank Units, respectively. The applicant committed in application Section 3.4.3 to a design piping network with a maximum operating pressure of 1.034 MPa (150 psi) based on the specifications of the piping. The applicant committed in application Section 3.4.3 to operating the system at pressures less than or equal to this operating pressure to prevent piping failures. As the design operating pressure is less than the wellhead pressure constraints, the staff finds that the operating pressures are acceptable and will not cause the well to exceed the maximum bottomhole formation fracture pressures at either unit.

The applicant provided a description of the header houses that will be used to distribute injection fluid to injection wells and collect production solution. Figures 3-9A and 3-9B in the application provided schematics of two possible header house designs. The first will have a concrete foundation with a sump; the second is on a bermed pad. Each header house may contain up to 30 injection and 30 recovery wells.

Application Figure 3-9C provided a schematic of header house piping and instrumentation. The applicant stated that the recovery and injection trunk lines for each header house will have electronic pressure gauges and the information will be monitored from the respective Nichols Ranch Unit or Hank Unit control room. The control system will contain high and low alarms for pressure and flow, which will alert control room personnel to make adjustments, and certain ranges of pressure and flow will signal automatic shutoffs and shutdowns. The applicant also reported that the flow rate and pressure readings of individual injection and production wells will be manually monitored at the header house. Well flow readings will be recorded on a shift basis, and overall well flow rates will be balanced at least once per day. Alternatively, the applicant stated that flow data will be transferred to the main or satellite plant and checked automatically.

The applicant described the well field and header house physical inspection program. Daily inspections of various process components will be required including process and storage areas, header houses, and well fields to ensure proper operation and to detect leaks. The header house design, instrumentation, monitoring, and inspection schedule are consistent with existing licensed ISR operations and represent standard industry practices which the NRC has found to be safe. Therefore, the staff finds the description of these items acceptable.

The applicant reported that liquid wastes will be generated from well development water, pumping test water, process bleed solutions, washdown water, and restoration water. Nonprocess water generated during well development and pumping tests is expected to satisfy WDEQ Class IV livestock standards, so it may be disposed of on the ground in accordance with WYPDES (Wyoming Pollutant Discharge Elimination System) discharge permits. Process bleed and washdown water from each unit will be transferred to a deep disposal well and disposed of as byproduct material.

The applicant plans to use up to eight Class I underground injection control (UIC) deep disposal wells. Up to four disposal wells may be located at the Nichols Ranch Unit, and the others will be located at the Hank Unit. The applicant is anticipating a capacity of 378.5 Lpm (100 gpm) for each well. WDEQ, which is authorized by EPA to implement the UIC Program, will issue permits for these wells. The applicant has committed in application Section 3.2.6 to installing two deep disposal wells before beginning operations at the Nichols Ranch ISR Project, and will install additional wells, as needed. The NRC staff notes that the capacity of a specific disposal well can be verified only after it has been installed. Therefore, the NRC has imposed a license condition in SER Section 4.2.4, which states that the licensee must demonstrate that the installed disposal wells provide sufficient capacity for proposed operations. Uranerz has committed in application Section 3.2.6 to installing additional wells to accommodate the disposal requirements if the flow estimates for one disposal well prove to be inadequate. Application Figure 3.8A provides a schematic of the expected deep well completion. SER Section 4.2 further discusses disposal of liquid byproduct material in deep disposal wells.

The applicant also provided predictions of waste volumes to be sent to each disposal well for each unit for the production, production and restoration, and restoration only phases. These calculations showed that with a capacity of 378.5 Lpm (100 gpm) for each disposal well, if restoration and production operations were operating at full capacity at both units, each single well would be operating with only 3.79 Lpm (1 gpm) available extra capacity. Adequate disposal capacity is critical for ISR operations. To ensure adequate capacity for deep disposal of byproduct material, the staff will require the license condition presented in SER Section 4.2.4. The license condition will require the licensee to demonstrate that the installed disposal wells provide adequate deep well capacity to dispose of the projected liquid volumes from each unit under normal operating conditions during production, production and restoration, and restoration phases, as stated in Section 3.2.6 of the license application.

The applicant provided a plant material balance in application Figure 3-6 and showed a typical plant water balance in application Figure 3-7. These figures show that all byproduct material liquid waste will be sent to the deep disposal wells during production and restoration operations. No storage or evaporation ponds will be constructed for liquid byproduct material disposal. The applicant will have to amend its license application to propose another disposal option if it does not receive the UIC permit.

3.1.3.3 Nichols Ranch Unit Production Area Operations

The applicant plans to start production in the “A sand” ore zone in succession and also perform restoration sequentially. The Nichols Ranch Unit will be divided into two production areas, Nichols Ranch Unit Production Area (PA) #1 and Nichols Ranch Unit PA #2, which are shown in Figure 3-10 in the application. Operations in PA #1 will start first, and as the uranium yield drops below the economic limit, wells in PA #2 will start producing to maintain the desired flow rate. When uranium in all of PA #1 is depleted past its economic limit, restoration will begin, and all production flow will come from PA #2.

The applicant stated that the Nichols Ranch Unit will be operated at a maximum rate of 13,247 Lpm (3,500 gpm), and that more fluid will be recovered than injected to maintain an inward hydraulic gradient in each well field in the ISR operation. This difference, known as a bleed, is adjusted as necessary to maintain a ground water cone of depression to prevent excursions. The applicant reported that the operating well field bleed at the Nichols Ranch Unit will be approximately 0.5-1.5 percent, with an average bleed anticipated to be 1 percent or 132.4 Lpm (35 gpm). Maintaining an inward hydraulic gradient which draws ground water flow into the well field is a critical aspect of operations at ISR facilities to prevent excursions and lixiviant escaping the ore zone. Therefore, the staff will require maintenance of an inward hydraulic gradient with the license condition presented in SER Section 3.1.4. The bleed amount will not be specified in the license condition, as the required amount will vary depending on the operational stage of the well field set by the licensee.

The applicant prepared a ground water flow and contaminant transport model for the Nichols Ranch Unit to evaluate the extent of the cone of depression, excursion control and capture behavior, and horizontal flare during production and restoration operations. The ground water model was presented in application Addendum 3B, and the USGS codes of MODFLOW 96 (Harbaugh and McDonald, 1996) and MT3DMS (Zheng and Wang, 1999) were used for ground water flow and contaminant transport, respectively. These codes are widely available and are generally accepted for use in addressing issues related to ground water flow and contaminant transport. Therefore, the staff agrees with the use of these models.

The applicant's ground water model for the site included the proposed license area and covered approximately 13,080 km^2 (5,050 mi^2), as shown in application Figure MPG 1-1. A refined grid was used with a grid size in the license area of approximately 15.24 m by 15.24 m (50 ft by 50 ft). The NRC staff concludes that this grid size is acceptable to create sufficient scale resolution to simulate the variation in head within the well field and monitoring well ring. The "A sand" ore zone was simulated as five layers of varying thickness to capture the location of ore bodies within three distinct ore zones in layers three, four, and five. These layers were identified as the upper, middle, and lower ore zones, respectively. The transmissivity (hydraulic conductivity multiplied by thickness) of layers one, two, and four was set at 0.929 m^2/d (10.0 ft^2/day), and layers three and five were set at 0.708 m^2/day (8.4 ft^2/day) based on the results from field pumping tests. Storage coefficients and vertical conductivities were based on estimated field values. The NRC staff finds the applicant's model grid definition and input parameters acceptable.

The applicant simulated and matched the natural ground water gradient across the model using general head boundary conditions. However, staff notes that the applicant did not attempt to calibrate the model to field measured water levels or to verify the model with pumping test data. No sensitivity analysis of input parameters was conducted. The NRC staff finds that without calibration, verification, or a sensitivity analysis, the model is not considered to be a rigorous representation of the ground water flow behavior of the license area, but staff concludes it is still useful for general predictions of the ground water flow behavior.

To simulate the flow behavior during production, the applicant defined two separate well fields, Well Field #1 and Well Field #2, and two different operating periods. Operations were first simulated in Well Field #1 with 18 months of extraction. Well Field #1 operations were then discontinued and followed by 18 months of extraction operation in Well Field #2. The simulation continued for another 3 years with no extraction operations.

Each well field simulation by the applicant contained a combination of staggered injection and production wells arranged in a line-drive pattern for the long, thin ore bodies. The applicant presented the location of the injection and production wells for Nichols Ranch Unit Well Field #1 and #2 in the upper, middle, and lower ore zones in application Figures MPG1-3, 1-4, and 1-5, respectively. Injection wells were generally located on the upgradient side and the production wells on the downgradient side of the ore body. A total of 221 production wells and 266 injection wells were distributed among the three zones in Well Field #1, and production rates were approximately 59.8 Lpm (15.8 gpm). Injection rates ranged from 20.82 to 106.7 Lpm (5.5 to 28.2 gpm). A total of 164 production wells and 183 injection wells were distributed among the three ore zone layers in Well Field #2. The anticipated production rate was 80.6 Lpm (21.3 gpm), and the injection rates ranged from 35.95 to 151 Lpm (9.5 to 39.9 gpm). The total production rate of each well field while in operation was 13,247 Lpm (3,500 gpm), and the bleed rate was 1 percent or 132.5 Lpm (35 gpm).

The applicant presented the modeled drawdown for the middle ore zone of Well Field #1 after 1 year of production at a bleed of 132.5 Lpm (35 gpm), as shown in Figure MPG 1-6 in the application. Drawdown for this layer was selected as the maximum anticipated drawdown because over half of the production comes from the middle ore zone. Drawdown is shown to be approximately 3.05 m (10 ft) at 3.2 km (2 mi) from the license boundary after 1 year. The applicant also presented the modeled drawdown for the middle ore zone of Well Field #2 after 3 years in Figure MPG 1-13 in the application. This timeframe includes 1.5 years for Well Field #1 and then 1.5 years of Well Field #2 production at a bleed of 132.5 Lpm (35 gpm). Drawdown for the middle ore zone was selected as the maximum anticipated drawdown because over half of the production comes from this layer. Drawdown is shown to be about 10.7 m (35 ft) at 3.2 km (2 mi) from the license boundary after 3 years.

However, the staff notes that the applicant did not simulate the expected drawdown for the combined production and restoration phases in Well Field #1 and Well Field #2. The applicant estimated that the consumptive use will be approximately 378.5 Lpm (100 gpm) in these combined phases, which the staff finds will increase the magnitude and extent of the drawdown. The NRC staff notes that a larger drawdown will increase the inward gradient, which will lessen the probability of an excursion.

In Section 7.2.3.1 of the application, the applicant stated that confidential surface use agreements will be put in place with the landowners to address mitigation measures that the applicant would implement if a landowner's well is impacted by drawdown from the proposed Nichols Ranch ISR Project (Uranerz, 2007). The applicant stated that these measures may include providing additional pumping capacity or replacing the well. The NRC staff notes that the drawdown in private wells is not a safety issue, so the NRC will not require any other commitment from the licensee to address this issue.

In application Figure MPG 1-7, the applicant also presented the modeled potentiometric contours for the middle ore zone of Well Field #1 after 1 year of operation. The staff determined that the simulated contours demonstrated that an inward gradient is maintained to prevent excursions. The application also presented several potentiometric contours for both Well Field #1 and #2 at different times during production. These simulated contours also support the conclusion that an inward gradient would be maintained during anticipated production operations and during restoration operations that will have even greater consumptive use. Although the ground water modeling presented by the applicant is a simulation that generally represents the site conditions, the staff concludes that it is sufficient to demonstrate that an inward gradient is created by the proposed operating condition and can be maintained to prevent excursions. To support the ground water modeling predictions submitted by the applicant, the staff will impose a license condition, discussed in Section 5.7.8.4 of this SER, which requires the applicant to perform well field testing of the first production area in the Nichols Ranch Unit once the entire well field is installed and to provide the NRC staff with a report on the results for review and approval. The NRC staff will assess the report to determine if the field testing verifies the ground water flow modeling predictions showing that the inward gradient will be sufficient to prevent excursions under the proposed operating conditions.

The applicant also used the ground water flow model to perform contaminant transport modeling to determine the pore volume of the ore zone aquifer that will be impacted by lixiviant at the Nichols Ranch Unit. The NRC staff notes that the pore volume is used as a basis for determining the surety cost for restoration, but its value is otherwise not a safety issue. The pore volume is initially calculated as the product of the aquifer area, thickness, and porosity. It is then multiplied by a combined horizontal and vertical flare factor. Horizontal flare and vertical flare are essentially safety factors, expressed as percentages of original pore volume, which are used to estimate the volume affected by dispersion of a contaminant. Dispersion represents the movement vertically and horizontally outside the original pore volume as the result of small variations in the pore pathways in the aquifer. The NRC staff notes that contaminant modeling is routinely used to predict the dispersive motion of a contaminant in ground water and is therefore an acceptable method to assess horizontal flare. SRP Chapter 6.1.3 presents additional discussion of pore volume and flare.

The applicant used the industry-accepted MT3DMS contaminant transport software package to determine the horizontal flare. The applicant described the contaminant modeling approach and simulations in detail in Addendum 3B, and these are acceptable to the NRC staff. The applicant estimated that the horizontal flare was 1.19 from the contaminant modeling simulation. The applicant used a vertical flare of about 1.22 based on reported values from ISR operations in nearby Wasatch ore zone aquifers. The applicant stated that the combined flare was about 1.45, which is equivalent to a 45 percent increase in the original pore volume due to dispersion. The NRC staff concludes that the applicant's estimated flare values are acceptable based on the guidance provided in SRP Section 6.1.3(2).

Finally, the applicant used the ground water flow modeling to predict the potential for excursions and the ability to capture an excursion. For this case, the applicant first simulated the operation of Well Field #1 using balanced injection and extraction rates for 60 days. Then the production rates were adjusted at two wells in the middle ore zone to create a local imbalance in injection and extraction rates to create an excursion. Extraction rates at the wells were then adjusted to retrieve the excursion.

Application Figure MPG 1-17 presents the results of the change in head for the well imbalance simulation which lasted 60 days. This figure shows that the imbalance created a large outward gradient which is over 244 m (800 ft) wide and extends a distance of more than 366 m (1,200 ft) from the well field. Thus, the staff concludes that the reduction in production rates results in a loss of inward gradient and therefore the potential for excursion over a large area. Application Figure MPG1-18 shows the head contours when the production wells are increased for 60 days to retrieve the excursion. This figure shows that the inward gradient has been reestablished over 305 m (1,000 ft). Based on this modeling, the applicant stated that a distance of 152 m (500 ft) for monitoring wells spaced 152 m (500 ft) apart would be adequate to detect this excursion. SER Figure 3.1-1 shows the general location of perimeter monitoring wells at the Nichols Ranch Unit for excursion detection monitoring. The NRC staff agrees with the applicant's selection of spacing based on the modeling. The use of modeling to assess monitoring well spacing conforms to the guidance provided in SRP Section 5.7.8.3(3).

The staff concludes that general ground water modeling at the Nichols Ranch Unit shows that an excursion could happen with an imbalance in production and extraction rates and spread over a large area. The applicant concluded that the excursion could be captured by reestablishing an inward gradient to reverse the ground water flow back into the well field. The modeling also indicated that an excursion will be detected and captured at the Nichols Ranch Unit within 60 days. Based on its review of the application, including modeling results and a commitment under a license condition to verifying this modeling by production area well field testing, the staff concludes that the applicant has adequately described its monitoring program, provided an initial demonstration that inward gradients will be maintained, and showed that the proposed monitoring well network will detect excursions in the Nichols Ranch Unit.

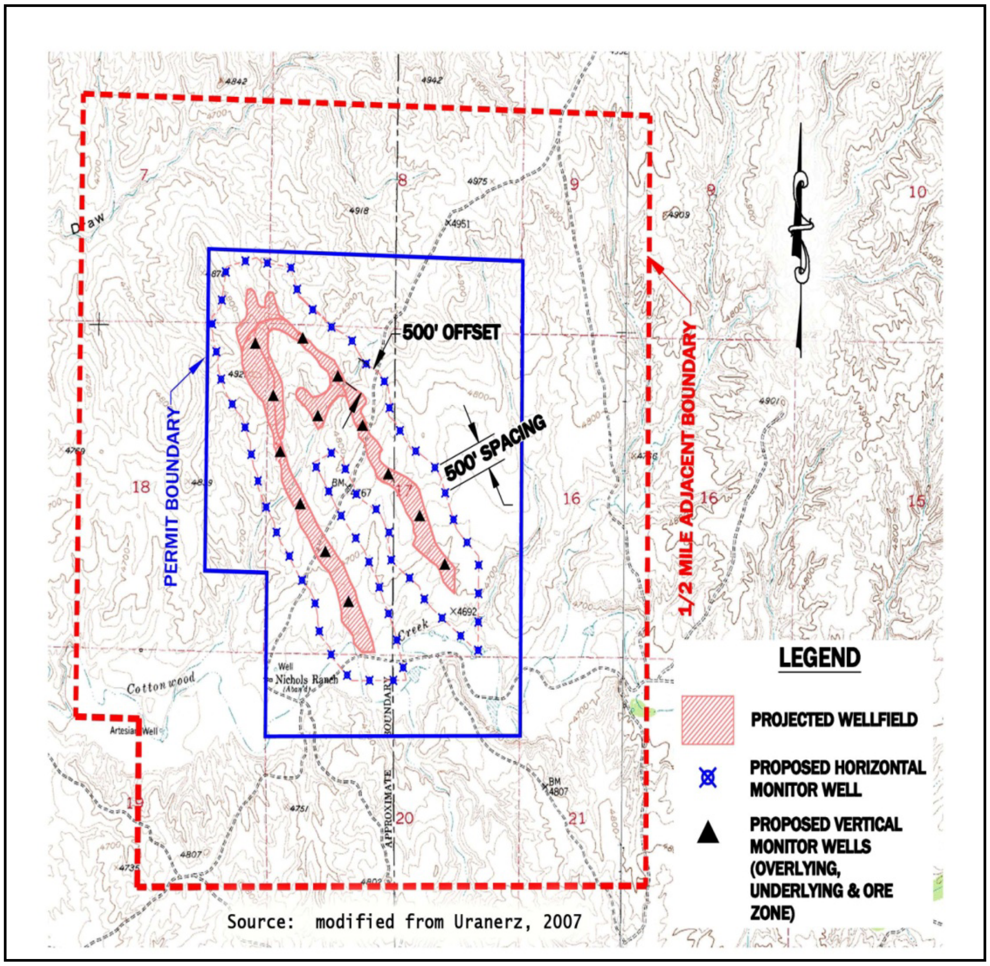

Figure 3.1-1 Proposed Nichols Ranch Unit horizontal monitor wells

3.1.3.4 Hank Unit Production Area Operations

The applicant plans to start production in the Hank Unit well fields in succession and also perform restoration sequentially. The Hank Unit will be divided into two production areas, Hank Unit PA #1 and Hank Unit PA #2, as shown in Figure 3-11 in the application. Operations in PA #1 will start first, and, as uranium is depleted below the economic limit, operations in PA #2 will start to maintain the desired flow rate. When all of PA #1 is past its economic limit, it will go into restoration, and all production flow will come from PA #2.

The applicant reported that the Hank Unit will be operated at a maximum rate of 9,462 Lpm (2,500 gpm) and will have a well field bleed of 2.5–3.5 percent to maintain an inward hydraulic gradient in each well field. The average bleed is therefore anticipated to be 3 percent or 284 Lpm (75 gpm), which will be disposed of in deep disposal wells. The applicant reported that the ore zone in the Hank Unit is in the “F sand” unconfined (unsaturated over part of its thickness) aquifer.

The NRC staff notes that the ground water flow in the unconfined (unsaturated) “F sand” aquifer at the Hank Unit behaves differently than flow in a confined (saturated) aquifer. It therefore poses unique safety challenges to the ISR operation, which the applicant must address. The following sections discuss these safety issues individually.

3.1.3.4.1 Demonstration of Inward Gradient in the “F Sand” Unconfined (Unsaturated) Aquifer

The NRC staff notes that flow to a production well in an unconfined aquifer produces a different response than in a confined aquifer. The water drawn into the well in an unconfined aquifer is derived from gravity drainage of the sediments, in addition to the mechanisms of compression of sediments and expansion, which alone move water to a well in a confined aquifer. This drainage provides more water to the well per pore volume of aquifer and creates dewatered cones of depression of limited areal extent around production wells. In contrast, when water is injected into an unconfined aquifer, it creates mounding of the ground water at the injection wells because of the addition of fluids. The dewatered depressions and injected water mounds in an unconfined aquifer produce a continuous variation in the water levels in the aquifer, which can be visualized as numerous peaks and valleys within a well field. This is in contrast to the water level response in a confined aquifer like the “A sand” in the Nichols Ranch Unit. In a confined aquifer, a continuous inward gradient is present as the drawdown is expressed as a large cone of depression much like a large bowl which is deepest within the well field and extends over and outside the well field. This difference in ground water response in the unconfined aquifer can alter an operator’s ability to maintain an adequate inward hydraulic gradient for excursion prevention and control.

To evaluate the inward gradient created in the unconfined aquifer setting by the proposed bleed, the applicant presented an analytical simulation of the well fields using the “Welflo” program developed by Walton (1989). Based on this analysis, the applicant concluded that an inward gradient could be maintained with a 3-percent bleed in the Hank Unit. The staff accepts the use of this model as the author is a recognized expert in this type of modeling. The staff, however, finds this analysis to be inadequate for the unconfined aquifer because the simulations used only extraction wells at low bleed rates to represent consumptive use. Therefore, it did not consider the fact that, during operation, the extraction wells will create dewatered cones and the injection wells will create ground water mounds that will affect the inward gradient estimates.

To address staff concerns about the analytical modeling, the applicant prepared an unconfined (unsaturated) aquifer ground water flow and contaminant transport model to evaluate the inward gradient produced by anticipated operations. The applicant used the widely accepted USGS codes of MODFLOW 2005 (Harbaugh, 2005) with a module, UZF, for unsaturated ground water flow and MT3DMS (Zheng and Wang, 1999) for contaminant transport. Application Addendum 3C presents ground water flow and contaminant transport models.

The model for the site was centered over the license area and extended out for several miles to cover 786 km^2 (283 mi^2), as shown in application Figure MPH 1-1. A refined grid size was used in the license area of about 9.1 m by 9.1 m (30 ft by 30 ft) to create sufficient resolution to simulate the variation in head within the proposed well fields and monitoring well ring. The "F sand" ore zone unconfined aquifer was simulated as one layer with an initial saturated thickness of 27.4 m (90 ft). Hydraulic conductivity was set at $3.53x10^{-4}$ cm/s (1 ft/day), and the specific yield of the unconfined aquifer was set to 0.14. The applicant stated that these values were derived from the field pumping test data. The staff finds the design and input parameters of the model to be acceptable.

In a method similar to that of the Nichols Ranch Unit ground water model, the applicant simulated and matched the natural ground water gradient across the model using general head boundary conditions. The staff notes, however, that the applicant did not attempt to calibrate the model to field measured water levels or to verify the model with pumping test data. Therefore, the staff finds that the model cannot be considered a rigorous representation of the flow behavior of the Hank Unit license area, though it is still useful for general predictions of the ground water flow behavior.

To determine if an inward gradient was established during production in the unconfined "F sand" aquifer, the applicant defined two separate well fields, Well Field #1 and Well Field #2, and two different operating periods. Operations were first simulated in Well Field #1 with 18 months of extraction. Well Field #1 operations were then discontinued and followed by 18 months of extraction operation in Well Field #2. The simulation continued for another 3 years with no extraction operations. Drawdown was not simulated for the combined production and restoration phases that will be used in the actual operation of Well Field #1 and #2.

For the production phase simulations, each well field contained a combination of staggered injection and production wells arranged in a line-drive pattern for the long, thin ore body. The applicant presented the location of the injection and production wells for Well Field #1 and #2 in application Figures MPH1-2 and 1-3, respectively. Injection wells were generally located on the upgradient side and the production wells on the downgradient side of the ore body. A total of 198 production wells and 271 injection wells were located in Well Field #1. Production rates were stated to be 47.3 to 48 Lpm (12.5 to12.7 gpm), and injection rates ranged from 21.6 Lpm to 48 Lpm (5.7 to 12.7 gpm). A total of 93 production wells and 119 injection wells were distributed among the three ore zone layers in Well Field #2. The production well rates were 101.8 Lpm (26.9 gpm) each, and the injection rates ranged from 59 to 75.7 Lpm (15.6 to 20 gpm). The total production rate in each well field while in operation was 9,462 Lpm (2,500 gpm), and the bleed rate was 3 percent or 284 Lpm (75 gpm).

The applicant presented the modeled drawdown for the "F sand" ore zone in Well Field #1 after 1 year of production at 284 Lpm (75 gpm) in Figure MPH 1-5 in the application. The NRC staff finds that, on the downgradient west side of the ore body, a sufficient inward gradient is maintained with at least 1.52 m (5 ft) of drawdown extending out at least 61 m (200 ft). On the upgradient eastern side, however, the staff finds that the injection wells create three large areas of outward gradients as a consequence of the ground water mounding. The heads in the ground water mounding areas range from 0 to -1.52 m (0 to -5 ft) (negative drawdown indicates a mound in ground water models) over a distance of more than 152 m (500 ft) from the ore zone. The staff concludes that these results demonstrate that an inward gradient is not maintained at the Hank Unit in this Well Field #1 operating scenario. The outward gradient that is created indicates that ground water is flowing away from the ore zone and thus could create an excursion. The staff notes that the simulation is only an estimate of the possible flow for a given production pattern and rates; however, the staff concludes that the line-drive pattern with injection wells on the upgradient side, as presented in the model, could result in ground water mounding, which creates an outward gradient and flow away from the well field that may lead to well field excursions.

In Figure MPH 1-7 in the application, the applicant presented the modeled drawdown for the "F sand" ore zone in Well Field #2 after 1.5 years of production at 284 Lpm (75 gpm). The NRC staff finds that, for the downgradient west side of the ore body, a sufficient inward gradient is maintained with at least 1.52 m (5 ft) of drawdown extending out almost 305 m (1,000 ft). On the upgradient eastern side, however, the staff finds that the injection wells on the northern half create a large region of outward gradient as a consequence of the ground water mounding. Hydraulic heads in the ground water mounding areas range from 0 to -4.5 m (0 to -15 ft) over a distance of more than 305 m (1,000 ft) from the ore zone. These results are also reflected in the potentiometric head surfaces for the same simulation in Figure MPH 1-8. The staff concludes that this modeling exercise demonstrates that an outward gradient is created at the Hank Unit in this Well Field #2 operating scenario such that ground water is flowing away from the ore zone, which could potentially create an excursion. Similar to Well Field #1, the simulation is only an estimate of the possible flow for given production pattern and rates; however, the staff notes that the line-drive pattern, as presented in the model, could result in an outward gradient that may lead to well field excursions.

The NRC staff therefore concludes that the applicant has not demonstrated the ability to maintain an inward hydraulic gradient in either Hank Unit Well Field #1 or Well Field #2 for the line-drive operating scenarios. The staff recognizes the limitations of the ground water modeling, but also notes that it is generally representative of expected field conditions. To ensure the safety of operations at the Hank Unit, the staff will therefore impose several license conditions before operations may commence and during operations at the Hank Unit. First, before any operations may begin, the NRC staff will require that the applicant, by license condition presented in Section 3.1.4, conduct a hydrologic field test in the Hank Unit, at a scale of its choosing, to demonstrate that an inward gradient can be created and maintained during proposed Hank Unit operations. The applicant must submit a complete report on the hydrologic field test for review and approval by the NRC before full-scale well field installation and operations may begin in the Hank Unit. If the NRC staff does not find the results of the hydrologic test satisfactory, it will not approve operations in the Hank Unit.

In addition, the NRC staff finds that, for the ISR operation to be safe, an inward gradient must be routinely demonstrated at the Hank Unit to show that ground water flow is toward the well field to prevent excursions. Therefore, if the NRC approves the operation of the Hank Unit based on its evaluation of the results of the hydrologic field test, the applicant will be required, by license condition presented in SER Section 3.1.4, to confirm the presence of an inward gradient at the Hank Unit during the lifetime of the operation. Under this license condition, the licensee will be required to install dedicated water level monitoring wells, known as "trend wells," in the "F sand" production unit to demonstrate that an inward gradient is maintained during full-scale operations. The NRC will require these "trend wells" to be installed on the upgradient (eastern) side of the well field spaced approximately every 152 m (500 ft) horizontally, between the edge of the production wells and the production zone monitoring well ring wells. The licensee will be required to collect water-level measurements every 2 weeks for these trend wells and monthly for all upgradient perimeter monitoring wells during the lifetime of operations. The applicant must interpret the gradient between these trend wells and perimeter production zone monitoring wells to ensure that the inward gradient is maintained between the trend wells and the production zone perimeter monitoring wells. If an outward gradient is observed, the applicant will be required to inform the NRC within 7 days and adjust operations until the outward gradient is eliminated.

3.1.3.4.2 Excursions and Limiting Extraction Rates in the “F Sand” Aquifer

The NRC staff notes that dewatering may occur in an unconfined aquifer during extraction, which can substantially lower water levels in the aquifer. Dewatering near a production well in an unconfined aquifer may affect the operation of the well fields by limiting extraction rates as submersible pumps have a water-level requirement to prevent motor burnout. This dewatering limitation on pumping rates could potentially affect the control and capture of excursions.

To demonstrate excursion capture in the unconfined (unsaturated) “F sand” aquifer, the applicant first presented analytical modeling of the well fields using the “Welflo” program developed by Walton (1989). Based on these analytical results, the applicant concluded that it could provide adequate excursion capture. The staff determined the analytical modeling of excursion capture to be unacceptable, as it reported only the difference in head between nodes and not the actual drawdown experienced at each node in the aquifer. The NRC staff finds that the reporting of only this difference masks the magnitude of the drawdown at the individual nodes that will be created during excursion capture. The staff concludes that when true extraction and injection rates are applied over this area, excessive dewatering from drawdown at the extraction wells may occur. Excessive dewatering can lead to the failure of the extraction wells, as they are essentially pumped dry, which may prevent the capture of the excursion.

To estimate the extent of the dewatering expected in the Hank Unit, the staff evaluated the field results from the applicant’s multiwell pumping test at URHZF-5. The pumping test results showed that a drawdown of approximately 12.2 m (40 ft) occurred after a 5-day pumping test at 15.1 Lpm (4 gpm). The NRC staff concludes that, if the saturated thickness above the ore zone averages 15 m (50 ft) as reported by the applicant, this drawdown would reduce the water level to 3.3 m (10 ft) at the extraction well. If more extraction wells are operating, such as in the case of actions taken to capture an excursion, the dewatering will be even more severe. Lowering the water level near the well can dewater the well and also impact submersible pump performance as such pumps require a certain head (water level) to operate efficiently. Therefore, the staff concludes that dewatering of wells in the unconfined (unsaturated) aquifer will limit the flexibility in the extraction rates that can be used at Hank Unit to capture an excursion.

To address the excursion capture and dewatering issue, the applicant used the unconfined (unsaturated) ground water flow and contaminant transport model for the Hank Unit described in SER Section 3.1.3.4.1 to evaluate the dewatering limitation on extraction rates and the ability to capture excursions. The excursion scenario involved creating a temporary and local imbalance in the production and extraction rates in the well field and then increasing production rates to retrieve the excursion.

The applicant began the modeling simulation by operating a subset of Well Field #1 with 88 production wells at 47.3 Lpm (12.5 gpm) and 125 injection wells at rates from 19.7 to 48 Lpm (5.2 to12.7 gpm) under a balanced extraction and injection condition for 30 days. Application Figure MPH-13 shows the potentiometric head for this well field scenario at the end of 30 days. The staff concludes that an acceptable inward gradient is formed on the downgradient side during this simulation. The staff, however, found that an unacceptable outward gradient is present in the southern section on the upgradient side. The applicant then changed the modeling inputs by reducing the production rates by 3.94 Lpm (1.04 gpm) each in the four southernmost wells for 30 days to create a local imbalance in rates to simulate an excursion. The potentiometric surface for this imbalance, shown in application Figure MPH1-14, indicates that an outward gradient is created, which could allow an excursion to occur. To simulate a retrieval of the excursion, the applicant adjusted the model input production rates at the four wells up to 3.94 Lpm (1.04 gpm) for 30 days to retrieve the excursion as shown in application Figure MPH 1-15. This figure shows that an inward gradient has been reestablished to draw the excursion back towards the well field. The applicant repeated the same simulation for imbalance and retrieval using a 60-day timeline for each, with results similar to those shown in Figures MPH 1-16 and MPH 1-17. The applicant indicated that the loss of inward gradient as a consequence of an imbalance in rates in an unconfined aquifer is a slow process, which is gradually reversed by overproduction due to the flow behavior. The NRC staff finds that these simulations produce the expected behavior of the unconfined aquifer and that the applicant has demonstrated that excursion capture is possible by increasing extraction rates.

The applicant also stated that the results of these simulations show that a small reduction in production rates creates a loss of inward gradient over at least an area of 152 m (500 ft) which would be detected by a monitoring well ring spacing of 152 m (500 ft). Based on these simulations and the guidance in SRP Section 5.7(3), the staff finds that the monitoring well spacing is sufficient to detect an excursion.

The applicant did not use this modeling to provide a limiting extraction rate for excursion capture. The applicant, however, did use a second model, the accepted USGS WTAQ program (Barlow and Moench, 1999), to determine a limiting extraction rate (Uranerz, 2010a). The applicant determined that the average extraction rate for the Hank Unit unconfined aquifer "F sand" will likely be limited to 30.3 Lpm (8 gpm), which would produce drawdowns of about 16.5 m (54.0 ft) at the extraction wells at 1 year from a saturated thickness of 15.2 to 21.3 m (50 to 70 ft) over the ore body. The applicant stated that with these rates, the Hank Unit will have to operate at less than the projected 9,462 Lpm (2,500 gpm) to prevent dewatering.

The NRC staff finds that this initial estimate of the limiting extraction rate using the WTAQ analytical model is acceptable. However, by license condition stated in SER Section 3.1.4, the applicant will be required to conduct a production area pumping test in the Hank Unit before operations may begin. The results of these pumping tests will be provided to the NRC staff for review and approval and will provide the field data the staff will need to determine the limiting extraction rate. If staff determines that the limiting extraction rate is not acceptable for excursion capture and therefore poses a safety issue, the staff may choose not to approve operations in the Hank Unit or to require additional testing or license conditions to ensure the safety of the operations.

3.1.3.4.3 Horizontal and Vertical Flare

The NRC staff notes that ground water dewatering and mounding in an unconfined aquifer affect the estimation of vertical and horizontal flare as sediments are drained and resaturated.

Section 3.1.3.3 of this SER provides the definition and estimation of horizontal and vertical flare and their use to determine the pore volume affected by lixiviant. The applicant used contaminant transport modeling to predict the size of the horizontal flare at the Hank Unit with the widely accepted MT3DMS contaminant transport code. Application Addendum 3C describes this modeling in detail. The applicant determined that the horizontal flare was 1.39 from the simulations, a value that staff noted to be higher than the typical horizontal flare at other ISR projects; however, the higher value is considered to be a function of the line-drive pattern.

To determine the vertical flare, the applicant analyzed the mounding and drawdown behavior of a representative injection well and extraction well in an unconfined aquifer using standard analytical techniques. Application Addendum 3C describes this analysis in detail. The applicant's analysis of this information resulted in a vertical flare estimate of approximately 1.22. The staff concludes that this vertical flare estimate should be doubled so that an additional 22 percent of the ore zone aquifer will be exposed to the lixiviant to account for the fact that the applicant has indicated that production zone wells will be alternated between extraction and injection during operations. The staff therefore concludes that the corrected value of vertical flare is 1.44. When added to the horizontal flare, the staff calculated a total flare factor of 1.83. The applicant has committed in the application to the use of a flare factor of 1.89. The NRC staff concludes that the applicant's estimated flare values are acceptable, based on the guidance in SRP Section 6.1.3(2).

3.1.3.4.4 Pumping Test Strategy for Monitoring Well Ring Communication

The NRC staff notes that localized dewatering and mounding behavior affects the pumping tests that are needed to show communication across the well field with the perimeter monitoring ring wells. The applicant stated that monitoring wells will be installed in the production zone in an example pattern shown in Figure 3.9 in the application. Excursion monitoring wells for each well field are located on a ring that is set 152 m (500 ft) from the nearest production well pattern, with 152 m (500 ft) between monitoring wells. Figure 3.1-2 shows the general location of perimeter monitoring wells for excursion detection monitoring at the Nichols Ranch Unit. The applicant provided analytical and ground water model simulations, which indicate that the cone of depression will reach the monitoring well ring at the Hank Unit under anticipated operating scenarios, as described above, except where an outward gradient is present. Although staff accepts the use of modeling to make an initial assessment of connectivity, the staff concludes that to verify the modeling, which indicates wells installed in the well field are in communication with the monitoring well ring, the applicant must conduct field pumping tests.

The staff finds that the steep drawdown and limited areal extent of drawdown created by pumping in the unconfined (unsaturated) "F sand" aquifer will require a unique pumping test strategy to ensure that the well field is in communication with the monitoring well ring. Such pumping tests will need to be conducted when the well fields are installed, as part of the hydrologic data collection for each well field. By license condition, the applicant will be required to submit these pumping tests for the first production areas in both the Nichols Ranch and Hank Units to the NRC for review and approval and also to submit other production area tests to the NRC for review. Section 5.7.8.4 of this SER discusses this license condition. The applicant indicated that it would require at least three pumping tests to establish communication with observation wells 305 m (1,000 ft) distant. The staff notes that a 5-day multiwell pumping test conducted by the applicant at URZHF-5 at 15.2 Lpm (4 gpm) in the Hank Unit did not create a response at observation wells located 152 and 305 m (500 and 1,000 ft) distant. Therefore, to demonstrate the effectiveness of the proposed monitoring well spacing, the applicant committed

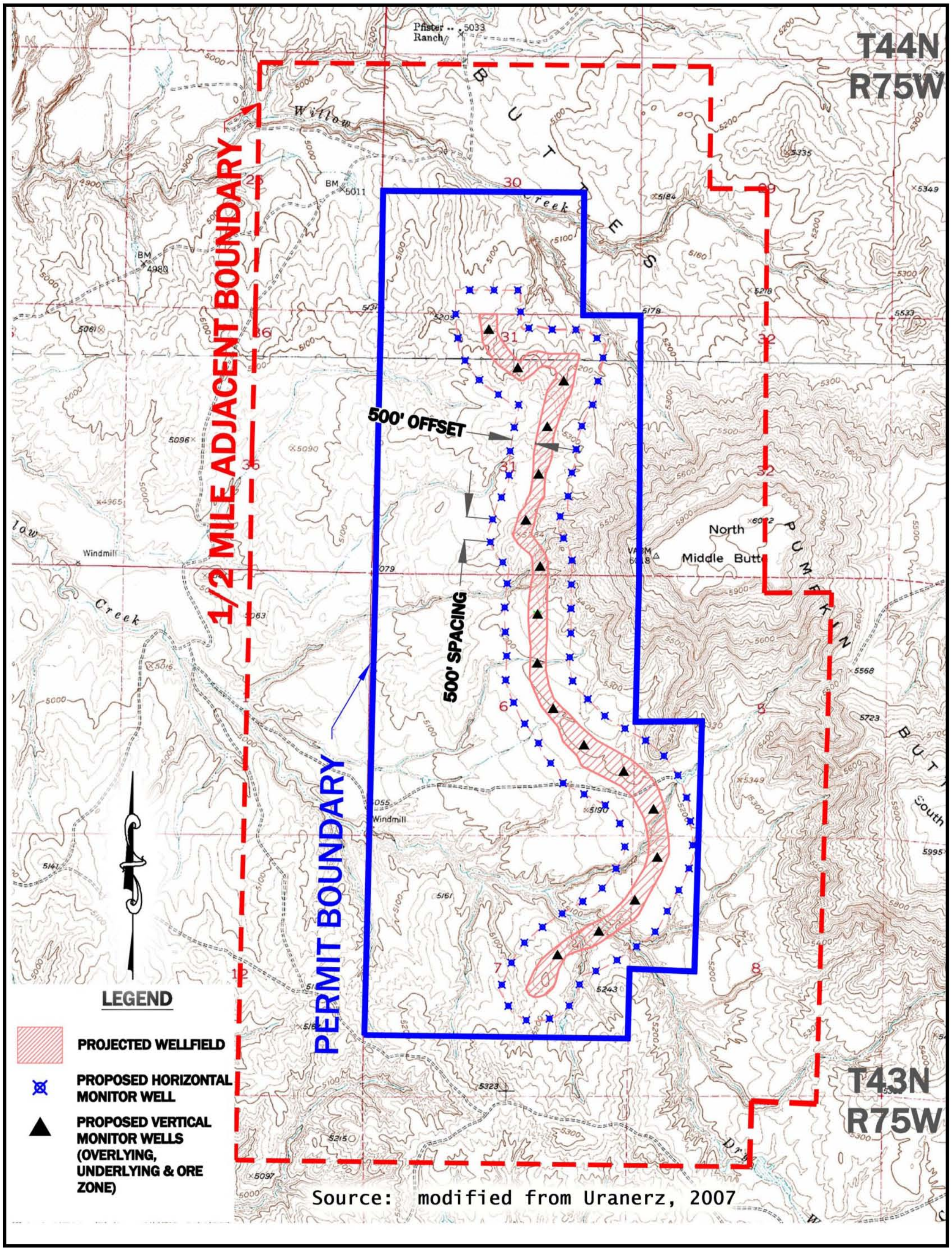

Figure 3.1-2 Proposed Hank Unit horizontal monitor wells

in response 3.1.9 to open issues dated February 24, 2010 (Uranerz, 2010c), to present a pumping test strategy to the NRC for approval before conducting the well pumping test, as stated in application Section 5.7.8.4.

3.1.3.4.5 Dissolved Oxygen Use in Lixiviant

The NRC staff notes that the unconfined aquifer in the Hank Unit has a lower potentiometric head because of the initially lower water levels. These water levels will decrease as the aquifer experiences dewatering during production. The staff also notes that when lixiviant with high concentrations of dissolved oxygen is injected into lower hydrostatic head, the dissolved oxygen will evolve out of solution to create a gas phase along with the existing water phase in the aquifer. This two-phase flow system can create reduced hydraulic conductivity, known as “gas lock,” near the injection and extraction wells and throughout the aquifer (Bear, 1972). This reduced hydraulic conductivity can unpredictably change the flow system and may therefore impact the control of excursions. In addition, reduced hydraulic conductivity may also cause portions of the production zone to be bypassed during restoration.

The applicant stated that the lixiviant will be composed of varying concentrations and combinations of sodium carbonate, sodium bicarbonate, oxygen, and carbon dioxide added to native ground water. The staff notes that this composition of lixiviant with dissolved oxygen has been used in ISR operations in confined aquifers and is known to be amenable to ground water restoration. Its successful application in unsaturated/unconfined (unsaturated) aquifers, however, has not been established.

The NRC staff notes that if the use of dissolved oxygen in lixiviant causes gas lock at the Hank Unit, it may create regions of lower hydraulic conductivity in the “F sand,” which can lead to the following safety issues in the operation of the ISR extraction process:

- If injectivity is reduced at the injection well due to gas lock, it will cause pressures to rise in the tubing and potentially result in well shut-in or in a worst case scenario, well casing failures.

- As the evolution of the gas will depend on the hydrostatic head in the aquifer, the reduction in hydraulic conductivity due to gas lock may change the flow system unpredictably. Instead of the expected pattern of dewatering and mounding for the well field and associated cone of depression, preferential flow may develop, which cannot be predicted. This may lead to more excursions and difficulty in correcting excursions.

- Reduced hydraulic conductivity from gas lock may cause portions of the production zone to be bypassed during restoration, such that complete restoration of the aquifer may not be achieved.

- The presence of a gas phase can lead to two-phase flow in piping, casing, and pumps that were not designed to handle simultaneous water and gas flow. This can lead to failures in equipment and problems with instrumentation used to measure flows and pressures.

To address gas lock, the applicant originally stated that the water level in the “F sand” was at least 15.2 m (50 ft) over the ore body and would be sufficient to keep oxygen in solution. In addition, it stated that the increase in head at injection wells would also assist with retaining oxygen in solution (Uranerz, 2009a).

To evaluate this conclusion, the NRC analyzed the potential for gas lock to occur during operations at the Hank Unit. Using a general rule for dissolved oxygen concentration of 1 milligram per liter (mg/L) per 0.3 m (1 ft) of hydrostatic head, the staff determined that the maximum dissolved oxygen that can be maintained in the lixiviant at the injection wellhead will be 50 mg/L plus perhaps another 20 mg/L due to increased injection pressure. At the extraction well, the dissolved oxygen level that can be maintained in the lixiviant will be less because drawdown may be up to 15.2 m (50 ft) leaving the water level at 6.1 m (20 ft) or 20 mg/L oxygen at the extraction wells. The NRC staff notes that ISR operations report dissolved oxygen levels in lixiviant in excess of 200 mg/L during production. Based on this analysis, the staff concludes that operations using dissolved oxygen in lixiviant at the Hank Unit at levels greater than around 70 mg/L could lead to a free gas phase which can create gas lock. This could affect the flow system in the “F sand” aquifer such that excursions would increase, and contact during restoration could be impacted. The presence of a free oxygen gas phase could also damage wells, piping, and pumps and interfere with instrumentation such as flow and pressure measurements.

To address this issue, the applicant stated in the license application that it will monitor the solution recovered from extraction wells to ensure that excess oxygen is not present to prevent gas lock (Uranerz, 2010a). It stated that periodic testing of oxygen levels will be performed on the recovery solution to ensure that the oxygen solubility limit is not exceeded. Special care will also be taken to control the amount of oxygen added to the injection solution in areas of low hydrostatic pressure to ensure that free gas oxygen does not present a problem. Additional corrective actions, such as alternating wells between injection and extraction, may be used to keep oxygen in solution. Finally, the applicant stated that if necessary, additional wells will be installed in the ore zone just below the upper aquitard to bleed off any gas collected. The staff agrees that these actions should detect and correct for the presence of free gas evolution in the “F sand” and infrastructure. The staff finds that the proposed detection and corrective measures if free gas is observed should be sufficient to prevent safety issues with gas lock and prevent the occurrence of free gas in piping and pumps. However, the staff will require that any gas lock conditions be reported to the NRC so that staff can monitor how the issue is being addressed and determine whether further action is needed.

3.1.3.5 Schedule

The applicant presented a general production, restoration, and decommissioning schedule for the ISR operation in Figure 3-12 in the application. This schedule shows the following:

- Nichols Ranch Unit PA #1—Production will begin in late 2010 and continue until mid-2013. Restoration will begin in early 2013 and continue through mid-2016.
- Nichols Ranch Unit PA #2—Production will begin in early 2013 and continue through 2014. Restoration will begin in 2016 and continue until early 2107 for 1 year.
- Hank Unit PA #1—Production will begin in early 2011 and continue through 2013. Restoration will begin in mid-2013 and continue for 5 years through 2018.

- Hank Unit PA # 2—Production will begin in late 2013 and continue through 2015. Restoration will not begin until late 2018 and continue for 1 year.

- Decommissioning will commence in either Nichols Ranch Unit or Hank Unit well fields at the end of restoration. The applicant noted that these are proposed timelines which depend on the disposal well capacity, and restoration methods will be updated as necessary.

The staff finds these estimates acceptable for the Nichols Ranch Unit PA #1. The staff finds the schedule for the Nichols Ranch Unit PA #2 unacceptable because restoration is not scheduled to begin until 2 years after the end of production, and the applicant has not presented a basis for this delay in restoration. Additionally, the staff finds that the schedule for the Hank Unit is not acceptable because the applicant has indicated that the extraction rates will be limited by dewatering to an average of 30 Lpm (8 gpm), such that the proposed total production rate of 9,462 Lpm (2,500 gpm) will not be achieved. The staff is also requiring a hydrologic test for the Hank Unit to resolve several issues related to the demonstration of inward gradient and excursion capture. The applicant has also not explained the 3-year delay in restoration for Hank Unit PA #2. This delay is not consistent with NRC regulations in 10 CFR 40.42 for the decommissioning of outdoor areas, such as well fields. Therefore, the NRC will require the applicant to provide a schedule and a basis for its restoration schedule for Nichols Ranch PA #2 and Hank Unit PA #1 and #2 by license condition, as described in SER Section 3.1.4. The NRC would consider any delay in restoration under the regulations in 10 CFR 40.42(i), which allows for an alternative decommissioning schedule if the Commission determines it is warranted.

3.1.4 Evaluation Findings

The staff reviewed the ISR process and equipment proposed for use at the Nichols Ranch ISR Project in accordance with SRP Section 3.1.3. The applicant described the well field infrastructure, equipment, and ISR operations and used the results from field testing and ground water modeling to support the safe application of ISR. The applicant addressed the mineralized zone(s) and demonstrated protection against the vertical migration of water, proposed acceptable well designs and tests for well integrity, and demonstrated that the ISR process will meet the following criteria:

- Downhole injection pressures are less than formation fracture pressures.

- Overall production rates are higher than injection rates to create and maintain a cone of depression, with exceptions noted below.

- Plant material balances and flow rates are appropriate.

- Reasonable estimates of gaseous, liquid, and byproduct material and effluents are provided (used in evaluation of effluent monitoring and control measures in SRP Section 4.0).

- Disposal operations and capacity are sufficient (see SER Section 4.2.4 for the staff's findings on disposal operations).

The applicant has described operations in the Hank Unit PA #1 and PA #2. However, the applicant has not demonstrated the ability to maintain an inward hydraulic gradient in either Hank Unit PA #1 or PA #2 for the line-drive operating scenarios. Therefore, the staff will impose the following license condition which will require the applicant to conduct a hydrogeologic test to demonstrate that an inward gradient can be maintained:

A. Prior to lixiviant injection at the Hank Unit, the licensee will conduct a hydrologic test. The hydrologic test must be scaled and designed to simulate proposed injection and extraction operational conditions at the Hank Unit to demonstrate that an inward hydraulic gradient can be maintained that prevents excursions beyond the perimeter production zone monitoring well ring. The licensee will report the results of the hydrologic test to the NRC for review and approval prior to lixiviant injection into the production area.

B. The licensee will install "trend" monitoring wells on the upgradient (eastern) side of Hank Unit PA #1 and PA #2 approximately every 500 feet apart and approximately 300 feet from the injection wells. The licensee will collect water level measurements twice monthly and at least 10 days apart from the trend wells and monthly water level measurements from the production zone monitoring well ring. If water level measurements indicate that an outward gradient exists, the licensee will inform the NRC within 7 days and adjust operations until the outward gradient is eliminated.

The ability to operate with overall production rates higher than injection rates to create and maintain a cone of depression is an important aspect of operations. In addition to demonstrating the ability to maintain an inward gradient in the above license condition, the staff will impose the following license condition to ensure that a cone of depression is maintained during operations:

> The licensee shall maintain an inward hydraulic gradient in each individual production area, starting when lixiviant is first injected into the production zone and continuing until the restoration target values (RTVs) have been reached.

The applicant has also not explained the 3-year delay in restoration for Hank Unit PA #2. Therefore, the NRC will require the applicant to provide a schedule for Nichols Ranch PA #2 and Hank Unit PA #1 and #2 by the following license condition:

> The licensee will update or confirm the restoration schedule for the Nichols Ranch Unit Production Area (PA) #2 and provide a basis to the NRC for review and approval for any alternate schedule request that meets the requirements of 10 CFR 40.42.
>
> The licensee will update or confirm the restoration schedule for Hank Unit PA #1 and #2 at the completion of the hydrologic test in the Hank Unit as required by this license. The licensee will provide a basis to the NRC for review and approval for any alternate schedule request that meets the requirements of 10 CFR 40.42.

The staff will impose the following license condition related to possible gas lock in the "F sand" at the Hank Unit:

> The licensee will notify the NRC within 24 hours if "gas locking," as discussed in the approved license application, has occurred in the "F sand" at the Hank Unit

during operations. The licensee will submit a report within 30 days to the NRC documenting corrective actions taken to ensure that operation of the production zone is proceeding as provided in the application.

Staff has determined that the confined and saturated aquifer conditions and properties at the Nichols Ranch Unit are similar to those observed at other ISR facilities throughout the PRB that have operated safety and have been protective of human health and the environment. At the Hank Unit, the unconfined and unsaturated aquifer conditions have not been widely observed within the PRB ISR facilities, and staff has had little experience with these conditions. Therefore, staff has determined that the additional testing and field data required by license conditions for the Hank Unit will allow for further staff evaluation of the conditions at the site to ensure the protection of public health and safety before operations. Staff notes that after the license has been issued, including that for the Hank Unit, the licensee will not be able to operate the Hank Unit until the staff approvals required by the license conditions have been granted. Based on the review conducted by the staff as indicated above, the information provided in the application, as supplemented by the noted license conditions during operations, meets the applicable acceptance criteria of SRP Section 3.1.3 and the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.1.5 References

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3.2 Central Processing Plant and Other Facilities

3.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the equipment and processes used during operation in the CPP and other facilities at the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.2.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in SRP Section 3.2.3 (NRC, 2003).

3.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and drawings submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The Nichols Ranch Unit would consist of the CPP, auxiliary facilities (office, change room, laboratory, and maintenance), well fields in the Nichols Ranch Unit ore zone, and deep disposal wells. Major equipment inside the 45.7 x 76.2 m (150 x 250 ft) processing building would be the IX circuit, lixiviant makeup circuit, elution/precipitation circuit, and yellowcake drying facility. At the Hank Unit site, facilities would include a plant building, a maintenance building, well fields in the Hank Unit ore zone, and deep disposal wells. Major equipment inside the 24.4 x 48.8 m (80 x 160 ft) processing building would be an IX circuit and lixiviant makeup circuit.

The CPP at the Nichols Ranch Unit would have three major solution circuits: recovery/extraction circuit, elution circuit, and yellowcake slurry production circuit. The recovery/extraction circuit includes the flow of lixiviant from the well field to the IX columns and back to the well field. Bleed, as discussed previously, will constitute 0.5 to 3.5 percent of the barren lixiviant stream. Bleed fluids would be disposed of in deep disposal wells.

The elution circuit would release the uranium from the loaded IX resin by application of an aqueous solution of salt and sodium carbonate or sodium bicarbonate. The yellowcake production circuit would begin with the addition of an acid to the eluate, which will destroy the carbonate portion of the dissolved uranium complex. Precipitation reagents (hydrogen peroxide and sodium hydroxide or ammonia) then would be added to precipitate uranium yellowcake slurry. This slurry would then be filtered, washed, dried, and drummed. Application Figure 3-3A is a flow diagram of the Nichols Ranch Process circuit.

The applicant stated that the potential effluents requiring controls at the Nichols Ranch ISR Project include radon, radioactive particulates, and radionuclides in liquid streams. Locations of potential sources for radiological emissions in the CPP are the IX columns, elution circuit area, precipitation area, rotary vacuum dryer room, and yellowcake storage area. In the IX column, elution area, and/or precipitation area, radon could be present; to prevent its accumulation, building ventilation systems and tank vents would be used. The applicant committed in application Section 4.1.1.1 to maintaining general ventilation of work areas with a forced air system circulating through the process area and providing local ventilation piping for process vessels where significant concentrations of radon may be released. The potential effluents and sources of radiological emissions identified by the applicant, as well as proposed ventilation, are similar in nature and design to those typical of the ISR industry. Therefore, the staff considers these aspects of the applicant's proposed facility to be adequately protective.

To protect against the release of air particulates, the applicant committed in application Section 4.1.2 to using a rotary vacuum dryer under negative pressure, along with ventilation and dust collection equipment controls, including a bag house and condenser. Each of these areas will be monitored as described in SER Section 5.7. In addition, SER Sections 4.1 and 4.2 discuss information on gaseous, liquid, and solid effluent control including descriptions of the size, type, and location of all ventilation, filtration, confinement, dust collection, and radiation monitoring equipment. The applicant committed in application Section 3.2.6 to having readily available the most current safety equipment and personal protective equipment at the Nichols Ranch Unit and the Hank Unit. The CPP, satellite facilities, and equipment proposed for use by the applicant are similar in nature and design to those the staff has observed in use throughout the uranium ISR industry. Therefore, the staff considers these aspects of the applicant's proposed facility to be adequately protective.

The Nichols Ranch Unit will be designed for a production flow rate of up to 13,265 Lpm (3,500 gpm), while the Hank Unit will be designed for a production flow rate of 9,475 Lpm (2,500 gpm). The applicant committed to installing two deep injection wells on the Nichols Ranch Project that are anticipated to accept, at a minimum, 379 Lpm (100 gpm) each. The applicant is planning to seek permits through the WDEQ for up to four wells at each unit; however, installation of deep disposal wells will be staged to install only those that are necessary for operations, restoration, and backup capacity.

The applicant has included a list of chemicals that may be used in the uranium recovery process. These include hydrochloric acid, hydrogen peroxide, sodium chloride, sodium hydroxide, sodium hypochlorite, ammonia, oxygen, carbon dioxide, sodium carbonate, and sodium bicarbonate. Material safety data sheets for each of the chemicals will be located at the Nichols Ranch Unit and the Hank Unit. Hazardous chemicals that have the potential to impact radiological safety are ammonia, hydrogen peroxide, and hydrochloric acid; these would be stored outside and segregated from areas where licensed materials are processed and stored. The applicant stated that for these hazardous chemicals, it will comply with EPA's risk management program regulations. Chemicals proposed for use are similar to those discussed in NUREG-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees," Chapter 4, "Consequence Analyses" (NRC, 2001). NUREG-6733, Table 4-1, presents a list of chemicals used at ISR facilities and pertinent regulations for those chemicals. The applicant has listed (consistent with NUREG-6733) the specific regulations that apply to the chemicals that would be used. The applicant's identification of applicable Federal regulations to ensure proper handling of hazardous chemicals is consistent with the SRP and is therefore acceptable to the staff.

Gasoline, diesel, and propane will also be used, but not in the uranium process. Since these materials are flammable, bulk quantities will be stored outside of the main buildings. The storage tanks will be located above ground and within secondary containment basins in compliance with local regulations. The applicant's identification of applicable local regulations to ensure proper storage of flammable materials is consistent with the SRP. Therefore, the staff considers this approach adequately protective and acceptable.

3.2.4 Evaluation Findings

The staff reviewed the proposed equipment to be used and materials to be processed in the recovery plant and chemical storage facilities at the Nichols Ranch ISR Project in accordance with SRP Section 3.2.3. The applicant described the equipment, facilities, and procedures that it will use to protect health and minimize danger to life or property. The proposed processing facilities, equipment, and materials to be used at the Nichols Ranch ISR Project are the same or very similar to the facilities, equipment, and materials widely used throughout the ISR industry. Staff has regularly observed and inspected facilities similar to those being proposed by the applicant. These facilities have been found to be protective of public health, safety, and the environment over their operational history. Based on the review described above, the staff concludes that the information provided in the application meets the acceptance criteria of SRP Section 3.2.3, as well as the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.2.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2001. NUREG/CR-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees," Washington, DC, June 2001.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

3.3 Instrumentation and Control

3.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the instrumentation and control proposed for the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.3.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c) using the acceptance criteria in SRP Section 3.3.3 (NRC, 2003).

3.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and drawings submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant committed to installing instrumentation to monitor and control the ISR process in the CPP, satellite plant, production circuits, well fields, header houses, lines from the well field to the plant, and the deep disposal well. The control system would provide continuous monitoring and alarms that are set to go off when operating parameters are outside of the specified operating ranges. Operators will be required to perform corrective actions to correct the reason for the alarm. Extreme tank levels or pressures would activate automatic shutdown of equipment for that area. Header houses, pipelines, and deep disposal wells are the sources of risk for large spills and would have high- and low-pressure and flow alarms for automatic shutdown of related equipment.

Within the plant, the applicant committed to monitoring the total plant flow, total waste flow leaving the plant, and tank levels. Additionally, a low vacuum alarm for the dyer would indicate either the need for corrective action or automatic shutdown. The applicant will follow the manufacturer's recommendations for the operation and maintenance of the dryer. The applicant will record the operating information on dryer performance that is required by 10 CFR Part 40, Appendix A, Criterion 8. Critical systems would be equipped with backup systems that are automatically activated in a power failure or operating failure.

The applicant stated in application Section 3.4.6 that during well field operations, well fields will be designed to operate at 1034 kPa (150 psi), and injection pressure at the injection wellheads will not exceed 90 percent of the MIT pressure. Well field flows and pressures may be continually recorded but, at a minimum, would have once a day recordings, and pressures would be maintained below casing and formation rupture pressures.

The applicant has committed to monitoring individual injection and recovery flows and pressures at each header house. Individual well flow readings will be recorded at least once per day, and the overall well field flow rates will be balanced at least once per day. Standard operating procedures (SOPs) would address alarm responses, automatic shutdowns, and startup after automatic shutdowns.

Although specific details of the control and shutdown interlock systems selected will be provided later in the design and construction process, the applicant has indicated that one potential system could be the Allen-Bradley Programmable Logic Controllers. Whatever the final selection, the applicant has committed that it will be based on a process safety hazard analysis that will identify and define parameters for normal and emergency operation and include a cause and effect chart that will detail actions to be taken based on operational events. The applicant will fully test the control system to confirm that it meets the design parameters and shutdown requirements.

The staff has determined that the instrumentation and control systems have been acceptably described (or otherwise acceptably committed to) for components including the well fields, well field houses, trunk lines, production circuit, and deep injection disposal wells. The staff observes that the instrumentation allows for continuous monitoring and control of systems, including total inflow to the plant, total waste flow exiting the plant, tank levels, and the yellowcake dryer. Additionally, appropriate alarms and interlocks would be included with the instrumentation systems. Each control system would be equipped with a backup system that automatically activates in the event of a failure of the operating system or a common cause failure such as a power failure. As control would be maintained in the event of a common cause failure, the staff considers this approach protective of public health and safety. Therefore, the applicant's proposed approach is acceptable to the staff. The NRC will review and inspect final as-built details of the instrumentation and control systems prior to facility operation.

3.3.4 Evaluation Findings

The staff reviewed the proposed instrumentation and controls for the Nichols Ranch ISR Project in accordance with SRP Section 3.3.3. The applicant adequately described the instrumentation and controls that will be used at the Nichols Ranch ISR Project. The instrumentation and controls proposed for this ISR project are the same or very similar to instrumentation and controls widely used throughout the ISR industry. Staff has observed and inspected facilities similar to those being proposed by the applicant, and these facilities have shown themselves to be protective of public health, safety, and the environment over their operational history. Based on the review conducted by the staff as indicated above, the information provided in the application meets the applicable acceptance criteria of SRP Section 3.3.3 and the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.3.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

4.0 EFFLUENT CONTROL SYSTEMS

4.1 Gaseous and Airborne Particulates

This section discusses the basic design of the gaseous and airborne particulate effluent control systems for the Nichols Ranch ISR Project. The purpose of the effluent control systems is to prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere by the use of emission controls and to ensure compliance with radiation dose limits for the public.

4.1.1 Regulatory Requirements

For gaseous and airborne particulates generated at the Nichols Ranch ISR Project, the staff determines if the applicant has demonstrated compliance with Criterion 8 of Appendix A to 10 CFR Part 40, which requires that milling operations be conducted so that all airborne effluent releases are reduced to ALARA levels. Criterion 8 states, "Milling operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this must be by means of emission controls." Although Criterion 8 focuses on effluent releases from the yellowcake dryer and tailings, it does not exclude radon releases from ISRs. The applicant must also demonstrate that releases of gaseous and airborne particulates comply with other relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria presented in SRP Section 4.1.3 (NRC, 2003).

4.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in the technical report of its application (Uranerz, 2007) and as updated.

The applicant stated in application Section 4.1 that the two main contaminants of concern for air effluents are radon gas and radioactive particulates. The staff agrees with the applicant's assessment of the principal contaminants of concern. In application Section 4.1 and Section 7.3.1, the applicant has identified several potential gaseous effluent release points. Small amounts of Rn-222 may be released into the plant building during solution spills, filter exchanges, resin exchanges, and maintenance activities. The plant building will be equipped with a general area and local ventilation system to remove any radon that may be released into the building. The staff agrees that the ventilation systems described should control radon daughters and uranium air particulate levels and ensure that workers do not exceed 10 CFR Part 20 dose limits and that exposures are ALARA. Additionally, the applicant will make periodic surveys to ensure that airborne radioactive materials are adequately controlled. Another set of radon release points is the plant vents. Vents from the individual IX units will be connected to a manifold that will be exhausted outside the plant building through the plant vent(s).

The applicant used operations parameters and the MILDOS-AREA computer code (Yuan et al., 1989) to predict the source terms and public doses for the Nichols Ranch ISR Project. Application Section 7.3 provides this radiation dose information. SRP Section 7.3.1.2.2 states, "An acceptable computer code that calculates off-site doses to individuals from airborne emissions from in situ leach facilities is MILDOS-AREA." The staff agrees that the methodology used by the applicant is acceptable to the NRC for determining source terms and public doses.

The applicant will use process design and engineering controls to limit the concentrations of radioactive material in air. Examples of process design and engineering controls proposed by the applicant include the use yellowcake vacuum dryers to control uranium releases and the use of a pressurized downflow system to collect and control radon releases from process equipment. Staff notes that the use of yellowcake vacuum dryers and pressurized downflow systems is known to limit airborne releases (NRC, 2003). The applicant also plans to use general area and local ventilation systems to control radon progeny concentrations in the workplace.

4.1.3.1 Airborne Uranium

The applicant stated that it will use a vacuum dryer to dry yellowcake and that, by design, vacuum dryers discharge no uranium particulates during normal operations. The staff evaluation is that uranium airborne releases from vacuum dryer operations are very low (NRC, 2003) and that the applicant's radiological monitoring programs are designed to verify that radioactive releases are within 10 CFR Part 20 limits and exposures are ALARA. Airborne uranium particulates would be eliminated by the vacuum dryer emissions control equipment, which consists of a bag house, condenser, and a vacuum pump. A vacuum pump also provides local ventilation for the yellowcake-packaging hood. According to the applicant, the bag house is an air filtration unit mounted directly above the drying chamber to allow uranium solids collected on the bag filter surfaces to be periodically returned to the drying chamber. The bag house will be heated to prevent condensation and will be kept under negative pressure. A condenser will be located downstream of the bag house and will be water cooled. Uranium particulates that pass through the bag filters will be wetted and entrained in the condensing moisture within this unit. Lastly, the vacuum pump will capture entrained uranium particulates.

The applicant stated that the yellowcake dryer and packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weight scale, or other suitable device will be used to determine when a drum is full. Discussed by the applicant as a local ventilation system, the yellowcake packaging hood fits on the top of the drum and is vented through the bag house to the condenser and the vacuum pump system when the yellowcake is being packaged. Staff notes that this design is considered to reduce airborne uranium to ALARA levels.

The applicant stated in application Section 4.1.2 that operating procedures will be implemented to satisfy the requirements of 10 CFR Part 40, Appendix A, Criterion 8, regarding operational checks. These procedures will include dryer emission control instrumentation to provide an audible and/or visual alarm if the vacuum level is outside specifications. Operation of the system will be monitored during drying and packaging operations, and alarm capability will be checked and recorded each shift. Yellowcake drying operations will be immediately suspended if any emission controls equipment for the yellowcake packaging and drying operations is not operating within the manufacturer's specifications. Otherwise, effluent controls will be operated in accordance with 10 CFR Part 40, Appendix A, Criterion 8. The staff concludes that the applicant has operating procedures and instrumentation to ensure that the yellowcake dryer emissions control equipment will be operational during yellowcake drying operations. In addition, if the emissions controls monitoring instrumentation should fail, the applicant stated in application Section 4.1.2 that an operator will document checks of the vacuum every 4 hours. The staff concludes that this is consistent with the 10 CFR Part 40, Appendix A, Criterion 8, requirements for checks of emissions control system operability and is acceptable to protect public health and safety from airborne uranium.

4.1.3.2 Radon

Rn-222 is found in pregnant lixiviant extracted from the well fields and piped into the facility for separation of uranium. Because the applicant proposed pressurized downflow columns, as described in application Section 7.2.4, Rn-222 will remain in solution and be present in the barren lixiviant. The applicant indicated that a separate, local ventilation system would be installed for all indoor process tanks and vessels where Rn-222 or process fumes would be expected. The ventilation system will consist of air ducts or piping systems connected to the top of each of the process tanks. Vents from individual vessels will be connected to a manifold that will exhaust effluent outside the plant building through the plant stack.

The applicant proposes redundant exhaust fans that will direct collected gases to discharge piping. Discharge stacks will be located away from building ventilation intakes to prevent the introduction of exhausted radon into the facility. Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation systems, controlling any releases that occur inside the vessel. The staff has determined that the applicant has developed sufficient controls for plant equipment to channel potential radon in the workplace to the outside atmosphere and minimize radon exposure to workers in the plant.

Based on staff experience with similar ventilation controls at similar uranium recovery facilities, the staff concludes that the radon ventilation controls will be adequate to control worker exposure to below 10 CFR Part 20 limits and to keep exposures ALARA.

To the extent that it applies, Criterion 8 of Appendix A to 10 CFR Part 40 requires milling operations to be conducted so that all airborne effluent releases are reduced to ALARA levels, and the primary method of accomplishing this must be through the use of emission controls. The applicant plans to discharge gaseous effluents outside the plant building through a plant stack but has not demonstrated how the gaseous effluents will be monitored and reduced to ALARA levels. The staff evaluation determined that the applicant did not have an adequate technical basis for the environmental monitoring program regarding the location of radon monitors. The applicant has not demonstrated that the radon monitor locations are at the expected highest radon concentrations for assessment of the public dose from facility radon releases. The staff has thus determined that the applicant has not demonstrated that dose limits to individual members of the public will meet the requirements of 10 CFR 20.1301, "Dose Limits for Individual Members of the Public," and 10 CFR 20.1302, "Compliance with Dose Limits for Individual Members of the Public." Therefore, the license condition discussed in SER Section 4.1.4 will be included in the license. This condition will require that the applicant demonstrate that monitor locations are at the expected highest radon concentrations for assessment of the public dose from facility radon releases.

The staff expects radon releases during IX column maintenance operations. After the columns are disconnected, small amounts of Rn-222 may be released in the plant building during solution spills, filter changes, IX resin transfer operations, and maintenance activities. In addition to the general forced air ventilation system, the applicant proposed in application

Section 4.1.1.2 that local ventilation systems may be used temporarily for functional areas within the plant to control radon levels.

As described in application Section 4.1.1.1, the Nichols Ranch CPP general ventilation system will draw fresh air into the building by using four fans with a capacity of 283 cmm (cubic meters per minute) (10,000 [cubic feet per minute] cfm) each to exhaust inside air out of the building. The air exchange rate will be approximately 2.7 air exchanges per hour. For the Hank satellite facility, the general ventilation system will consist of two fans with a capacity of 283 cmm (10,000 cfm) each, and the air exchange rate for the two fans is approximately 3.1 air exchanges per hour. The staff concludes, based on operational experience at similar uranium recovery operations, that the applicant has proposed sufficient controls to minimize air radon concentrations in the plant and minimize radiation exposures from radon and radon progeny to workers in the plant. In addition, the applicant stated in application Section 4.1.1 that routine air sampling measurements will be made to ensure that radon and radon progeny levels do not exceed 10 percent of the applicable 10 CFR Part 20 limits.

The staff notes that the applicant does not directly address radon emissions or controls in the PA header houses. However, the staff observes that exhaust fans used to control the buildup of oxygen and to prevent explosions in the PA header houses, as discussed in application Section 7.5.4, will also control the buildup of radon and radon progeny at these locations. The staff notes that radon air monitoring in header houses at similar uranium recovery facilities has indicated that the radon levels are adequately controlled by header house fans.

4.1.4 Evaluation Findings

The staff reviewed the proposed effluent control systems for gaseous and airborne particulates for the Nichols Ranch ISR Project in accordance with SRP Section 4.1.3. The applicant acceptably described sources of radon and uranium, emission controls for the yellowcake dryer, the use of pressurized downflow systems to control radon releases from IX tanks, and the use of general and local ventilation to exhaust any radon released into the workplace and outside of the building. However, the applicant has not proposed an acceptable method for monitoring air effluent to unrestricted areas. The staff concludes, based on the lack of radioactive effluent monitors and the lack of an adequate technical basis for the design of the environmental monitoring program, that the applicant cannot demonstrate that it does not exceed the 10 CFR Part 20 public dose limits. Therefore, the staff is imposing the following license condition to ensure that an acceptable method for monitoring air effluent to unrestricted areas is developed so that proper effluent monitoring is in place during operations:

> Prior to the preoperational inspection, the licensee shall provide for the following information for the airborne effluent and environmental monitoring program in which it shall develop procedures to:
>
> (a) Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for, and verified by, surveys and/or monitoring.
>
> (b) Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.

(c) Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2.

(d) Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire License Area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.

The staff concludes that the instrumentation proposed will monitor the status of the dryer emission control systems and is adequate to meet 10 CFR Part 40, Appendix A, Criterion 8, for required periodic checks needed to demonstrate operability of the emission control systems. In addition, if the instrumentation is inoperable, the applicant stated that the operator will make periodic checks of emissions control systems to ensure operability.

The staff concludes that the proposed effluent control systems for gaseous and airborne particulate meet the applicable acceptance criteria of SRP Section 4.1.3 and 10 CFR Part 20 and Part 40 requirements. This conclusion is based on the review conducted by the staff as indicated above, the information provided in the application, as updated, and the information required in accordance with the license condition listed above.

4.1.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

Yuan, Y.C., J.H.C. Wang, and A.J. Zielen, 1989. “MILDOS-AREA: An Enhanced Version of MILDOS for Large-Area Sources,” ANL/ES-161, Argonne National Laboratory, Argonne, IL, June 1989.

4.2 Liquid and Solid Effluents

4.2.1 Regulatory Requirements

For liquid effluents generated at the Nichols Ranch ISR Project, the applicant must demonstrate compliance with 10 CFR 20.1301; 10 CFR 20.2002, “Method for Obtaining Approval of Proposed Disposal Procedures”; and 10 CFR 20.2007, “Compliance with Environmental and Health Protection Regulations.” For solid effluents generated at the Nichols Ranch ISR Project, the applicant must demonstrate compliance with 10 CFR Part 40, Appendix A, Criterion 2.

4.2.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 4.2.3 (NRC, 2003).

4.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

4.2.3.1 Liquids

The Nichols Ranch ISR Project will generate liquid waste from production bleed, restoration, miscellaneous plant wastewater, and domestic liquid waste. These liquid wastes can be considered as either liquid byproduct material waste or liquid non-byproduct material waste.

4.2.3.1.1 Liquid Byproduct Material Waste

Liquid wastes generated during the uranium recovery process are considered liquid byproduct material. Such waste streams include process bleed, process solutions, washdown water, restoration water, and water from well or accidental pipeline releases. The applicant stated that the process bleed and washdown water would be transferred to deep disposal wells and that the deep disposal wells would be equivalent in design and depth to existing deep disposal wells at similar ISR uranium recovery sites. Ground water restoration water would be treated by reverse osmosis (RO) or other purification technology. Treated RO restoration water (permeate) would be reinjected into the production area undergoing restoration, with the RO restoration reject (brine) transferred to a deep disposal well. The applicant stated that the liquid byproduct material waste stream would be approximately 378.5 Lpm (100 gpm) during the production and restoration phase of normal operations. Use of deep disposal wells requires a UIC permit for a Class I well from the WDEQ Water Quality Division. A maximum of eight deep disposal wells would be permitted through the WDEQ and operated according to permit requirements (Uranerz, 2010a).

Use of deep disposal wells also requires an NRC finding that the requirements of 10 CFR 20.1301 and 10 CFR 20.2002 are met. An applicant seeking approval for a waste disposal method under 10 CFR 20.2002 should include the following:

- a description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation and the proposed manner and conditions of waste disposal
- an analysis and evaluation of pertinent information about the environment
- the nature and location of other potentially affected licensed and unlicensed facilities
- analyses and procedures to ensure that doses are maintained ALARA and within the dose limits of 10 CFR 20.1301

Based on a currently operating ISR deep disposal well, the applicant has characterized the expected liquid waste stream in SER Table 4.2-1.

The applicant plans to seek permits for up to four Class I deep disposal wells at each of the Nichols Ranch and Hank Units for a total of eight wells and has committed in application Section 3.2.6 to having two wells drilled before the Nichols Ranch ISR Project startup (Uranerz, 2010a). The staff observes that having two disposal wells available at startup provides an alternative disposal option in the event that one of the wells becomes inoperable. The applicant has identified other hydraulic control methods that may be used if a disposal well becomes inoperable. These methods include the use of surge tanks, reducing production, or renting additional bladder tanks to increase the surge capacity. Staff finds these methods to be acceptable to ensure that the applicant has adequate disposal capacity and will be able to control its production area fluids to protect public health, safety, and the environment.

Table 4.2-1 Summary of Anticipated Waste Stream Water Quality

Chemical Species	Minimum (mg/L)	Maximum (mg/L)
pH (*standard units*)	5	7
Ammonia as nitrogen	1	1
Sodium	50	100
Calcium	400	700
Potassium	15	30
Bicarbonate as HCO_3	500	700
Carbonate as CO_3	0	0
Sulfate	600	800
Chloride	150	900
Uranium as U_3O_8	1	10
Radium-226 (pCi/L)	900	3,200
TDS	1,900	3,200

To ensure that the applicant will have a plan for other hydraulic control methods in case one of the disposal wells becomes inoperable for an extended period of time, the NRC staff will require by license condition that the applicant develop procedures for such a scenario for NRC review before the preoperational inspection. Staff finds that the development of procedures for hydraulic control is acceptable, and these procedures will be inspected before the start of operations. This license condition is presented in SER Section 4.2.4.

Class I wells are used to inject wastes into deep, isolated aquifers. Typically, deep disposal wells are constructed with several layers of materials that provide redundant layers of protection to minimize the possibility of liquids contaminating underground sources of drinking water. Additionally, operators are required to demonstrate that no significant leaks exist prior to operation through an MIT and every 5 years after for the life of the well. Operators are required to monitor several parameters, such as injection pressure, that would indicate potential failure of a deep injection well. These operational data will be included in reports that are available for NRC review during inspections of the facility.

The staff performed a conservative dose analysis for the direct radiation exposure expected from Ra-226 from one of the Nichols Ranch ISR Project deep disposal wells. The staff used the computer code MICROSHIELD version 7.0 for its calculations (Grove Software, Inc., 2006).

Dose rates were calculated based on a conservative value of 100 curies of Ra-226 in secular equilibrium with its daughters injected to a subsurface level of 1,127 m (3,700 ft) with a soil density of 1.76 grams per cubic centimeter (g/cm^3) (110 pounds per cubic foot (lb/ft^3)) (Lindenburg, 2003). The calculated dose rate at a receptor point 3 feet (0.91 m) directly above the wellhead was indistinguishable from natural background external radiation levels (e.g., natural background exposure level is typically 25 μR/hr). The staff has determined that the uranium inventory was not included in this dose analysis because natural uranium by itself is not a significant external dose hazard, and the uranium inventory dose rate would not have significantly altered the final calculated dose rate for the direct or external radiation exposure.

For its deep well disposal plans, the applicant has shown that it would be in compliance with the NRC regulations found in 10 CFR 20.2002 for the alternate disposal of byproduct material, as well as 10 CFR 20.1301. The applicant has described the expected liquid byproduct composition and has committed to obtaining a Class I deep well disposal permit from the WDEQ. The applicant's disposal plans for liquid byproduct material are contingent on approval by the WDEQ. The applicant did not identify the proposed geologic formation for deep well disposal. At other licensed ISR operations in the PRB and permitted by the WDEQ, injection is typically into formations greater than 1,127 m (3,700 ft) at depth. Staff notes that for WDEQ to issue a UIC permit, no exposure pathway can exist through drinking water. The UIC review process verifies that the injected fluids are isolated from the accessible environment, including potential sources of drinking water. The staff has analyzed potential radiologic doses through feasible exposure pathways; this analysis demonstrated that liquid waste disposal operations would result in doses that are ALARA. Additionally, SRP Section 6.1.3(13) states, "In general, applications that satisfy EPA regulations under the UIC Program, which are approved by the EPA or EPA-authorized State issuing the UIC permit and the applicable provision of 10 CFR Part 20, will also be approved by the staff."

The staff finds that approval of the deep disposal wells by WDEQ will satisfy 10 CFR 20.2007, which requires that disposal by injection in deep wells must also meet any other applicable Federal, State, and local government regulations pertaining to deep well injection. As a standard license condition, the applicant will be required to submit a copy of the WDEQ-approved permit to the NRC before injection of lixiviant can commence. Additionally, the staff will include a condition identifying the approved liquid effluent disposal method in the license issued to the applicant. SER Section 4.2.4 presents this license condition.

Liquid wastes also may occur due to accidental releases. In addition to monitoring equipment, the applicant will inspect for releases by conducting daily inspections of the process and storage areas, the operating well fields, and the header houses. Inspections will provide a visual survey of proper implementation of procedures and contamination control.

If a spill were to occur in the well field or process plants, measures would be taken to contain the spill and mitigate the impacts of any released material. These measures include notification of plant and corporate management along with contacting the NRC and State, if applicable. The applicant has stated in application Section 5.2.1.4 that spills, leaks, or excursions will be reported in accordance with 10 CFR 40.60, "Reporting Requirements." Staff notes that additional reporting, such as excursions, will be required by license condition, as discussed in other sections of this SER. The applicant stated that spills are likely to occur from leaking pipelines and fittings. If a pipeline leak or spill occurs in the plants, the spill or leak would be contained within the building with all spilled material collected in the plant sump. This material either would be pumped back into the process circuit or sent to the deep disposal well. Plants at both units will have a concrete foundation with concrete curbed sidewalls. The applicant has stated that the height of the concrete sides would be such that the curbed foundation would contain from 3 to 5 times the volume of the largest tank in the unit and would contain flow from a ruptured pipeline for enough time so that the automatic shutdown system can engage. Staff agrees with this assessment.

The applicant stated that production area spills would be contained using methods that are developed for process flow alarm responses, automatic shutdowns, and corrective action for such events and documented in SOPs. The spill area would be surveyed to identify any contaminated soil, and any identified contaminated soil would be removed for disposal according to NRC and State regulations. If any process vessels or tanks that contain, or have contained, radioactive materials need to be entered for any reason such as cleaning, inspection, or repairs, a radiation work permit (RWP) will be issued detailing the requirements for special air sampling, protective equipment, and increased exposure surveillance. The staff finds these methods acceptable and notes that they are consistent with generally accepted ISR industry practices.

4.2.3.1.2 Other Liquid Wastes

The applicant identified that the Nichols Ranch ISR Project would generate liquid waste from well development water and pumping test water. The applicant stated, and the staff agrees, that water generated during well development and pumping tests is regulated by WDEQ WYPDES permits and is expected to satisfy WDEQ-WQD Class III (Livestock) standards at a minimum. This water is not regulated by the NRC as it is not source or byproduct material because it has not been processed primarily for its source material content. The NRC would require no alternate handling or disposal method, as disposal of this water is regulated exclusively by WDEQ.

Domestic liquid wastes from restrooms and lunch facilities will also be generated at the Nichols Ranch ISR Project. These wastes are considered non-byproduct material and will be disposed of via a septic system that meets the requirements of the State of Wyoming. Other hazardous or nonhazardous liquids wastes not regulated by the NRC are subject to regulation by other Federal and State government agencies and are not discussed in detail in this SER.

4.2.3.2 Solids

Solid wastes normally would consist of spent resin, empty packaging, miscellaneous pipes and fittings, tank sediments, and domestic trash. These materials would be classified as either byproduct material or noncontaminated solid waste based on their radiological characteristics.

4.2.3.2.1 Solid Byproduct Material

Solid byproduct material would consist of solid waste contaminated with radioactive material that cannot be decontaminated (including any soils contaminated from the operations) and would be classified as byproduct material. This byproduct material would include filters, personal protective equipment, spent resin, soils, and piping. The applicant expects to produce approximately 45.9 to 68.8 m^3 (60 to 90 cubic yards [yd^3]) of byproduct material as waste per year. These materials would be temporarily stored on the sites within the fenced plant boundaries.

The applicant stated that accumulated byproduct material would be stored in 208-L (55-gal]) lined drums, which, when filled, would be moved to the plant’s byproduct storage area and placed in tight rolloff containers. Byproduct storage areas would have concrete pads and appropriate signage. Filled rolloff containers would be periodically disposed of at a site licensed to receive byproduct material, with which the applicant would establish a disposal agreement. The applicant has committed to notifying the NRC within 7 days if any disposal agreement is terminated and submitting within 90 days of agreement termination, a new agreement for NRC review. By license condition, the applicant will be required to submit a copy of the byproduct material disposal agreement before operations begin. The staff notes that solid byproduct material can be disposed of at a site licensed by the NRC or by an Agreement State. The requirement for a byproduct material disposal agreement will be included in a license condition presented in SER Section 4.2.4. This approach to solid byproduct material is consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 2, and is acceptable to staff.

4.2.3.2.2 Solid Non-Byproduct Material

Uncontaminated solid waste would be collected on the site in designated areas and disposed of in the nearest permitted sanitary landfill. The applicant stated that the project would produce approximately 535 to 765 m^3 (700 to 1,000 yd^3) of noncontaminated solid waste per year. These materials will be collected on site and disposed of at the nearest sanitary landfill, as authorized by State and/or local authorities.

The applicant has not identified hazardous waste. However, based on the staff's experience at other ISR facilities, it is possible that waste oil and universal hazardous wastes, such as used batteries, would be generated at the Nichols Ranch ISR Project. It is likely that the Nichols Ranch ISR Project could be considered a Conditionally Exempt Small Quantity Generator under the Resource Conservation and Recovery Act (RCRA). If the Nichols Ranch ISR Project cannot be considered a Conditionally Exempt Small Quantity Generator, the applicant may need to apply for additional permits from WDEQ, which has delegated authority under RCRA to regulate hazardous waste. The NRC does not regulate hazardous waste.

4.2.4 Evaluation Findings

The staff reviewed the aspects of solid and liquid effluents of the proposed Nichols Ranch ISR Project in accordance with SRP Section 4.2.3. The applicant described the solid and liquid effluents that would be generated at the facility. An acceptable disposal method (i.e., deep disposal wells) is identified for liquid byproduct material, pending approval through a WDEQ permit, and the disposal method would be of sufficient capacity to handle liquids from production and restoration efforts. As the safe disposal of liquid byproduct material is an important component of operations at the facility, the staff will include the following condition in the license issued to the applicant:

> All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit or disposed of as allowed by NRC regulations. Additionally, the licensee is authorized to dispose of process solutions, injection bleed, and restoration brine using deep well injection, as permitted by WDEQ and described in the approved license application.
>
> The licensee will obtain the necessary permits and construct a minimum of two Class I Underground Injection Control (UIC) deep disposal wells prior to the commencement of operations of the Nichols Ranch ISR Project. The licensee shall ensure the deep disposal wells shall have enough capacity to handle the

disposal of the total liquid effluent generation as stated in Section 3.2.6 of the license application. The licensee will ensure adequate deep well disposal capacity exists at each unit to dispose of liquids from each unit under normal operating conditions during production, production and restoration, and restoration phases as stated in Section 3.2.6 of the license application.

The licensee will notify the NRC within 24 hours if a disposal well is shut down and becomes inoperable, with the exception of routine maintenance or required testing that is completed within 48 hours of shutdown. If necessary, the licensee will use additional deep well capacity, surge tanks or cease injection activities until the disposal well is restored to use as written in Section 3.2.6 of the application. The licensee will notify the NRC when the disposal well is placed back into service and report any repairs or service completed on the well that is not associated with routine maintenance.

The licensee shall maintain a record of the volumes of solution disposed of in each disposal well and submit this information in the annual monitoring report.

Prior to the preoperational inspection, the licensee shall develop written procedures to control production fluids and maintain inward hydraulic gradient as required in license condition (LC) 10.9 if a disposal well becomes inoperable as discussed in LC 10.11.[1]

Although it has committed to securing and providing to the NRC its disposal agreement for solid byproduct material, the applicant does not yet have a plan in place for the disposal of these materials that will be generated by its facility. The applicant will be required by a standard license condition, listed in SER Appendix A, to submit a copy of the disposal agreement to the NRC prior to operations and maintain a copy of the agreement onsite.

The NRC staff concludes that the effluent control systems for liquids and solids generated by the facility meet the applicable acceptance criteria of SRP Section 4.2.3 and 10 CFR Part 20 and Part 40 requirements. This conclusion is based on the review conducted by the staff as indicated above, the information provided in the application, as updated, and the information required in accordance with the license condition listed above.

4.2.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

Grove Software, Inc., 2006. MICROSHIELD® Version 7.02, Lynchburg, VA.

Lindenburg, M.R., 2003. *Civil Engineering Reference Manual for the PE Exam*, Ninth Edition, May 2003.

[1] See Draft Materials License for Nichols Ranch ISR Project, LC 10.9 and LC 10.11 (NRC, 2011a).

NRC, 2011a. "Draft Materials License for Nichols Ranch ISR Project," Washington, DC, July 13, 2011, ADAMS Accession No. ML111950106.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Resource Conservation and Recovery Act, 42 U.S.C. §6901 et seq. (1976), Pub. L. 94-580.

Uranerz, 2010a. "Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application," file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.0 OPERATIONS

5.1 Corporate Organization and Administrative Procedures

5.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed corporate organization and administrative procedures for the Nichols Ranch ISR Project are consistent with the requirements of 10 CFR 40.32(b), which requires that the applicant is qualified through training and experience to use source materials.

5.1.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 5.1.3 (NRC, 2003).

5.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant's organizational structure is presented in application Section 5.1. The applicant's organizational structure flows vertically downward from the company's President. The President has the overall responsibility and authority for the radiation safety and environmental compliance programs. This person is responsible for ensuring that operations are compliant with applicable regulations, license conditions, and thus, for maintenance of the license. The President directly supervises the Executive Vice President in this capacity (Uranerz, 2007).

The Executive Vice President reports to the President and is directly responsible for ensuring that operations personnel comply with radiation safety and environmental protection programs and for ensuring compliance with all Federal and State regulations, license conditions, and reporting requirements. This person directly supervises the two functional area managers (Production Manager and Environment, Safety, and Health (ESH) Manager). The Production Manager reports directly to the Executive Vice President and is responsible for all production activity at the site and for implementation of industrial and radiation safety and environmental protection programs associated with operations. The Production Manager directly supervises the Mine Superintendent.

The Mine Superintendent reports directly to the Production Manager. This person is responsible for the day-to-day operation and management of construction and production activities at the site. The Mine Superintendent oversees and provides integration among the line management for the functional areas of administration, operations, maintenance, construction, and support. Various line managers provide oversight of all well field, production, and lab personnel and, in this capacity, directly supervise construction, operations, maintenance, and support activities.

The ESH Manager reports directly to the Executive Vice President and is responsible for all radiation protection, health and safety, and environmental programs, and for ensuring that environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. The ESH Manager advises senior management on matters involving radiation safety and has no production-related responsibilities. The ESH Manager supervises the Radiation Safety Officer (RSO).

The RSO, who reports directly to the ESH Manager, is responsible for conducting the radiation safety program and for assisting in ensuring compliance with NRC regulations and license conditions applicable to worker health protection. The RSO is responsible for overseeing the day-to-day operation of the radiation safety program and for ensuring that records required by the NRC are maintained. The applicant specified that the RSO has no production-related responsibilities. The staff notes that the RSO's principal responsibility is the protection of the environment and safeguarding the health and safety of workers and these responsibilities must not conflict with the applicant's production goals or schedules. The RSO supervises the Radiation Safety Technician(s). The staff agrees that the RSO's responsibilities and authority are consistent with those outlined in Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Section 2.1 (NRC, 2002b).

The Environmental Technicians and Radiation Safety Technicians report directly to the ESH Manager and the RSO, respectively. The Environmental and Radiation Safety Technicians assist the ESH Manager and the RSO in implementing the environmental monitoring and radiation safety programs and are responsible for collecting and recording all monitoring data. The Environmental and Radiation Safety Technicians have no production-related responsibilities. The staff notes that the Environmental Safety and Radiation Safety Technicians do not have production-related duties that could conflict with their principal responsibility to support the implementation of the environmental monitoring and radiation safety programs. The staff agrees that these duties are consistent with the authorities and responsibilities in Regulatory Guide 8.31, Section 2.1 (NRC, 2002b).

A Safety and Environmental Review Panel (SERP) would be established, in whole or part, from these management positions. SER Section 5.2 describes the SERP. The radiation safety and environmental programs at the Nichols Ranch ISR Project would be implemented in the context of keeping personnel and environmental exposure to radiation and radioactive material ALARA. Management, the RSO, and all workers at the Nichols Ranch ISR Project would share responsibilities for implementing the ALARA program.

The applicant has stated that all workers will be responsible for the following:

- adhering to all policies, operating procedures, and instructions for environmental protection and radiation safety as established by management

- reporting promptly to management equipment malfunction or violation of standard practices or procedures that could result in increased radiological hazard

- suggesting improvements for the environmental protection, radiation safety, and ALARA programs

The applicant has committed, as discussed above, to giving all employees the responsibility and independence to report violations or equipment malfunctions to management. SER Section 5.2 discusses administrative procedures developed by the applicant, and SER Section 5.7.9 discusses quality assurance.

5.1.4 Evaluation Findings

The staff reviewed the corporate organization and the applicant's commitment to developing administrative procedures for the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.1.3. The applicant described its corporate organization and defined management responsibilities and authority at each level. The organizational management structure diagram portrays the proposed integration among groups that support operation and maintenance of the facility. The proposed management structure is similar to the management structure and responsibilities at currently licensed ISR facilities that have proven to be protective of public health, safety, and the environment. Based on the review described above, the staff concludes that the proposed corporate organization and administrative procedures described in the application meet the acceptance criteria of SRP Section 5.1.3 and the requirements of 10 CFR 40.32(b).

5.1.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.2 Management Control Program

5.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed management control program for the Nichols Ranch ISR Project is consistent with the requirements of 10 CFR Part 20, Subpart L, "Records," and Subpart M, "Reports," and with 10 CFR 40.61, "Records."

5.2.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 5.2.3 (NRC, 2003).

5.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant stated in application Section 5.2.1.1 that it will develop written operating procedures for all process activities involving handling, processing, or storing radioactive materials at the Nichols Ranch ISR Project. Procedures will also be written for document control, recordkeeping, corrective action, quality assurance, operations, industrial and radiation safety, workplace and environmental monitoring, and emergency response. The RSO will review and approve all procedures involving radiation safety and will perform an annual review of the operating procedures and document the results of this review. RWPs will be issued for nonroutine activities with a potential for significant exposure to radioactive materials and for which no operating procedure exists. The applicant has developed a management control program to ensure that all safety-related operating activities can be conducted according to written operating procedures. The management control program includes a process that will be used to develop SOPs. Furthermore, the applicant has acceptably identified radiation protection, maintenance activities (especially in radiation areas), development of well fields, and SERP reviews as areas where SOPs are applied. Also, nonroutine work or maintenance activity will comply with radiation safety requirements, and RWPs will be issued for activities where SOPs do not apply. The staff finds that this approach is consistent with the practices recommended in Regulatory Guide 8.31, “Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable” (NRC, 2002b), for maintaining exposures of workers, members of the public, and the environment ALARA, and this approach is acceptable.

The applicant stated in application Section 5.2.1.3 that it will develop instructions for maintenance, control, and retention of records that would be consistent with 10 CFR Part 20, Subpart L, and 10 CFR 40.61. Records will be maintained of receipt, transfer, and disposal of source or byproduct material processed or produced at the site. The applicant has identified the RSO as the person responsible for maintenance of records at the Nichols Ranch ISR Project. Records maintained and retained until license termination include, but are not limited to, the following:

- records of deep well injection
- descriptions of spills, contamination events, and their associated corrective actions
- information on aquifer characterization and background radiation levels
- as-built drawings of all structures and any modifications to them
- drawings of any inaccessible contamination
- occupational exposure records
- environmental monitoring records

The applicant stated that records will be maintained with safeguards against tampering and loss and would be maintained at the site for review during inspections. The staff finds that the description of recordkeeping is consistent with the 10 CFR Part 20, Subpart L, requirements and is acceptable.

The applicant has requested a performance-based license that will allow it to make changes in the facility or process, changes in procedures, and conduct tests or experiments not contained in the current NRC license. The applicant has provided for the establishment of a SERP. The SERP composition, responsibilities, and review procedures are appropriately described in detail in the application. The SERP will contain at least three individuals with expertise in management/financial, operations/construction, and radiation safety matters. Also, the applicant has stated that the SERP will deal with specific technical issues, with support from other qualified staff members, or consultants, as appropriate. The SERP will be responsible for monitoring any proposed change in the facility or process, making changes in procedures, and conducting tests or experiments not contained in the current NRC license. As such, the SERP will be responsible for ensuring that any such changes result in no degradation in the essential safety or environmental commitments. The applicant will submit an annual report to the NRC that describes all changes, tests, or experiments made pursuant to the performance-based license, including a summary of the SERP evaluation of each change. The SERP will review and document all proposed changes, determine whether such proposed changes require a license amendment, and document that result. Staff notes that all current NRC ISR licenses are performance-based licenses that operate with a SERP with duties similar to those outlined in this paragraph. Decisions of the SERP in its annual report are subject to NRC inspection and review. Currently licensed ISR facilities operating under performance-based licenses have proven to be protective of public health, safety, and the environment. Staff finds that the description of the proposed SERP is acceptable.

Through a standard license condition, the applicant will be required to submit the results of the annual audit of the radiation safety and ALARA programs, one of the semiannual effluent and environmental monitoring reports, and all SERP evaluations. In addition, any spills, leaks, or excursions will be reported in accordance with 10 CFR 40.60, “Reporting Requirements.” However, the NRC staff finds that some spills, excursions, and other contamination events at ISR facilities may not be captured by the 10 CFR Part 20 and Part 40 reporting requirements, but such events nonetheless need to be tracked to adequately ensure that the health and safety requirements of 10 CFR 40.32(c) will be met. Therefore, NRC notification and documentation of such events will be required through the license condition presented in SER Section 5.2.4.

The applicant has proposed recordkeeping and retention and reporting programs that are able to track, control, and demonstrate control over the source and byproduct materials that are processed, produced, or stored at the facility during its operating life, through decommissioning and license termination. Recordkeeping and retention plans will assist in ensuring that both onsite and offsite exposures are kept within regulatory limits by documenting compliance with NRC regulations. Staff finds that the proposed recordkeeping and retention programs comply with 10 CFR 20.2103(b)(4) and 10 CFR Part 40, Appendix A, Criterion 8 and 8A.

The applicant has developed a program to maintain records of spills, likely contamination events, and unusual occurrences for use in calculating annual surety amounts and to ensure acceptable decommissioning. Records will be maintained for decommissioning, onsite and offsite disposal, personnel exposure, and offsite releases of radioactivity. These will be permanent facility records that will be transferred to any new owner or licensee, and ultimately to the NRC, before license termination. Reports will be made to the NRC as required by 10 CFR Part 20 and Part 40. The staff finds that these reporting requirements may not capture spills, excursions, and other contamination events, but such events still need to be tracked to adequately ensure that the health and safety requirements of 10 CFR 40.32(c) will be met. Therefore, NRC notification and documentation of such events will be required through the license condition presented in SER Section 5.2.4, which is consistent with the guidance in SRP Section 5.2.3(8)(d)(i).

5.2.4 Evaluation Findings

The staff reviewed the management control program of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.2.3. The applicant has requested a performance-based license and has described the actions that will be considered by the SERP. The applicant described the process that will be used to develop SOPs. The applicant will document spills and contamination events as required by 10 CFR Part 20 and 10 CFR Part 40. The staff notes that the 10 CFR Part 20 and 10 CFR Part 40 reporting requirements may not capture spills, excursions, and other contamination events at ISR facilities, but staff concludes that such events nonetheless need to be tracked to adequately ensure that the health and safety requirements of 10 CFR 40.32(c) will be met. Therefore, NRC notification as required by 10 CFR 40.60 and documentation of such events as required by 10 CFR 40.36, "Financial Assurance and Recordkeeping for Decommissioning," and consistent with the guidance in SRP Section 5.2.3(8)(d)(i), will be required through a license condition, which is listed as a standard condition in SER Appendix A.

Based on the review (described above) of the information provided in the application, as supplemented by additional notification and documentation in accordance with the noted license condition, the staff concludes that the management control program meets the applicable acceptance criteria of SRP Section 5.2.3 and the requirements of 10 CFR Part 20, Subparts L and M; 10 CFR 40.32(c); and 10 CFR 40.61. Staff finds that the proposed recordkeeping and retention programs comply with 10 CFR 20.2103(b)(4) and 10 CFR Part 40, Appendix A, Criterion 8 and 8A.

5.2.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.3 Management Audit and Inspection Program

5.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed management audit and inspection program for the Nichols Ranch ISR Project meets the requirements of 10 CFR 40.32(b) and (c).

5.3.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 5.3.3 (NRC, 2003).

5.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by Uranerz in its application (Uranerz, 2007) and as updated.

Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (NRC, 2002b) recommends that a daily inspection be conducted by the RSO or designated Health Physics Technician (HPT) and that a weekly inspection be conducted by the RSO and the facility foreman. The applicant states in application Section 5.3.2 that an ESH staff representative will conduct a daily walkthrough inspection of the process and storage areas to provide a visual survey of proper implementation of procedures, housekeeping, and contamination control. Additionally, the applicant stated that ESH staff will complete a weekly inspection of the entire site. The scope of the applicant's inspection will include radiation safety practices, procedural compliance, environmental monitoring, and environmental conditions. The applicant stated that the ESH manager will provide site management with a monthly written summary report of the conditions of radiation safety and environmental monitoring. Report contents would include summaries of personnel monitoring, radiation and contamination surveys, trends important to ALARA considerations, a general assessment of compliance, and a description of problems with recommendations for corrective action. The staff finds that this reporting of walkthrough observations is consistent with the Regulatory Guide 8.31 practices, records of which are subject to NRC inspection, and is acceptable.

The Regulatory Guide 8.31 recommended practices and 10 CFR 40.32(b) require, in part, that an applicant show that its personnel have sufficient training to ensure that any source material will be used safely. The applicant stated that an ESH staff representative will perform daily and weekly inspections; however, the applicant has not described the qualifications or training required for an ESH staff member to perform these actions. This approach is not consistent with Regulatory Guide 8.31, and the staff does not concur that adequate training per Regulatory Guide 8.31 and 10 CFR 40.32(b) has been demonstrated. The Regulatory Guide 8.31 recommended practices specify that the RSO or an RSO-designated HPT conduct the daily and weekly inspections. The regulatory guide recommends specific training and experience for the RSO and HPT; the applicant has not demonstrated that an ESH representative will be required to have equivalent qualifications to perform these functions. Therefore, the staff has determined that a license condition is necessary to require the applicant to identify the qualifications or training for an ESH representative who will be allowed to perform daily and weekly inspections. Appendix A of this SER presents the license condition requiring the applicant to follow the guidance in Regulatory Guide 8.31. The qualifications of applicant staff performing such inspections will be subject to NRC inspection and therefore must meet the requirements of 10 CFR 40.32(b). Staff notes that the applicant can use approaches other than that recommended in the regulatory guide to fulfill regulatory requirements, but alternative approaches require NRC review and written verification by the NRC that the proposed exception does not require a license amendment.

The applicant proposes in application Section 5.3.1 to conduct annual audits of the radiation safety and ALARA programs in accordance with the requirements of 10 CFR 20.1101, "Radiation Protection Programs," and to review the topics recommended in Regulatory Guide 8.31 to ensure that all radiation health protection procedures are being followed and license condition requirements are being met. The annual audit report will be submitted to corporate and site management and will be provided to the SERP for action as applicable. The NRC staff finds that this approach fulfills the requirements of 10 CFR 20.1101 and the

Regulatory Guide 8.31 recommended practices, which specify the areas to be reviewed in the annual audit. The staff finds the proposed actions to be acceptable.

5.3.4 Evaluation Findings

The staff reviewed the management audit and inspection program of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.3.3. The applicant described the various aspects of daily and weekly inspections to be performed by the applicant's staff. The NRC staff has determined that the frequency and scope of inspections are consistent with Regulatory Guide 8.31 recommended practices. The applicant proposes that an ESH representative will perform these inspections; however, the applicant has not identified the qualifications or training required for designated ESH representatives who will perform daily and weekly inspections. Staff finds that the standard license condition listed in SER Appendix A requiring the applicant to follow the guidance in Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposure at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (as revised), will ensure that personnel who conduct daily and weekly inspections must have qualifications equivalent to those specified in Regulatory Guide 8.31 to ensure that a properly qualified person performs these inspections at the facility:

Based on the review (described above) of the information provided in the application, as supplemented with the noted license condition, the staff concludes that the management audit and inspection program meets the applicable acceptance criteria of SRP Section 5.3.3 and the requirements of 10 CFR 20.1702, "Use of Other Controls," 10 CFR 20.1101, and 10 CFR 40.32(b) and (c).

5.3.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.4 Qualifications for Personnel Conducting the Radiation Safety Program

5.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the personnel conducting the radiation safety program meet the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.4.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 5.4.3 (NRC, 2003). Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (NRC, 2002b) also provides recommendations for technical qualifications of radiation safety staff.

5.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information and data submitted by Uranerz in its application (Uranerz, 2007) and as updated.

5.4.3.1 Radiation Safety Officer

In application Section 5.4, the applicant specified the education, training, and experience requirements for an RSO. Education requirements include a bachelor's degree in physical science, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiation protection related to uranium recovery.

Other minimum qualifications for the RSO identified by the applicant include health physics experience—specifically, at least 1 year of work experience relevant to uranium recovery operations in applied health physics, radiation protection, industrial hygiene, or similar work. The applicant also identified specialized training for the RSO that would include at least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery. Lastly, RSOs undergo training to acquire a thorough knowledge of the proper application and use of all health physics equipment used during uranium recovery activities. The staff has determined that the proposed RSO qualifications identified are consistent with the Regulatory Guide 8.31 recommended qualifications and, therefore, finds them acceptable.

5.4.3.2 Health Physics Technician

The applicant specified in application Section 5.4 that the minimum qualifications for an HPT will include one of the following combinations of education, training, and experience. A first combination of qualifications includes an associate degree or 2 or more years of study in the physical sciences, engineering, or a health-related field; at least a total of 4 weeks of generalized training in radiation protection applicable to uranium recovery facilities; and 1 year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium recovery facility.

A second combination of qualifications includes a high school diploma, a total of at least 3 months of specialized training in radiation protection relevant to uranium recovery facilities of which up to 1 month may be on-the-job training, and 2 years of relevant work experience in applied radiation protection.

The staff has determined that the proposed HPT qualifications identified by the applicant are consistent with the Regulatory Guide 8.31 recommended qualifications and, therefore, finds them acceptable.

5.4.4 Evaluation Findings

The staff reviewed the qualification requirements of the personnel conducting the radiation safety program at the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.4.3. The staff finds that the applicant described qualifications that are consistent with those recommended in Regulatory Guide 8.31. Therefore, based on its review described above, the staff concludes that the information in the application meets the applicable acceptance criteria of SRP Section 5.4.3 and the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.4.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.5 Radiation Safety Training

5.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed radiation safety training program for the Nichols Ranch ISR Project meets the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.5.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 5.5.3 (NRC, 2003).

5.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information and data submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant stated in application Section 5.5 that it will administer the training program in accordance with NRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" (NRC, 1999b); NRC Regulatory Guide 8.29, "Instruction Concerning Risks from

Occupational Radiation Exposure" (NRC, 1996); and NRC Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (NRC, 2002b). The applicant stated that all new workers, including supervisors, will receive instruction on the health and safety aspects of the specific jobs they will perform. Training topics will include fundamentals of health protection, facility-provided protection, health protection measurements, radiation protection regulations, and emergency procedures. Each worker will be given a written test including annual refresher training, and training records will be kept until license termination. HPTs will also receive on-the-job training. The staff has determined that the training program is consistent with the recommended training in Regulatory Guides 8.13, 8.29, and 8.31, except as noted, and the staff finds that this is acceptable. The staff finds that specialized training is needed for ESH staff (for staff other then the RSO and HPT) to conduct daily and weekly inspections according to the recommended practices in Regulatory Guide 8.31.

The applicant stated that visitors not receiving training will be escorted by site personnel properly trained and knowledgeable about the hazards of the facility. Contractors having work assignments at the facility will receive appropriate radiation safety training. Contractors performing work on heavily contaminated equipment will receive the same training normally required of site workers. The staff has determined that the training and/or escort requirements for visitors and contractors are consistent with the Regulatory Guide 8.31 recommended training requirements and finds these practices acceptable.

5.5.4 Evaluation Findings

The staff reviewed the radiation safety training aspects of the proposed Nichols Ranch facility in accordance with SRP Section 5.5.3. The applicant proposed a radiation safety training program for the Nichols Ranch ISR Project, which the staff finds consistent with the guidance in Regulatory Guides 8.31, 8.13, and 8.29. Therefore, the staff finds that the content of the training material, the testing, the on-the-job training, and the extent and frequency of retraining are acceptable. The staff also finds that the radiation safety instructions for employees are acceptable. Based on the review described above, the NRC staff concludes that the radiation safety training program presented in the application meets the applicable acceptance criteria of SRP Section 5.5.3 and complies with the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b).

5.5.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

NRC, 1999b. Regulatory Guide 8.13, Revision 3, "Instruction Concerning Prenatal Radiation Exposure," Washington, DC, June 1999.

NRC, 1996. Regulatory Guide 8.29, Revision 1, "Instruction Concerning Risks from Occupational Radiation Exposure," Washington, DC, February 1996.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.6 Security

5.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed security measures for the Nichols Ranch ISR Project meet the requirements of 10 CFR Part 20, Subpart I, "Storage and Control of Licensed Material."

5.6.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria outlined in SRP Section 5.6.3 (NRC, 2003).

5.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant committed in application Section 5.6 to providing active and passive security measures to prevent unauthorized entry to controlled areas and unauthorized access to licensed material in storage. Passive controls include fencing of well fields and process areas and postings indicating that radioactive material may be present and that permission is required for entry. Active controls include locking gates and doors. Visitors would not be allowed inside the well fields or process area without an escort. These security measures are subject to NRC inspection to ensure that they are adequate and meet the regulatory requirements of 10 CFR Part 20. The active and passive controls discussed by the application are consistent with security measures and controls observed at NRC-licensed ISR facilities and have been found to be protective of public health and safety.

The staff notes that the applicant is required to meet U.S. Department of Transportation regulations for packaging, shipping, and security of transportation of hazardous materials.

5.6.4 Evaluation Findings

The staff reviewed the security aspects of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.6.3. The applicant described security measures for stored material and control measures for material not in storage. Based on the review described above, the staff concludes that the information provided in the application meets the applicable acceptance criteria of SRP Section 5.6.3 and the requirements of 10 CFR Part 20, Subpart I.

5.6.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7 Radiation Safety Controls and Monitoring

5.7.1 Standards

Section 5.7 describes the techniques that the applicant proposes to use to monitor and minimize radiation exposures. As part of its assessment, the NRC staff will present certain standards with which the applicant must comply. These standards are listed below and referenced throughout the remainder of Section 5.7.

<u>Guidance</u>

- Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills”, Revision 1, issued April 1980 (NRC, 1980b)

- Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment,” Revision 2, issued July 2007 (NRC, 2007)

- Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” Revision 2, issued November 2005 (NRC, 2005)

- Regulatory Guide 8.15, “Acceptable Programs for Respiratory Protection,” Revision 1, issued October 1999 (NRC, 1999a)

- Regulatory Guide 8.13, Revision 3, “Instruction Concerning Prenatal Radiation Exposure,” Washington, DC, June 1999 (NRC, 1999b)

- Regulatory Guide 8.22, “Bioassay at Uranium Mills,” Revision 1, issued August 1988 (NRC, 1988a)

- Regulatory Guide 8.25, “Air Sampling in the Workplace,” Revision 1, issued June 1992 (NRC, 1992a)

- Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities,” Revision 1, issued May 2002 (NRC 2002a)

- Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Revision 1, issued May 2002 (NRC 2002b)

- Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses," issued July 1992 (NRC, 1992b)

- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus," issued July 1992 (NRC, 1992c)

Regulations

- 10 CFR Part 20, Subpart C—"Occupational Dose Limits": 20.1201–1208
- 10 CFR Part 20, Subpart F—"Surveys and Monitoring": 20.1501 and 20.1502
- 10 CFR Part 20, Subpart L—"Records": 20.2101–20.2110
- 10 CFR Part 20, Subpart M—"Reports": 20.2201–20.2207

Numerical Standards

- 10 CFR Part 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," Table 1, DAC, Natural Uranium Class W: -3.0E-10 microcuries per milliliter (µCi/mL) DAC Natural Uranium Class D: -5E-10 µCi/mL

- 10 CFR 20.1201—Total Effective Dose Equivalent (TEDE): 5 rem, or the sum of the deep dose equivalent (DDE) and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem

- 10 CFR 20.1201—Annual Limit to the Eye Lens: 15 rem

- 10 CFR 20.1201—Annual Limits to the Skin of the Whole Body and Extremity: 50 rem

- 10 CFR 20.1201(e)—10-mg per week limit on intake of soluble uranium

5.7.2 External Radiation Exposure Monitoring Program

This section discusses the external radiation exposure monitoring program. The purpose of this section is to describe the devices and methods that the applicant will use to detect, measure, calculate, and/or monitor external radiation exposures.

5.7.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed external radiation exposure monitoring program for the Nichols Ranch ISR Project meets the requirements of 10 CFR Part 20, Subpart C; 10 CFR 20.1501(c); 10 CFR 20.1502; 10 CFR Part 20, Subpart L; 10 CFR Part 20, Subpart M; and 10 CFR 40.61.

5.7.2.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria presented in SRP Section 5.7.2.3 (NRC, 2003). Regulatory Guides 8.30 and 8.31 provide guidance on how to demonstrate compliance with the regulations.

5.7.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

5.7.2.3.1 Surveys

The applicant has identified radiological survey locations depicted in the plant layout in application Figures 5-2a and 5-2b. Surveys will be performed at least quarterly in the process areas (i.e., process vessels, filter press, dryer, and yellowcake storage) and in controlled areas and uncontrolled areas (i.e., well fields, eating areas, change rooms, and office space). The applicant stated in application Section 5.7.2.2 that the survey frequency for controlled and unrestricted areas that exceed 2 millirem (mrem) per hour will be increased from quarterly to monthly, and the survey frequency in process areas that exceed 5 mrem per hour will also be increased from quarterly to monthly. However, 10 CFR 20.1301(a)(2) does not allow dose rates from external radiation sources to exceed 2 mrem in any 1 hour in unrestricted areas. The staff notes that the statement in the application concerning the allowable exposure rates for unrestricted areas is contrary to 10 CFR 20.1301(a)(2) requirements. Therefore, a license condition is warranted to ensure that unrestricted areas remain below the 2 mrem per hour exposure rate. SER Section 5.7.2.4 presents this condition.

In application Section 5.7.2.2, the applicant identified the types and frequency of radiation surveys to be performed and stated the proposed use of the survey information in specified areas of the Nichols Ranch ISR facility. The applicant stated in application Section 5.2.1.3 that survey and monitoring records will be maintained in accordance with 10 CFR Part 20, Subpart L. Survey records include documentation of the results of exposure rate and dose rate surveys and instrument calibrations. Monitoring records include documentation of the results of personnel monitoring described in application Section 5.7.2.1 and results of exposure rate or dose rate surveys used to supplement the results of personnel monitoring. The staff has determined that the information on recordkeeping and surveys is consistent with the 10 CFR Part 20 requirements and finds it acceptable.

The applicant stated that the portable ion chamber survey meters will have a range of 0.10 mrem/hr to 5,000 mrem/hr. These survey instruments will be available for gamma exposure rate surveys and beta dose rate surveys, and a correction factor for the beta dose rate survey meter will be established using a uranium metal slab. Survey instruments will be calibrated at least annually and operated in accordance with manufacturer’s instructions. The staff finds that the survey meters and calibration frequencies described are consistent with Regulatory Guide 8.30 recommended practices and finds them acceptable.

5.7.2.3.2 Personnel Monitoring

The applicant stated in application Section 5.7.2.1 that personnel dosimetry accredited by a National Voluntary Laboratory Accreditation Program (NIST, 2006) to measure external occupational dose will be provided to workers with unescorted access to restricted areas and that the dosimeters will be exchanged at least quarterly. The staff determined that external exposure monitoring will be conducted in accordance with Regulatory Guides 8.30 and 8.34 and documentation of monitoring results will be completed consistent with 10 CFR Part 20, Subpart L. The staff finds that external exposure monitoring of personnel is consistent with recommended practices in the NRC guidance and meets 10 CFR Part 20 requirements.

The applicant also stated that if beta dose rate radiation surveys (i.e., evaluations and/or measurements) indicate that a worker's dose could exceed 10 percent of the applicable 10 CFR 20.1201, "Occupational Dose Limits for Adults," dose limit for the skin of the whole body or skin of an extremity, then finger and/or wrist dosimetry will be used in additional to "whole body" personnel dosimetry. The staff notes that beta dose to the lens of the eyes was not addressed in the applicant's commitment for surveys of areas within the plant that may have beta dose rates exceeding 10 CFR Part 20 limits. The staff has determined that the applicant did not adequately address monitoring for all the individual organs or tissues of occupational exposed workers that is required by 10 CFR 20.1201. The staff notes that the applicant is required to comply with the beta dose limits in 10 CFR Part 20, which include extremities, skin, and lens of the eyes, and this requirement is reinforced in the license condition discussed in SER Section 5.7.6.4.

5.7.2.3.3 Records and Reporting

The applicant stated in application Section 5.2.1.3 that records of surveys and monitoring will be maintained in accordance with 10 CFR Part 20, Subpart L. Records of surveys includes documentation of the results of exposure rate and dose rate surveys and instrument calibrations. Records of monitoring include documentation of the results of personnel monitoring (described in application Section 5.7.2.1) and the results of exposure rate or dose rate surveys used to supplement the results of personnel monitoring. The applicant includes a commitment in application Section 5.2.1.4 to report results of personnel and environmental monitoring in accordance with 10 CFR Part 20, Subpart M. The staff has determined that records and reporting commitments are consistent with the applicable 10 CFR Part 20 requirements and finds them acceptable.

5.7.2.4 Evaluation Findings

The staff reviewed the radiation safety controls and monitoring aspects of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.2.3. The applicant has proposed an acceptable external radiation exposure monitoring program at the Nichols Ranch ISR Project. An acceptable drawing was provided that depicts the facility layout and the location of external radiation monitors. The applicant identified radiation instrumentation for use in conducting both beta and gamma radiation surveys and the frequency of these surveys. The applicant will provide dosimetry to all process plant employees and measure the DDE and shallow dose equivalent, if applicable.

The applicant has provided acceptable information on the range of the gamma radiation survey meter and the ability of this survey meter to meet the posting requirements for a radiation area or even higher levels. Beta survey meters were identified for use in measuring beta radiation in the plant. The applicant has adequately demonstrated that beta radiation surveys will be conducted to comply with Subpart F of 10 CFR Part 20.

However, the staff is including two license conditions. The first is to address the treatment of controlled areas or restricted areas:

> Any areas with exposure rates that exceed 2 millirem in any 1 hour must be immediately treated as either a controlled area or restricted area in accordance with 10 CFR Part 20.

A second license condition addresses Regulatory Guide 8.30, "Health Physics at Uranium Recovery Facilities" (as revised), recommended practices for external monitoring of beta radiation. The license condition listed in SER Appendix A, requires the applicant to follow the guidance in Regulatory Guide 8.30, "Health Physics at Uranium Recovery Facilities" (as revised), therefore, this license condition is not repeated here.

Based on its review described above of the information provided in the application and the license conditions, the NRC staff concludes that the external radiation exposure monitoring program meets the applicable acceptance criteria of SRP Section 5.7.2.3 and the applicable requirements of 10 CFR Part 20.

5.7.2.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NIST, 2006. National Institute of Standards and Technology (NIST) Handbook 150, "Procedures and General Requirements," National Voluntary Laboratory Accreditation Program, February 2006.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002a. Regulatory Guide 8.30, Revision 1, "Health Physics Surveys in Uranium Recovery Facilities," Washington, DC, May 2002.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7.3 In-Plant Airborne Radiation Monitoring Program

This section describes the in-plant airborne radiation monitoring program, which includes airborne uranium particulate monitoring, radon daughter concentration monitoring, and the respiratory protection program. Results of the airborne monitoring program provide the information needed for personnel exposure calculations in application Section 5.7.4, and the monitoring results will also be used to control airborne exposures ALARA regarding airborne radioactivity exposures and airborne radioactive releases.

5.7.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed in-plant radiation monitoring program for the Nichols Ranch ISR Project meets the requirements of 10 CFR Part 20, Subpart B, "Radiation Protection Programs," and Subpart C; 10 CFR 20.1501, "General"; and 10 CFR 20.1702.

5.7.3.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in SRP Section 5.7.3.3 (NRC, 2003). Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (NRC, 2002a) provides guidance on how to demonstrate compliance with the regulations.

5.7.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The following sections describe the in-plant airborne radiation monitoring program, which consists of airborne uranium particulate monitoring, radon daughter concentration monitoring, and the respiratory protection program. In-plant airborne radiation monitoring measures airborne concentrations at various locations in the CPP to determine necessary posting requirements, respiratory protection methods, and dose assessments.

5.7.3.3.1 General Program Description

The staff notes that, while the primary operations at Nichols Ranch ISR Project will be wet operations that limit radioactive releases during routine operations and the lixiviant will be contained within its primary boundaries, airborne radioactivity may result from spills, leaks, and maintenance activities. These events may result in contaminants leaving the primary component boundaries. The applicant has proposed an in-plant airborne radiation monitoring program that is designed to detect these radioactive contaminants if they escape the primary boundaries.

Regulatory Guide 8.25, Revision 1, "Air Sampling in the Workplace" (NRC, 1992a), recommends that air sampling be used to do the following:

- determine whether the confinement of radioactive materials is effective
- measure airborne radioactive material concentrations in the workplace
- estimate worker intakes
- determine posting requirements
- determine what protective equipment and measures are appropriate
- warn of significantly elevated levels of airborne radioactive materials

Application Figures 5-2a and 5-2b identify the applicant's proposed in-plant airborne radiation locations. The applicant will use data collected at these locations to determine posting requirements and respiratory protection needs and to perform dose assessments. The staff reviewed Figures 5-2a and 5-2b and determined that the applicant's proposed locations are consistent with Regulatory Guide 8.30 recommended practices and so finds these locations acceptable.

5.7.3.3.2 Airborne Particulate Uranium Monitoring

The applicant stated in application Section 5.7.3.1 that it will collect breathing zone samples using lapel air samplers worn by the workers and will collect area air samples using fixed or portable air samplers. These breathing zone samples will be used routinely for the yellowcake drying and packaging operations to monitor workers' intake of uranium. Breathing zone sampling also will be used for nonroutine operations, maintenance, and cleanup as required by operating procedures and an RWP.

The applicant proposed that the assessment of airborne uranium will be performed by gross alpha counting of the air filters for uranium. However, the staff notes that the applicant did not provide the lower limit of detection (LLD) for the onsite gross alpha counting instrumentation or demonstrate that gross alpha counting will detect all airborne radioactivity in air samples, including radionuclides that are not uranium. Regulatory Guide 8.30 recommends that the air sampling program be able to detect 10 percent of the DAC value. The 10 CFR Part 20, Subpart F, requirements specify that adequate surveys be made to demonstrate that the radiation hazard (in this case, airborne radioactivity) is adequately evaluated so the appropriate DAC value will be used to control personnel exposures. Because the applicant has not provided this information, the staff is imposing a license condition to address this issue. The condition, presented in Section 5.7.3.4 of this SER, requires the applicant to measure and identify the radionuclides in airborne samples.

The staff has determined that the applicant needs to measure and identify the radionuclides in airborne radioactivity and, without an adequate technical basis, cannot assume that this radioactivity is solely natural uranium. The staff notes that Ra-226 and Th-230 may also be present in the air, and thus a mixture of radionuclides may be present on the air filters, and gross alpha counting of these filters will not be able to differentiate specific radionuclides. To address this issue, the staff will impose the license condition presented in SER Section 5.7.3.4.

The applicant stated initially in application Section 5.7.4.1 that it will assume that all uranium is solubility Class D. The staff notes that the applicant later revised this statement in application Section 5.7.4.1 and has committed to initially using solubility Class W to establish the appropriate ALI and DAC for natural uranium. The staff agrees with the assumption that all airborne uranium is solubility Class W, since it has been shown at other sites that the airborne uranium is some fraction of Class D and Class W uranium. The staff has determined that the assumption that airborne uranium is solubility Class W is a conservative approach for worker protection and finds this assumption acceptable. The staff notes that the applicant may conduct solubility studies, which may provide an adequate technical basis showing that airborne uranium at the Nichols Ranch ISR project is a mix of solubility Class D and Class W uranium compounds.

5.7.3.3.3 Radon Monitoring

The applicant stated that radon monitoring will be conducted in the general work areas using track-etch radon detectors, and the detectors will be exchanged quarterly. The applicant stated that the detection limit would be at least 0.33 pCi/L of Rn-222 for a 90-day exposure period.

The staff has determined that these surveys are consistent with Regulatory Guide 8.30 recommended practices and finds the commitments acceptable.

5.7.3.3.4 Radon Daughter Concentration Monitoring

The applicant stated that it will sample radon daughter concentrations in the process areas using the modified Kusnetz method described in Regulatory Guide 8.30. The applicant identified sampling frequencies and action levels that will be consistent with those described in Regulatory Guide 8.30. In addition, air sampler flow meters will be calibrated after repair or modification, but at least annually. The staff determined that these surveys are comparable to Regulatory Guide 8.30 recommended practices and finds the commitments acceptable.

The applicant did not provide the LLD in accordance with Regulatory Guide 8.30 for the radiation instrumentation that will be used to analyze the radon daughter activity in air samples. The applicant must demonstrate that the instrumentation can detect 10 percent of the 10 CFR Part 20, Appendix B, value. Therefore, the staff will include a condition in the license issued to the applicant to require it to determine the LLD for this instrumentation prior to operations; SER Section 5.7.3.4 contains this condition.

5.7.3.3.5 Action Limits

The applicant stated that it will establish an administrative action level for breathing zone and area air samples of 25 percent of the DAC described in application Section 5.7.4. The DAC limit for Rn-222 with its daughters present is 0.33 working level (WL). The applicant proposed an action level of 25 percent of the DAC or 0.08 WL. Air sample results that exceed the action level will be reported to the RSO. An administrative limit will be established for air samples used to monitor the intake of 12 DAC-hours per week, and workers exceeding this action level will require restriction from work involving exposure to airborne radioactive materials, unless the work is approved by the RSO. The staff finds this acceptable because the applicant's proposal is consistent with Regulatory Guide 8.30 recommendations to comply with regulatory requirements.

5.7.3.3.6 Records and Reports

The applicant did not specifically address records and documentation for the airborne radiation monitoring program for uranium or radon daughters. Instead, the applicant stated that results will be used for personnel exposure calculations and to implement ALARA standards with respect to airborne exposure and releases and that the airborne monitoring program will be implemented in conjunction with the respiratory protection program. Documentation is required to demonstrate compliance with 10 CFR 20.1201, 10 CFR 20.1501, and 10 CFR 20.1101. Through a standard license condition listed in SER Appendix A, the applicant will be required to develop SOPs for recordkeeping to demonstrate compliance with the 10 CFR Part 20 requirements. These procedures will be subject to NRC inspection prior to operations to ensure compliance with 10 CFR Part 20.

5.7.3.3.7 Respiratory Protection

The applicant stated in application Section 5.7.3.4 that respiratory protection will be used when other means are not available or are not sufficient to control worker exposures to airborne radioactivity. Respiratory protection will be used for nonroutine operations, maintenance, and cleanup as required by operating procedures and/or an RWP. Also, respiratory protection will be used when airborne radioactivity levels are unknown or expected to exceed 1 DAC as described in application Section 5.7.4, and when removable alpha contamination levels are known or suspected to exceed 220,000 dpm (disintegrations per minute) per 100 cm^2. The applicant stated that the respiratory protection program will be implemented in accordance with or equivalent to Regulatory Guide 8.15, “Acceptable Programs for Respiratory Protection” (NRC, 1999a). The staff has determined that the proposed respiratory protection program is consistent with Regulatory Guide 8.15 recommended practices and finds this program acceptable.

5.7.3.4 Evaluation Findings

The staff reviewed the in-plant airborne radiation monitoring program of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.3.3. The applicant plans to conduct in-plant airborne monitoring consistent with 10 CFR Part 20, Subpart B, which defines the radiation protection program.

The applicant has proposed adequate methods to fully evaluate the airborne particulate monitoring. The applicant has also identified methods that will meet the occupational dose limit requirements of Subpart C of 10 CFR Part 20. If the applicant identifies that a “mixture” exists which does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC. However, the staff notes that the applicant’s analysis of radioactivity in air samples will not allow it to adequately identify all radionuclides in airborne radioactivity. The staff is imposing the following license condition to ensure compliance with 10 CFR 20.1204(g):

> The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first 2 years, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204 (g).
>
> The licensee shall determine if surface contamination limits are warranted for Th-230, Ra-226, Po-210, and Pb-210 identified in airborne sample analyses. Within 1 year of commencement of operations, the licensee shall provide for NRC review and written verification a technical basis for surface contamination limits for the applicable radionuclides of concern.

The applicant did not provide an LLD for radiation measurement instrumentation that is proposed for analysis of radon daughter monitoring at the site. Nor did the applicant adequately describe radiation monitoring equipment so that the staff could determine if the radiation survey capability meets 10 CFR Part 20 requirements. The staff determined that the following license condition will be included in the license to require the applicant to provide this information:

Lists of Instruments. At least 30 days prior to the preoperational inspection, the licensee shall provide the following:

A. A list of radiation measurement instrumentation that will be used to measure or quantify the radioactivity on air sampling media. The list will provide the manufacturer, model number and/or a description of the instrument, range, instrument sensitivity (LLD), and its planned use to measure radioactivity.

B. A list of radiation survey instrumentation available for radiation contamination surveys. The licensee will also provide adequate information to show the capability of each instrument such as the type of instrument, range, sensitivity (lowest range limits), and planned use.

Regarding airborne monitoring records and reporting, the licensee will be required to provide SOPs for maintenance of survey and monitoring records in accordance with a standard license condition listed in SER Appendix A regarding the development of SOPs.

Based on its review (described above) of the information provided in the application as supplemented by information to be submitted in accordance with the noted license conditions, the staff concludes that the airborne radiation monitoring program meets the applicable acceptance criteria of SRP Section 5.7.3.3 and the requirements of 10 CFR Part 20, Subparts B and C; 10 CFR 20.1501; and 10 CFR 20.1702.

5.7.3.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 2002a. Regulatory Guide 8.30, Revision 1, “Health Physics Surveys in Uranium Recovery Facilities,” Washington, DC, May 2002.

NRC, 1999a. Regulatory Guide 8.15, Revision 1, “Acceptable Programs for Respiratory Protection,” Washington, DC, October 1999.

NRC, 1992a. Regulatory Guide 8.25, Revision 1, “Air Sampling in the Workplace,” Washington, DC, June 1992.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7.4 Exposure Calculations

This section discusses the exposure calculations to be performed by the applicant. Workers may be exposed to radioactive material in the air or to loose surface contamination within the restricted area, which may result in an intake of radioactive material into the body. In addition to exposure calculations, this section also addresses exposure calculations for female workers who declare pregnancy and the calculation of dose to the embryo/fetus.

5.7.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed exposure calculation for the Nichols Ranch ISR Project meets the requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include 10 CFR 20.1201(e); 10 CFR 20.1204(f); 10 CFR 20.1204(g); and 10 CFR 20.1502, "Conditions Requiring Individual Monitoring of External and Internal Occupational Dose."

5.7.4.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in SRP Section 5.7.4.3 (NRC, 2003). Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" (NRC, 1999b) and Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus" (NRC, 1992c), provide guidance on how to demonstrate compliance with the regulations.

5.7.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The following sections discuss the exposure calculations, which include internal and external occupational radiation dose, as well as radiation doses to the embryo/fetus. Occupational workers may be exposed externally and internally to radioactive material in a number of ways. These include radioactive material in the air, loose surface contamination, or radioactive material that may be stored or processed inside equipment or components. In addition to exposure calculations applicable to the occupational workers, this section also addresses exposure calculations for female workers who declare pregnancy and the calculation of radiation dose to the embryo/fetus.

5.7.4.3.1 External Dose Calculation

The applicant has described the external dose monitoring program in application Section 5.7.2. This program consists of individual personnel monitoring devices for external exposure monitoring, and periodic exposure rate surveys to identify radiation levels and to facilitate posting for radiation areas. The applicant stated that Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data" (NRC, 2005) and Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses" (NRC, 1992b) will be used for documentation of external dose monitoring results and determining dose from external exposure monitoring. The staff has determined that external dose calculations are consistent with Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (NRC, 2002a), and Regulatory Guide 8.34 for dose measurements and with Regulatory Guide 8.7 for recordkeeping and thus finds that this program meets 10 CFR Part 20 requirements.

The applicant also stated in application Section 5.2.1.3 that the occupational exposure history of employees and contractors will include exposure rate measurement results for personnel monitoring and dose calculations and air sampling results used for personnel monitoring and dose calculations. Also, the applicant addressed the determination of external and internal exposure to the embryo/fetus in application Section 5.7.4.3. The staff has determined that these program elements are consistent with recommended practices in Regulatory Guides 8.30 and 8.34 and finds these program elements acceptable.

The applicant stated in application Section 5.7.2.1 that occupational exposure will be measured with individual personnel dosimeters such as TLDs or optically stimulated luminescence dosimeters. All workers requiring unescorted access to restricted areas to work around radiation and radioactive materials will be issued personnel dosimeters. The applicant stated that these personnel dosimeters will be provided by a vendor accredited by the National Voluntary Laboratory Accreditation Program as required by 10 CFR Part 20, Subpart F. This is consistent with the 10 CFR Part 20 requirements and is acceptable.

These personnel dosimeters will be used to principally measure the DDE which can be used as the effective dose equivalent (EDE) or the external dose component of occupational exposure. The committed effective dose equivalent (CEDE), or internal dose component of occupational exposure, must be calculated from air sampling results and/or bioassays. Both of these components are needed to determine the TEDE (i.e., TEDE = EDE + CEDE) to assess compliance with 10 CFR Part 20 annual occupational dose limits. Furthermore, the applicant proposes to implement corrective actions for workers who exceed 25 percent of the 10 CFR Part 20 annual occupational dose limits. The staff has determined that this program element is consistent with recommended practices in Regulatory Guides 8.30 and 8.34 and is acceptable.

Staff concurs with the approach for assessing external exposures by measurement with an external personal monitoring device. The applicant has committed in application Section 5.7.2 to record the results in accordance with Regulatory Guide 8.7; therefore, this approach is acceptable to the staff. The approach is also consistent with 10 CFR Part 20 recordkeeping requirements and thus acceptable.

5.7.4.3.2 Internal Dose Calculation

The applicant stated that methods for calculating internal doses will be equivalent to the methodologies in Regulatory Guides 8.30 and 8.34 or a combination of these methodologies. Intakes will be determined for actual exposure times, which will be determined from interviews, an RWP, other records of work, or a combination of these methods. Intake calculations will be equivalent to those recommended in Regulatory Guide 8.30; NUREG/CR-4884, “Interpretation of Bioassay Measurements” (NRC, 1987a); or a combination of these methods. Regulatory Guide 8.30 provides alternative methods for dose calculations for intake of radioactive materials and determination of doses. The applicant has not specified which methods it plans to use for internal dose calculations. Because the applicant has not provided this information, the staff will impose a license condition requiring the applicant to identify the methods in SOPs that will be used to calculate internal doses. SER Section 5.7.4.4 presents this license condition.

The applicant stated in application Section 5.7.4.1 that it will initially assume that airborne uranium radioactivity is solubility Class W for purposes of establishing the initial DAC and ALI upon plant startup. The staff has determined that this is a conservative assumption, consistent with Regulatory Guide 8.30 recommended practices, and thus acceptable.

The applicant also stated in application Section 5.7.4.1 that the intake of radioactive materials in air will be compiled to allow comparison to the weekly intake limit of soluble uranium in 10 CFR 20.1201(e). According to the applicant, limiting the worker airborne exposure to

50 percent of the Class W natural uranium DAC will ensure that the weekly soluble uranium intake limit is not exceeded. Furthermore, worker exposures to soluble uranium greater than 20 percent of the 10 mg/week limit will be recorded (as DAC-hrs), and the applicant plans to control airborne exposure to 25 percent of the uranium Class W DAC so that the 10 mg/week limit is not exceeded and exposure is ALARA. Worker exposure to soluble uranium will be assessed by standard grab and breathing zone air sampling and subsequent analysis of the radionuclide content of the filter media. The staff has determined that this approach is consistent with Regulatory Guide 8.30 recommended practices, will ensure that worker intake of soluble uranium is limited to 10 mg/week, and is thus acceptable.

The applicant plans to establish that natural uranium isotopes are the exclusive alpha-emitting radionuclides in airborne samples collected at the Nichols Ranch ISR Project by preparing composite samples for each of the air particulate monitoring locations in application Figures 2-25 and 2-26. The staff has determined that these sampling locations will adequately characterize various points in the process (e.g., lixiviant, precipitation, drying/packaging areas), and these composite samples will be analyzed for natural uranium (total uranium), Th-230, and Ra-226. The applicant plans to compare the radioisotopic analysis with mixture requirements in 10 CFR 20.1204, "Determination of Internal Exposure," to ensure that the appropriate DAC is used. If necessary, a "sum of fractions" rule will be applied to determine the appropriate DAC. The staff has determined that these proposed actions will be adequate to characterize the radionuclides in the facility in accordance with 10 CFR Part 20, Subpart F, and finds these actions acceptable.

The applicant stated that time studies of job functions will be performed to determine the actual time that workers are in the process area and the DAC-hrs of a worker's exposure will be estimated on a weekly basis whenever air monitoring indicates that workers were exposed to airborne radioactivity concentrations greater than 10 percent of the DAC. This DAC may be an "effective DAC" using the "sum of fractions rule." The applicant will make a dose assignment to the worker based on the ratio of the worker's DAC-hrs exposure to 2,000 DAC-hrs per year multiplied by 5 rem. The staff has determined that these proposed actions are consistent with Regulatory Guide 8.30 recommended practices and finds them acceptable.

The NRC staff determined that the applicant did not provide the LLD for the alpha activity radiation measurement instrumentation that will be used to quantify radon daughter activity as required by Regulatory Guide 8.30. To address this issue, the staff imposed a license condition related to the development of SOPs for instrumentation that will be used at the facility. This license condition appears in SER Section 5.7.3.4.

The applicant stated in application Section 5.7.3.3 that Rn-222 daughter monitoring will be performed by the modified Kusnetz Method described in Regulatory Guide 8.30. These measurements of radon daughter concentration (in WL) will follow the survey frequency and action levels in Section 2.3 of Regulatory Guide 8.30. The applicant did not provide adequate details in Sections 5.7.3.3 or 5.7.4.2 on the calculation of internal dose from Rn-222 daughter measurements. The staff cannot determine if the Rn-222 daughter monitoring will adequately evaluate worker radon daughter exposures and/or allow the determination of radon daughter exposure in WL-months per year. These exposure determinations are needed to determine if a worker's exposure exceeds the radon daughter ALI in 10 CFR Part 20, Appendix B, Table 1, Column 2. Therefore, the staff will impose a license condition requiring an adequately documented internal dose determination program to address this issue. SER Section 5.7.4.4 presents this condition. This license condition is applicable and adequate to evaluate worker radon daughter exposures and/or allow the determination of radon daughter exposure in WL-months per year.

5.7.4.3.3 Prenatal and Fetal Dose

The applicant stated in application Section 5.7.4.3 that the dose equivalent to the embryo/fetus will be determined by the monitoring of the declared pregnant female and that the declared pregnant woman will be monitored in accordance with 10 CFR 20.1502. Dose to the embryo/fetus will be estimated for the case in which the declared pregnant worker was not monitored before declaration of pregnancy. Dose estimates for the unmonitored period will be developed from the available combination of radiation surveys, air monitoring, and bioassay results. The staff has determined that this approach is consistent with Regulatory Guide 8.36 recommended practices and finds it acceptable.

The applicant stated in application Section 5.7.4.3 that the DDE to the declared pregnant woman during the gestation period will be used as the DDE to the embryo/fetus for external dose. For internal dose, exposure calculations will be performed in accordance with Regulatory Guide 8.36 methods. The applicant stated that the dose to the embryo/fetus will be controlled in accordance with 10 CFR 20.1208, "Dose Equivalent to an Embryo/Fetus." The staff has determined that this approach is consistent with Regulatory Guide 8.36 recommended practices and finds it acceptable.

The staff finds that the applicant has not provided the equations and parameters to be used to calculate the internal dose to the embryo/fetus for the radionuclides of concern in accordance with Regulatory Guide 8.36 at the Nichols Ranch ISR project. The staff cannot, therefore, determine from the information provided in the application whether the embryo/fetus internal dose calculations are adequate. Therefore, the staff will impose a license condition to specify an SOP for internal dose calculations to address this issue. The license condition presented in SER Section 5.7.4.4 is applicable and adequate to evaluate embryo/fetus internal dose calculations. These procedures will be subject to NRC inspection before operations to ensure compliance with 10 CFR Part 20.

5.7.4.3.4 Records

The applicant stated in application Section 5.7.4.4 that dose assigned as a result of internal dose calculations will be recorded in conformance with Regulatory Guide 8.7. The applicant has specified that resulting intakes and doses will be recorded in the worker's occupational exposure record. Also, reports of exposure to an individual will be provided in accordance with 10 CFR 19.13, "Notifications and Reports to Individuals," and reports to individuals will be handled in accordance with 10 CFR Part 20, Subpart M. The staff has determined that the proposed recordkeeping is consistent with 10 CFR Part 20, Subpart L, and finds this acceptable.

5.7.4.4 Evaluation Findings

The staff reviewed the exposure calculations for the proposed Nichols Ranch facility in accordance with SRP Section 5.7.4.3. The applicant has developed an acceptable method for assessing external exposures by measurement with an external personal monitoring device. However, the applicant has not acceptably described the procedures that will be used to determine internal exposure or prenatal and fetal doses. The standard license conditions listed in SER Appendix A related to the development of SOP's for internal exposure calculation methods and conduct of the applicant's bioassay program, subject to the NRC preoperational inspection, will ensure that these procedures are identified before operations begin.

The applicant has stated in application Section 5.7.4.1 that it will initially assume that airborne uranium is solubility Class W uranium to determine the weekly intake of soluble uranium as specified in 10 CFR 20.1201(e) and to determine the DAC and ALI for radiological dose controls. The staff agrees that an assumption of solubility Class W uranium will allow adequate control of worker intake of uranium for radiological dose control and will adequately address the potential for uranium chemical toxicity by limiting the worker intake to 10 mg/week.

Based on its review (described above) of the information provided in the application, as supplemented by information submitted in accordance with the noted license conditions, the staff concludes that the exposure calculations meet the applicable acceptance criteria of SRP Section 5.7.4.3 and the requirements of 10 CFR Part 20, Subparts C, F, L, and M.

5.7.4.5 References

10 CFR Part 19. Code of Federal Regulations, Title 10, Energy, Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations."

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

NRC, 2005. Regulatory Guide 8.7, Revision 2, "Instructions for Recording and Reporting Occupational Radiation Exposure Data," Washington, DC, November 2005.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002a. Regulatory Guide 8.30, Revision 1, "Health Physics Surveys in Uranium Recovery Facilities," Washington, DC, May 2002.

NRC, 1999b. Regulatory Guide 8.13, Revision 3, "Instruction Concerning Prenatal Radiation Exposure," Washington, DC, June 1999.

NRC, 1992b. Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses," Washington, DC, July 1992.

NRC, 1992c. Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus," Washington, DC, July 1992.

NRC, 1987a. NUREG/CR-4884, "Interpretation of Bioassay Measurements," Washington, DC, July 1987.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7.5 Bioassay Program

This section discusses the applicant's proposed bioassay program. The bioassay program monitors and documents potential internal uptakes and radiation exposures and confirms the results of the airborne uranium particulate monitoring program.

5.7.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed bioassay program for the Nichols Ranch ISR Project meets the requirements of Subparts C, L, and M of 10 CFR Part 20.

5.7.5.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in SRP Section 5.7.5.3 (NRC, 2003). Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program" (NRC, 1993a), Regulatory Guide 8.22 (NRC, 1988a), and Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (NRC, 2002a) and Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses" (NRC, 1992b), provide guidance on meeting the applicable regulations.

5.7.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The applicant has stated in application Section 5.7.5 that all new employees will be required to submit a background urinalysis bioassay sample prior to working at the facility. Bioassay samples will be collected at least monthly from those workers with duties in the recovery process from IX areas through yellowcake final packaging areas and from those workers who conduct regular maintenance on yellowcake drying, ventilation, and filtration equipment. Additional bioassay samples may be collected with respect to specific activities, as described on an RWP, or when air sampling data are not available. Random sampling of other personnel will be conducted on a monthly schedule. The applicant also stated in application Section 5.7.5 that upon termination of employment, an exit bioassay will be required from all employees. The applicant stated that the medium for the bioassay program will be urinalysis.

5.7.5.3.1 Bioassay Program Elements

The applicant stated in application Section 5.7.4.1 that the bioassay program will be used to confirm results of airborne radioactivity collected with standard grab and breathing zone particulate sampling, which will be the method used to determine worker exposure to soluble uranium. Bioassay results may need to be used in cases where the estimated dose could approach or exceed annual dose limits and/or it is determined by the RSO that confirmed bioassay results may provide greater accuracy or be more representative of actual intake than relying exclusively on air sampling results and related calculations. The staff observes that the bioassay program including time of sample collection, availability of results, methods of sample collection, measurement sensitivity, and quality control will be consistent with the recommendations of Regulatory Guide 8.22.

The applicant stated in Section 5.7.4 that internal dose to workers will be calculated from bioassay results performed in accordance with Regulatory Guide 8.30, Section 3, and Regulatory Guide 8.34, Section C.3. The applicant stated in application Section 5.7.3 that solubility Class W for natural uranium compounds will be used to determine the DAC and ALI at commencement of uranium recovery operations. The applicant also stated, in a response to an NRC request for additional information, that the Class W assumption will be used during initial operations, and the applicant may conduct dissolution studies to identify the actual solubility class or classes for the uranium compounds (Uranerz, 2010a). The staff has determined that the applicant has committed to doing internal dose calculations according to Regulatory Guide 8.30 and 8.34 recommended practices but has not provided adequate documentation of its proposed program. SER Section 5.7.4.4 presents a license condition specifying that the applicant must adequately define the internal dose calculations in an SOP or other procedure.

The applicant has committed in application Section 5.7.5 to following the applicable NRC guidance for the conduct of the bioassay program. The applicant has not provided details that demonstrate to the staff that the applicant plans to use acceptable equations and parameters for the determination of intakes from bioassay data and plans to use acceptable dose conversion factors to determine internal dose (e.g., CEDE). Therefore, the staff will impose a license condition to address this issue by specifying that the applicant develop procedures to adequately define the bioassay program.

The applicant stated in application Section 5.7.5 that corrective actions (action levels and actions) for bioassay results will be those described in NRC Regulatory Guide 8.22, Table 1. Bioassay results will be used to confirm results of the airborne radiation monitoring program in accordance with Regulatory Guide 8.22, Table 1, the “Interpretation” column (i.e., as an indicator of the adequacy of controls). The applicant stated in application Section 5.7.4 that bioassay results may be used for exposure calculations or in place of air sampling results. The staff notes that the applicant proposes to measure airborne radioactivity and to use personnel dosimetry to determine worker exposures and to calculate worker doses. The applicant stated that it intends to use bioassay program results to confirm results of the airborne radioactivity monitoring program. The staff finds this approach acceptable since the workplace monitoring and bioassay programs are complementary, and for a given specific situation, either approach may be a better indicator of worker exposure.

5.7.5.3.2 Records and Reporting

As stated in application Section 5.7.5, records of results will be placed in workers’ exposure history files and reporting of monitoring results will be consistent with 10 CFR Part 20, Subpart M. This approach is acceptable to the staff. The staff has determined that this commitment is consistent with applicable 10 CFR Part 20 recordkeeping requirements and finds this acceptable.

5.7.5.4 Evaluation Findings

The staff reviewed the bioassay program for the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.5.3. The applicant has described acceptable program elements for bioassay urinalysis prior to, during, and upon exiting employment. The bioassay program includes individuals routinely exposed to yellowcake recovery operations and maintenance. The applicant stated in application Section 5.7.5 that it will take corrective actions using the action levels identified in NRC Regulatory Guide 8.22, Table 1. The applicant has established reporting and recordkeeping in conformance with the requirements of 10 CFR Part

20, Subpart M, and the applicant committed to recording the prior dose histories in employees' files.

The staff concludes that the applicant has not provided sufficient information regarding its bioassay program to demonstrate that the conduct of the bioassay program is adequate to limit worker radioactivity intakes and radiation doses. The license condition listed in SER Appendix A requiring the applicant to follow the guidance in Regulatory Guide 8.22, "Bioassay at Uranium Mills" (as revised) and Regulatory Guide 8.30, "Health Physics at Uranium Recovery Facilities" (as revised) will ensure the applicant demonstrates that the conduct of the bioassay program is adequate to limit worker radioactivity intakes and radiation doses.

Based on its review (described above) of the information provided in the application, as supplemented by information submitted in accordance with the noted license condition, the NRC staff concludes that the bioassay program meets the applicable acceptance criteria of SRP Section 5.7.5.3 and the requirements of 10 CFR Part 20, Subparts C, L, and M.

5.7.5.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002a. Regulatory Guide 8.30, Revision 1, "Health Physics Surveys in Uranium Recovery Facilities," Washington, DC, May 2002.

NRC, 1993a. Regulatory Guide 8.9, Revision 1, "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program," Washington, DC, July 1993.

NRC, 1992b. Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses," Washington, DC, July 1992.

NRC, 1988a. Regulatory Guide 8.22, Revision 1, "Bioassay at Uranium Mills," Washington, DC, August 1988.

Uranerz, 2010a. "Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application," file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7.6 Contamination Control Program

This section discusses the proposed contamination control program, which is designed to detect radiological contaminants that have escaped the boundary of uranium recovery process equipment. Such contamination can take the form of loose surface contamination and reside on structures, equipment, materials, or personnel. The purpose of this program is to ensure that contamination will be confined and monitored in restricted and controlled areas and not spread to other areas (e.g., lunchroom, bathrooms, office areas) or to unrestricted areas.

5.7.6.1 Regulatory Requirements

The applicant must demonstrate that the proposed contamination control program for the Nichols Ranch ISR Project meets the requirements of Subparts B, C, and F, of 10 CFR Part 20.

5.7.6.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria outlined in SRP Section 5.7.6.3 (NRC, 2003). Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities” (NRC, 2002a) provides guidance on how to demonstrate compliance with the applicable regulations.

5.7.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The following sections discuss the applicant’s proposed contamination control program. This program is designed to detect radiological contaminants that have escaped the boundary of process equipment. Contamination can take the form of loose surface contamination and may be found on structures, materials, or personnel. The purpose of the program is to ensure that contamination is identified, confined, and monitored in known areas and to prevent movement of contamination to unrestricted areas.

In terms of release levels for uranium recovery facilities, natural uranium is considered to be composed of U-238, U-235, U-234, and the short half-life daughters of U-238 (i.e., Th-234, protactinium [Pa]-234 and Pa-234m) in secular equilibrium with the U-238. Since these short-half-life daughters are beta-gamma emitters, separate beta-gamma release limits apply to them. Separate alpha release limits throughout the uranium recovery process will also apply to other radionuclides that may be present, such as Ra-226 and Th-230.

Regulatory Guide 8.30 will be the standard by which the staff evaluates alpha contamination control for personnel monitoring and releasing material for unrestricted use. The staff is currently revising Regulatory Guide 8.30. When the guide is revised, a draft revision will be issued for public review and comment. If changes to the alpha contamination control limits are incorporated into the revision of Regulatory Guide 8.30, applicants and licensees will be expected to adopt the revised limits or provide an adequate technical justification for alternate limits.

5.7.6.3.1 Restricted Area Contamination Surveys

NRC regulations do not specify numeric contamination limits in restricted areas. The applicant is required to implement a radiation protection program in accordance with 10 CFR 20.1101 for uranium recovery operations that controls radioactive contamination levels so that doses to workers and the public are consistent with 10 CFR Part 20 and ALARA. The applicant stated in application Section 5.7.6.1 that inspections for yellowcake will be made at least once per shift in the drying and packaging areas. Inspections will be made daily in other process areas for visible yellowcake on surfaces. Visible yellowcake will be cleaned up promptly, but not later than the end of the shift or workday. Spills will be cleaned up before the yellowcake dries so that resuspension during cleanup is minimized.

The applicant stated in application Section 5.7.6.1 that a survey for removable surface contamination will be made daily in the drying and packaging areas or restricted areas when these areas are in use. An area will be promptly cleaned if removable alpha surface contamination levels exceed 220,000 dpm per 100 cm^2. A survey will be performed weekly in rooms within the process area where "work with uranium is not performed," such as break rooms, change rooms, control rooms, and offices. Surface contamination will be promptly cleaned up if levels exceed 1,000 dpm per 100 cm^2. The staff has determined that this is consistent with the Regulatory Guide 8.30 recommended practices and is acceptable.

The applicant stated in Section 5.7 6 that surface contamination in restricted areas will be assessed by visual inspection and measurement. Surface contamination in restricted areas will also be controlled to minimize the potential for resuspension of uranium dust that can result in inhalation or ingestion intake. Contamination limits of 5,000 dpm alpha per 100 cm^2 will be used for the soles of shoes, and a 1,000 dpm per 100 cm^2 limit for beta-gamma contamination will apply in controlled and unrestricted areas.

In application Section 5.7.3, the applicant has committed to conducting a radiological characterization for airborne radioactive materials in the restricted areas. This characterization will identify the extent that natural U, Th-230, and Ra-226 are present. The applicant has identified specific contamination limits for uranium, but has not identified limits for Th-230 or Ra-226. NRC contamination limit guidance (NRC, 1993c) for Ra-226 and/or Th-230 total alpha contamination limits is 100 dpm per 100 cm^2 (average). The staff has determined that the applicant assumes that all contamination is natural uranium and uses applicable uranium contamination limits. However, the applicant has not provided adequate information to demonstrate that Ra-226, Th-230, or both are not present. As the applicant has not identified contamination limits for Th-230 and Ra-226, the staff will impose a license condition to address this issue. This license condition appears in SER Section 5.7.3.4.

5.7.6.3.2 Controlled Area Contamination Surveys

The applicant stated in application Section 5.7.6.2 that a survey for total alpha contamination will be made monthly in controlled areas (e.g., well fields) to include personnel and equipment. The total alpha contamination limits for these surveys are 1,000 dpm per 100 cm^2. The applicant also proposes to use a 1,000 dpm per 100 cm^2 limit for beta-gamma contamination in controlled and unrestricted areas. The staff has determined that these limits are consistent with Regulatory Guide 8.30 recommended contamination limits and these limits are acceptable.

5.7.6.3.3 Contamination Surveys of Skin and Personal Clothing

The applicant stated in application Section 5.7.6.3 that all personnel leaving the restricted area will be required to survey the soles of their shoes. Total alpha contamination for these surveys is 5,000 dpm per 100 cm^2. Employees working in the precipitation, drying, and packaging areas, and those involved in process equipment maintenance or repair are provided appropriate protective clothing and equipment. Protective clothing is laundered on site or, if disposable, is disposed of as byproduct material at a facility licensed to accept this waste. Protective clothing during yellowcake packaging and drying will include coveralls, safety shoes, gloves, and other equipment as warranted (i.e., hearing protection and safety glasses). The staff has determined that these practices are consistent with Regulatory Guide 8.30 recommended practices and are acceptable.

All employees with potential exposure to yellowcake dust can shower and change clothes each day before leaving the site. An employee is considered uncontaminated after showering and changing clothes. In lieu of showering, employees are required to survey their clothes, shoes, hands, face, and hair with an alpha survey instrument before leaving the site. The alpha contamination limit for these surveys is 1,000 dpm per 100 cm^2. The applicant also proposes to use a 1,000 dpm per 100 cm^2 limit for beta-gamma surface contamination limit in controlled and unrestricted areas. The staff has determined that these practices are consistent with Regulatory Guide 8.30 recommended practices and finds these limits acceptable.

5.7.6.3.4 Contamination Surveys for Equipment Released to Unrestricted Areas

The applicant defined the requirements for contamination control of equipment and materials released for unrestricted use in application Section 4.3. All personnel will be allowed to conduct contamination surveys of small, hand-carried items for use in well field and controlled areas, as long as surfaces are accessible for surveys and the item does not originate in yellowcake areas. The total alpha contamination limit for these surveys is 1,000 dpm per 100 cm^2. The applicant also proposes to use a 1,000 dpm per 100 cm^2 limit for beta-gamma surface contamination limit in controlled and unrestricted areas. The staff has determined that the proposed limits are consistent with NRC contamination limits guidance (NRC, 1993c) and finds that these limits are acceptable.

The applicant's program for equipment release surveys does not address the potential for other alpha-emitting isotopes that may be present. The applicant has not performed radiological characterization to demonstrate that Ra-226, Th-230, or both are not present in process areas and assumes that all workplace surface contamination is natural uranium. As the applicant has not identified contamination limits for Th-230 and Ra-226, the staff will impose a license condition regarding the conduct of radiological characterization to address this issue. This license condition appears in SER Section 5.7.3.4.

5.7.6.3.5 Contamination Surveys for Respirators

The applicant stated in application Section 5.7.6.5 that respiratory protection equipment will be surveyed for alpha contamination by a standard wipe or smear technique. The applicant has committed in application Section 5.7.6.5 to conducting surveys to show that removable alpha contamination levels are less than 100 dpm per 100 cm^2 prior to reuse of the equipment.

The NRC staff has determined that the applicant's program for respirator contamination surveys does not address the potential for other alpha-emitting isotopes that may be present such as Ra-226 or Th-230. As the applicant has not proposed adequate radiological characterization surveys to determine that all contamination is only natural uranium and has not identified contamination limits for Th-230 and Ra-226, the staff will impose a license condition to address this issue. This license condition appears in SER Section 5.7.3.4.

5.7.6.3.6 Instrumentation for Contamination Surveys

The applicant stated in application Section 5.7.6.6 that the direct alpha surveys will be performed using a portable scaler/rate-meter with a zinc sulfide (ZnS)-type probe or detector. Removable alpha contamination surveys will be performed using a standard cloth smear and a scaler/rate-meter with a ZnS-type probe. In this section, the applicant committed to calibrating these instruments at least annually, operating them in accordance with manufacturer's instructions, and ensuring that they pass a performance check each day of use.

The NRC staff has determined that the applicant has not adequately described that the proposed instrumentation will be capable of measuring the types and levels of radioactive contamination expected. Specifically, the applicant has not demonstrated that it can detect Ra-226 and/or Th-230 at the required contamination limits identified in the NRC contamination guidance documents (NRC, 1983). Therefore, the staff is imposing a license condition, presented in SER Section 5.7.3.4, to address this issue. The applicant shall provide the survey instrumentation sensitivity or scan minimum detectable concentration (MDC) of survey instruments as recommended in the SRP. NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (NRC, 2000), describes the methods for determining the scan MDC. In addition, the manufacturer and model of survey meters are needed to assist the staff in its evaluation of survey meter capability and adequacy.

The applicant's program for personnel contamination monitoring and for equipment or materials contamination surveys for release to unrestricted areas does not address the potential for beta-gamma contamination. The applicant has not committed to performing surveys for beta-gamma contamination in addition to alpha contamination, and the NRC contamination guidance (NRC, 1993c) specifies surface contamination limits for both beta and alpha radiation. Therefore, the staff will include a condition in the license issued to the applicant for the Nichols Ranch ISR Project. SER Section 5.7.6.4 presents this condition.

5.7.6.3.7 Inspections

In application Section 5.3.2, the applicant has proposed daily inspections of the process and storage areas by an ESH staff representative to provide a visual survey of proper implementation of procedures, housekeeping, and contamination control. A weekly inspection of the site will include radiation safety practices, procedural compliance, environmental monitoring, and environmental conditions at the site. Furthermore, the ESH manager will provide a monthly summary of the conditions to site management. This summary will cover personnel monitoring, radiation and contamination surveys, trends important to ALARA considerations, general assessment of compliance, and a description of problems with recommendations for corrective action. The inspections will be performed and documented in accordance with a written procedure. The applicant's proposed inspections are consistent with Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (NRC 2002b). Staff notes that the RSO and HPT training is adequately described; however, other ESH staff training is not described. The staff finds the commitment to conducting daily and weekly inspection consistent with Regulatory Guide 8.31 and thus acceptable.

5.7.6.3.8 Records and Reporting

The applicant provides the information that will be recorded for each contamination survey in application Section 5.7.6.7. Information listed meets the requirements of 10 CFR 20.2103, "Records of Surveys." However, the applicant does not address retention of survey records. The applicant also does not address reports required by 10 CFR Part 20, Subpart M, which would include those for specific survey results. The staff concludes that the applicant has not met the requirements of 10 CFR Part 20, Subparts L and M. This will be addressed through the standard license condition listed in SER Appendix A related to development of SOPs for the facility that are subject to NRC inspection and written verification prior to operations.

5.7.6.4 Evaluation Findings

The staff reviewed the contamination control program for the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.6.3. The applicant has identified appropriate controls and limits for preventing contamination from leaving a restricted area. This includes identification of contamination limits for uranium; however, the applicant has not identified contamination limits for Th-230 or Ra-226. Because the applicant has not provided this information, the condition presented in SER Section 5.7.3.4 will be included in the Nichols Ranch ISR Project license.

To address the issue of insufficient information regarding survey instrumentation, the license condition in SER Section 5.7.3.4 will be included in the Nichols Ranch ISR Project license.

The applicant has not provided sufficient information regarding beta-gamma release and personnel contamination limits, therefore, the following license condition has been included in the Nichols Ranch ISR Project license:

> Prior to the preoperational inspection, the licensee shall develop a survey program for beta/gamma contamination for personnel contamination from restricted areas, and beta/gamma contamination in unrestricted and restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

To ensure that records and reporting requirements are consistent with 10 CFR Part 20, Subparts L and M, the applicant will be required by a standard license condition to provide records and reporting procedures prior to operations.

Based on its review (described above) of the information provided in the application, as supplemented by information to be submitted in accordance with the noted license conditions, the NRC staff concludes that the contamination control program meets the applicable acceptance criteria of SRP Section 5.7.6.3 and the requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.6.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

NRC, 2002a. Regulatory Guide 8.30, Revision 1, "Health Physics Surveys in Uranium Recovery Facilities," Washington, DC, May 2002.

NRC, 2002b. Regulatory Guide 8.31, Revision 1, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Washington, DC, May 2002.

NRC, 2000. NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," Washington, DC, August 2000.

NRC, 1993c. "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," Washington, DC, April 1993, ADAMS Accession No. ML003745526.

NRC, 1983. Memo, "Policy and Guidance Directive FC 83-23 (Termination of Byproduct, Source and Special Nuclear Material Licenses," Office of Nuclear Material Safety and Safeguards, Washington, DC, November 4, 1983, ADAMS Accession No. ML030650166.

Uranerz, 2007. "Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming," November 30, 2007, ADAMS Accession Package No. ML080080594.

5.7.7 Airborne Effluent and Environmental Monitoring Program

This section discusses the applicant's proposed airborne effluent and environmental monitoring program, which focuses on radiation monitoring outside of the plant area during operations.

5.7.7.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed airborne effluent and environmental monitoring program for the Nichols Ranch ISR Project meets the requirements of 10 CFR 20.1003, 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 20.1101(d), 10 CFR 20.1501 10 CFR 40.65, and Criterion 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.7.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria outlined in SRP Section 5.7.7.3 (NRC, 2003). Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980b), and Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities" (NRC, 1993b), provide guidance on how to demonstrate compliance with the applicable regulations.

5.7.7.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The following sections discuss the applicant's proposed airborne effluent and environmental monitoring program. This includes radiation monitoring outside of the plant area during operations and environmental monitoring around the facility.

5.7.7.3.1 Airborne Effluent Monitoring

The staff notes that several sources of radiological effluents exist that are associated with ISR uranium recovery operations. Generally, these sources can be classified as point sources, area or diffuse sources, and fugitive sources. Point sources include those operations that have exhaust confined in a stack, duct, pipe, or similar release point prior to atmospheric release. Area or diffuse sources such as well fields are not confined before being released to the atmosphere. Fugitive sources can include, among other things, pump seal leaks, losses from container loading not captured in ventilation systems, airborne contamination from dried spills, and releases resulting from pressure relief devices.

In addition, the staff notes that aside from the effluent monitoring reporting requirements in 10 CFR 40.65, "Effluent Monitoring Reporting Requirements," an applicant must provide details on how it will perform surveys in accordance with 10 CFR 20.1501 that are sufficient to demonstrate compliance with 10 CFR 20.1301 public dose limits. Surveys, defined in 10 CFR 20.1003, "Definitions," may include calculations or physical measurements to evaluate radiation hazards. The 10 CFR 20.1302 requirement addresses survey requirements to demonstrate compliance with dose limits for individual members of the public. An applicant must also demonstrate compliance with 10 CFR 20.1501 which, in summary, requires surveys that are reasonable under the circumstances to evaluate concentrations or quantities of radioactive materials and the potential radiological hazards.

In addition, the staff notes that in demonstrating compliance with 10 CFR 20.1302(a), applicants must show that they will either calculate or measure effluent quantities or concentrations released to unrestricted and controlled areas as specified in the requirement. For point sources (e.g., a defined stack or pipe), the release point will generally be the effluent discharge point (i.e., where the uncontrolled effluent is released to the air). If the effluent is discharged to a restricted area, the applicant may propose measuring or calculating the effluent quantities or concentrations at the effluent discharge point (and use this undiluted value, or may use appropriate modeling to estimate the concentrations to which people are exposed) or at the unrestricted/controlled area boundary. For dose assessments or surveys, the applicant may also propose taking direct measurements at the unrestricted area boundary.

The applicant stated that it used operations parameters and the MILDOS-AREA computer code (Yuan, et al., 1989), to calculate release rates (source terms) and public doses for the Nichols Ranch ISR Project. Application Section 7.3 provides this information. This staff finds that the MILDOS-AREA computer code, as referenced in the SRP, is an acceptable methodology for determining source terms and calculation of public doses. Although calculations are allowed in meeting the requirements of 10 CFR 20.1302 and 10 CFR 40.65, the NRC will require by license condition that the applicant discuss how it will verify the quantity of principal radionuclides released. The staff notes that this can be achieved through surveys or monitoring. SER Section 4.1.4 presents this license condition. These concepts apply to point sources as well as to area or diffuse sources, such as radon released in the well field. This license condition will require the applicant to address and/or describe how the radiation monitoring program measures and confirms that calculated or modeled radiation doses comply with 10 CFR Part 20 dose limits.

The applicant stated in application Section 5.7.7.1 that it does not plan to conduct effluent monitoring for the yellowcake vacuum dryer since no emissions and no exhaust are expected. The applicant cites statements in the SRP, NUREG/CR-6733, "A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees" (NRC, 2001), and NUREG-1910, "Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities" (NRC, 2009c), that vacuum dryer technology results in no particulate emissions. The staff agrees that yellowcake vacuum effluent releases are expected to be very low. The applicant stated that air particulate sampling was conducted for four quarters in 2009 and 2010 for background purposes. The data collected were compared to other background data collected for other ISR uranium recovery facilities for consistency in background radiological particulates. The applicant concluded that it had established a representative baseline for airborne particulates for the Nichols Ranch ISR Project. The staff has determined that the air particulate sampling was consistent with Regulatory Guide 4.14 and, except for the uncertainty associated with sample location because of lack of onsite meteorological data needed to predict the locations of highest concentrations, finds that the applicant's conclusions are appropriate.

Notwithstanding the information in NUREG-1910 that no uranium particulate releases result from yellowcake dryer operations, the staff notes that the applicant needs to demonstrate that other potential airborne uranium releases are not occurring from the processing facilities, such as yellowcake packaging operations and maintenance activities, that could result in uranium surface contamination that exceeds 10 CFR Part 20, Appendix B, Table 2, effluent concentrations or the applicable 10 CFR 20.1301 public dose limits in the unrestricted areas. The applicant will also need to show that its operations relating to uranium particulate releases are ALARA. The staff notes that with the exception of uranium packaging operations, operations frequently occur while the processing facility doors are open and ventilation systems are exhausting air from the buildings. These are potential pathways that could result in airborne radioactivity outside the facility. The staff has determined that the applicant has not adequately discussed how the facility would be monitored for airborne releases for these sources. Therefore, the staff will impose a license condition to ensure that the facility does not exceed the effluent concentrations in 10 CFR Part 20, Appendix B, Table 2, or the applicable 10 CFR 20.1301 public dose limits in the unrestricted areas. SER Section 4.1.4 presents this license condition.

The applicant stated in application Section 4.1 regarding effluent controls that separate ventilation systems will be installed for all indoor nonsealed process tanks and vessels where Rn-222 or process fumes would be expected to be released into the workplace. In addition, the applicant stated that the ventilation system will consist of an air duct or piping system connected to the top of each of the process tanks, which will exhaust effluents to the outside atmosphere. However, the staff cannot determine that the applicant has adequately specified how effluent monitoring would be accomplished for airborne releases for these ventilation systems. The staff has determined that it does not have adequate information to determine if the applicant's monitoring program for gaseous effluents is in compliance with 10 CFR 1302(a), Criterion 8 of Appendix A to 10 CFR Part 40, and 10 CFR 40.65, nor can the staff determine if the program is consistent with Regulatory Guides 4.14 and 8.37. Therefore, the staff will impose the license condition described in SER Section 4.1.4, which will require the applicant to adequately describe its monitoring program for effluent releases to demonstrate compliance with the 10 CFR Part 20 and 10 CFR Part 40 requirements.

5.7.7.3.2 Environmental Monitoring

5.7.7.3.2.1 Air Particulate Sampling

Regulatory Guide 4.14, Table 2, suggests that air particulate sampling locations should be installed at the following locations:

- at or near the site boundaries
- in different sectors that have the highest predicted concentrations of airborne particulate, as well as one at the nearest residence or inhabitable structure(s)
- at one control location which should be in the least prevalent wind direction from the site

Air particulate sampling should be continuous with weekly filter changes and quarterly composite by location for natural uranium, Ra-226, Th-230, and Pb-210 analysis.

The applicant stated in a March 11, 2009, response to an NRC request for additional information (Uranerz, 2009a) that the SRP, NUREG/CR-6733, and NUREG-1910 indicate that vacuum dryer technology results in no uranium particulate releases. Based on this information, the applicant plans to conduct background air particulate sampling for four quarters of air particulate sampling in 2009 and 2010. The applicant proposes that sampling results be compared to other particulate background sampling results at other ISR uranium recovery sites for consistency in background radiological particulates. Air particulate samplers will be located at four different locations at both the Nichols Ranch and Hank Units. These locations, shown in application Figures 2-25 and 2-26, will be located upwind, downwind, at the nearest residence, and at plant locations.

The applicant commits in application Section 5.7.3 to performing radiological characterization of airborne radioactivity for natural U, Th-230, and Ra-226 in the process facilities. The staff notes that this should provide useful radiological information on the potential extent of release of these radionuclides from uranium process operations.

The applicant has not adequately addressed some aspects of effluent and environmental monitoring for all sources and all pathways in Regulatory Guides 4.14 and 8.37. The staff has specified a license condition in Section 4.1.4 that requires the applicant to adequately describe how the air particulate monitoring program demonstrates compliance with 10 CFR 20.1301 and 10 CFR 40.65 for plant releases or radioactive effluent releases.

5.7.7.3.2.2 Air Radon Sampling

Regulatory Guide 4.14, Table 2, suggests that radon sampling be conducted at five or more locations using the same locations as stated for air particulate sampling, with the exception that the frequency of the analysis should be monthly for Rn-222. The applicant identified eight radon sampling locations for the Nichols Ranch Unit and Hank Unit in application Figures 2-25 and 2-26. The staff cannot conclude that the applicant has placed monitoring stations at locations where the highest Rn-222 and airborne particulate concentrations are expected since the applicant did not use site-specific meteorological information to select the monitoring locations. The applicant has not adequately demonstrated that the radon monitor locations are placed according to recommended practices in Regulatory Guide 4.14. Therefore, the staff has developed a license condition, discussed in SER Section 5.7.7.4, to address the location of air sampling stations.

5.7.7.3.2.3 Soil Sampling

Regulatory Guide 4.14, Table 2, recommends that soil sampling be conducted in five or more locations that are the same as the air particulate sampling locations. It recommends collecting annual grab samples and analyzing for natural uranium, Ra-226, and Pb-210. The applicant stated in application Section 5.7.7.5 that surface soil samples will be collected annually in the same location as radon sampling. Surface soil samples will be grab samples of 0 to 15 cm (0 to 6 in.), and samples will be analyzed for total U, Th-230, Ra-226, and Pb-210. The staff has determined that the number of samples taken is consistent with the recommendation in Regulatory Guide 4.14, but the applicant’s selection of sampling locations is not acceptable because it did not use site-specific meteorological data in choosing the downwind sampling locations. Therefore, the staff will include the license condition in SER Section 5.7.7.4 to address soil sampling locations.

5.7.7.3.2.4 Sediment Sampling

Regulatory Guide 4.14, Table 2, suggests that sediment sampling be conducted as an annual grab sample in one or two of the surface water sampling locations from each water body. The sediment samples should be analyzed for natural U, Th-230, Ra-226, and Pb-210. The applicant stated in application Section 5.7.7.5 that grab sediment samples will be collected annually at the same locations used for preoperational sediment sampling. The sediment samples will be analyzed for total U, Th-230, Ra-226, and Pb-210. The staff has determined that the sediment sampling is consistent with Regulatory Guide 4.14 recommended practices and concludes that sediment sampling is acceptable.

5.7.7.3.2.5 Food and Fish Sampling

The applicant has proposed not performing operational food and fish sampling. Table 2 of Regulatory Guide 4.14 suggests collecting samples from crops, livestock, or fish from lakes and streams, near the site. Samples should be collected during times of harvest, slaughter, or semiannually for fish, and samples should be analyzed for Ra-226 and Po-210. The applicant stated that the evaluation described in application Section 7.3 shows the ingestion pathway to be insignificant (i.e., the predicted dose to an individual will be less than 5 percent of the applicable radiation protection standard). The staff has determined that, based on the MILDOS calculations provided in application Section 7.3, food and fish ingestion is not an important pathway for public dose and is many times less than the applicable radiation protection standard in 10 CFR 20.1301 and 10 CFR 20.1302 and agrees with the applicant that operational food and fish sampling is not warranted.

The applicant stated that the evaluation described in application Section 7.3 shows the ingestion pathway to be insignificant. The applicant stated that it relies on statements in the SRP, NUREG/CR-6733, and NUREG-1910 that vacuum dryer technology results in no particulate emissions. Notwithstanding these reports, the applicant has not demonstrated that other potential sources of uranium could be released from the facility. The staff notes that the applicant has not demonstrated compliance with 10 CFR 20.1301 and 10 CFR 40.65 for these other potential sources. The applicant is required by the license condition in SER Section 4.1.4 to provide information on monitoring for other potential sources of radioactive particulates that could be released from the process facilities. If the applicant determines that there are other significant potential sources of radioactive particulates that could be released from the process facilities, food and fish sampling, if present, would be warranted.

5.7.7.3.2.6 Vegetation Sampling

Table 2 of Regulatory Guide 4.14 suggests collecting three or more samples for vegetation or forage from animal grazing areas near the site in the direction of the highest predicted airborne radionuclide concentration. The applicant collected pre-operational vegetation samples and addressed possible exposure pathways in application Section 7.3.1. In this application section, the applicant considered water, air, and external exposure pathways. The applicant stated that there are no liquid effluents to surface waters, the air pathway is limited to radon, and there are no uranium particulate emissions. Additionally, the applicant identified that process equipment is located on curbed, reinforced concrete pads to prevent liquids from entering the environment. In application Section 7.3.1.2, the applicant stated that no particulate radionuclides are released into the air; therefore, the vegetation exposure pathway was evaluated only for radon daughter releases.

In Regulatory Guide 4.14, Footnote O of Table 2 states that vegetation and forage sampling should be performed only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway. The staff finds that the applicant provided acceptable justification for not sampling vegetation during operations and the applicant stated that the evaluation described in application Section 7.3 demonstrates the ingestion pathway to be insignificant (i.e., the predicted dose to an individual will be less than 5 percent of the applicable radiation protection standard).

The applicant provided a summary of TEDE in mrem/yr to individual receptors in application Table 7-8 for the period 2011 to 2019. Doses reported in application Table 7-8 for seven receptors at nearby ranches adjacent to the property are below 1 mrem/yr for the period indicated. Application Table 7-9A provides a summary of TEDE in mrem/yr at the site boundary. The highest TEDE is for the Hank Unit in the east-central direction and is reported to be 11 mrem/yr for calendar year 2014, which is below the annual acceptable public dose rate of 100 mrem/yr.

As discussed in the preceding section, if the applicant determines that there are other significant potential sources of radioactive particulates that could be released from the process facilities, vegetation, food, and fish sampling may be warranted. The staff has determined that based on the MILDOS calculations provided in application Section 7.3, vegetation ingestion is not an important pathway for public dose and is many times less than the applicable radiation protection standard in 10 CFR 20.1301 and 10 CFR 20.1302. The staff agrees with the applicant that vegetation ingestion is not an important source of exposure and sampling is not warranted.

5.7.7.3.2.7 Direct Radiation

Regulatory Guide 4.14, Table 2, suggests placing five or more passive integrating radiation devices at the same locations as used for air particulate sampling. The passive integrating radiation devices would be changed on a quarterly basis and measured for gamma exposure rate. The applicant stated that direct radiation monitoring will be conducted at the air particulate monitoring stations, MRA-1 through MRA-4. Gamma radiation will be monitored continuously using the InLight dosimeter from Landauer, which has an LLD of 0.1 mrem. The applicant stated that the InLight dosimeters will be exchanged quarterly. The staff notes that the direct radiation measurement methodology and measurement frequency are consistent with Regulatory Guide 4.14 recommended practices and are therefore acceptable.

The applicant stated in application Section 5.7.7.6 that the same locations will be used for radon monitoring and direct radiation monitoring, consistent with the recommendations of Regulatory Guide 4.14. The staff notes that the applicant did not use onsite meteorological data to select the proposed direct radiation or radon monitoring locations; this is the same problem staff identified in SER Section 5.7.7.3.2.2 for radon monitoring locations. Therefore, the staff cannot find the proposed direct radiation monitoring locations acceptable. The applicant’s proposed direct radiation monitoring methods are consistent with Regulatory Guide 4.14 and acceptable to the staff. However, the staff will impose a license condition, presented in SER Section 5.7.7.4, to address the direct radiation monitoring locations.

5.7.7.4 Evaluation Findings

The staff reviewed the airborne effluent and environmental monitoring program of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.7.3. The applicant proposes to demonstrate compliance with the 10 CFR 20.1301 annual public dose limit by using the results from environmental monitoring in accordance with 10 CFR 20.1302(b)(2). The applicant proposes to use the average annual results of environmental monitoring for air particulates, direct radiation, and sediment and compare this information to the 10 CFR Part 20, Appendix B, Table 2, "Effluent Concentration," and will consider Note 4 in Appendix B.

The applicant proposes to measure or monitor radon, air particulates, surface soils, sediment, and direct radiation. The applicant's proposed methods are consistent with the guidance in Regulatory Guide 4.14, but the applicant has not demonstrated that the sample locations are at the predicted highest downwind concentrations for radioactive effluents released from the facility. These sample locations need to be determined using onsite meteorological data to predict the highest downwind airborne concentrations. Onsite meteorological data are not available nor has the applicant demonstrated that nearby meteorological data adequately represent conditions at the Nichols Ranch ISR Project. The staff has determined that the applicant has not demonstrated that the proposed radon monitoring, air particulate sampling, and direct radiation sampling locations are at locations or in sectors representing the highest predicted airborne concentrations for releases from the facility and is imposing the following license conditions:

> Radiological monitoring will be conducted for airborne particulate radioactivity and radon-222 at appropriate environmental monitoring locations in accordance with the criteria in Regulatory Guide 4.14 (as revised) during operations to demonstrate compliance with 10 CFR 20.1301, 10 CFR 20.1501, and 10 CFR Part 40, Appendix A, Criterion 7.
>
> Consistent with Regulatory Guide 4.14 (as revised), the licensee shall establish air particulate sampling stations in the three sectors with the highest predicted radioactivity concentrations resultant from operations and co-locate radon air samplers and direct radiation and soil sampling with the air particulate sampling stations.

Based on its review (described above) of the information provided in the application, as supplemented by the requirements of the noted license condition, the NRC staff concludes that the airborne effluent and environmental monitoring programs meet the applicable acceptance criteria of SRP Section 5.7.7.3 and the requirements of the applicable sections of 10 CFR Part 20 and Part 40.

5.7.7.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2009c. NUREG-1910, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities," Washington, DC, May 2009.

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 2001. NUREG/CR-6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees,” Washington, DC, June 2001.

NRC, 1993b. Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities,” Washington, DC, July 1993.

NRC, 1980b. Regulatory Guide 4.14, Revision 1, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Washington, DC, April 1980.

Uranerz, 2009a. Letter from Uranerz Energy Corporation with Responses to Request for Additional Information for Nichols Ranch ISR Project License Application, March 11, 2009, ADAMS Accession Package No. ML090820568.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

Yuan, Y.C., J.H.C. Wang, and A.J. Zielen, 1989. ANL/ES-161, “MILDOS-AREA: An Enhanced Version of MILDOS for Large-Area Sources,” Argonne National Laboratory, Argonne, IL, June 1989.

5.7.8 Ground Water and Surface Water Monitoring Programs

5.7.8.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed ground water and surface water monitoring program for the Nichols Ranch ISR Project meets the requirements of 10 CFR 40.32(c); 10 CFR 40.41(c); and 10 CFR Part 40, Appendix A, Criterion 5B(5) and 5D.

5.7.8.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 5.7.8.3 (NRC, 2003).

5.7.8.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. In this section, the staff reviewed the ground water and surface water monitoring programs to be implemented at the Nichols Ranch ISR Project to establish monitoring well placement, background water quality, and detect excursions during production operations. SER Chapter 2 addresses preoperational monitoring, and SER Section 6.1 addresses restoration monitoring. The following sections address baseline well sampling, operational monitoring, UCLs, pumping tests, well field hydrologic packages, excursions, and other sampling.

5.7.8.3.1 Ore Zone Monitoring Well Locations

To establish background ground water quality within the “A sand” ore zone at the Nichols Ranch Unit and the “F sand” ore zone at Hank Unit, ore zone monitoring wells will be installed at a spacing of one well in 1.6 ha (4 ac) in the well fields in both license areas. The applicant stated in application Section 3.1 that the ore zone monitoring wells will not have screens installed. The wells will be completed over the entire thickness of the production aquifer while others will be completed to contact the area of mineralization. The NRC staff finds the location and completion of the ore zone wells acceptable because they conform to the guidance criteria in SRP Section 5.7.8.3(1).

The applicant stated in application Section 5.7.8.5.1 that these ore zone wells will be sampled four times prior to well field operation, with a minimum of 2 weeks between samples. The samples will be analyzed for all of the water quality parameters listed in application Table D6-6a. The applicant will use averaging of the ore zone monitoring wells in both proposed license areas to establish the background ground water quality for a well field. If the applicant determines that the sampling results show that the ground water quality is significantly different in regions within a well field, the data will not be averaged for the entire region but will be separated into subzones. The applicant will average the ground water data for each zone and analyze it for variability and outliers using statistical assessment methods outlined in the WDEQ-LQD, Guideline 4, guidance document (WDEQ-LQD, 2000). The NRC staff finds the applicant’s approach acceptable as it is consistent with the guidance in SRP Section 5.7.8.3(1).

The applicant stated in application Section 5.7.8.5 that the final average and range of background values for each analyte will be used to calculate the restoration target values (RTVs). The NRC staff notes that RTVs are used to determine and assess the effectiveness of restoration. The applicant listed the parameters to be used for RTVs in application Table 5-1. The staff concludes that the applicant’s approach to averaging background ore zone ground water quality and setting RTVs is consistent with the guidance criteria in SRP Section 5.7.8.3(1) and is acceptable.

5.7.8.3.2 Monitoring Well Ring Locations

The applicant stated in application Chapters 3 and 5 that monitoring well rings will be established around each well field to monitor for horizontal excursions from the Nichols Ranch Unit “A sand” ore zone and the Hank Unit “F sand” ore zone during ISR operations. The applicant stated in the application that the ore zone monitoring wells will be screened across the entire aquifer (Uranerz, 2010a). Monitoring wells will be located 152 m (500 ft) from the production area boundary and 152 m (500 ft) apart at each license area as shown in application Figures 3-8 A and 3-8B. These distances provide the appropriate spacing to detect excursions, according to the applicant. The applicant’s conclusion was based on analytical and numerical ground water flow modeling to assess the “gradient reversal” for both the Nichols Ranch Unit and the Hank Unit, which showed that the cone of depression reaches the monitoring well ring under proposed operating conditions. This modeling is described in application Chapter 3.0 and reviewed by the staff in SER Section 3.1. The staff finds that the applicant’s preliminary analysis demonstrated that the proposed location and screening of the ore zone ring monitoring wells is acceptable as it conforms to guidance criteria in SRP Section 5.7.8.3(3) and (4). The NRC staff notes that it will confirm this analysis by using the information in the production area pumping test reports, which the applicant will provide to the NRC for review and approval under a license condition discussed in SER Section 5.7.8.4.

The applicant stated in application Section 5.7.8.5 that the ore zone monitoring ring wells in each license area will be sampled four times prior to well field operation at each unit, with a minimum of 2 weeks between samples. The first sample will be analyzed for all of the water quality parameters listed in application Table D6-6a, and the remaining samples will be tested for the UCL parameters only. The applicant stated in the application that if the sampling results show that the ground water falls into different regions along the monitoring ring, the data will not be averaged for the entire region but will be separated into subzones. Ground water quality data within zones will be averaged. The staff cannot conclude that the proposed reduced parameter sampling will yield a statistically valid background sample because the sampling methods do not conform to guidance in SRP Section 5.7.8.3(1) for baseline water quality assessment, which suggests at least four independent sets of samples for all constituents. The NRC staff will therefore require a license condition that all ore zone monitoring ring wells be sampled four times for all water quality parameters, with the exception of “nondetects” if they are found in the first two samples. SER Appendix A lists this license condition.

The applicant stated in application Section 5.7.8 that chloride, total alkalinity, and conductivity will act as UCLs for each license area; when exceeded at a monitoring ring well, these UCLs will signal an excursion. UCLs will be set at background mean concentration plus five standard deviations for alkalinity and conductivity. The UCL for chloride will be set at the background mean concentration and five standard deviations or by the background mean plus 15 mg/L, whichever is greater. Water levels will be measured but not used as an excursion indicator. The staff finds that these proposed indicators and UCLs are acceptable for monitoring excursions outside the production zone and consistent with the guidance criteria in SRP Section 5.7.8.3(2).

5.7.8.3.3 Overlying and Underlying Aquifer Well Locations

The applicant stated in application Section 5.7.8 that overlying and underlying aquifer monitoring wells would be established in both license areas at a spacing of one well in every 1.62 ha (4 ac) in the proposed well fields to detect vertical excursions. Overlying and underlying monitoring wells will be screened across the entire aquifer (Uranerz, 2010a). For the Nichols Ranch Unit, the overlying aquifer is the “B sand” and the underlying aquifer is the “1 sand.” For the Hank Unit, the overlying aquifer is the “G sand,” and the underlying aquifer is the “C sand" or “B sand.” The applicant stated in the application that the underlying “1 sand” at the Nichols Ranch Unit and underlying “C sand” at the Hank Unit are often thin or absent. In narrow areas of the well field where a line-drive pattern is used, overlying and underlying wells will be spaced no farther than 305 m (1,000 ft) apart. The applicant also stated in application Section 5.7.8.2 that the location of underlying and overlying monitoring wells, in the areas where overlying and underlying aquifers are nonexistent, or the confining unit (aquitard) is thin (less than 5 ft), will be determined in consultation with regulatory agencies. The staff finds that the applicant’s preliminary analysis demonstrated that the proposed location and screening of the overlying and underlying aquifer monitoring wells are acceptable as they conform to guidance criteria in SRP Section 5.7.8.3(3) and (4). Staff will confirm this analysis using the information in the production area pumping test reports, which will be provided for NRC review and approval under the license condition discussed in SER Section 5.7.8.3.4.

The applicant stated in application Section 5.7.8 that the overlying and underlying aquifer wells will be sampled for baseline water quality four times prior to well field operation, with a minimum of 2 weeks between samples. The applicant indicated that the first two samples will be analyzed for all of the water quality parameters listed in application Table 5-1, as discussed in application Section 5.7.8.5.1; however, the final two samples will be for only the UCL indicators.

The staff cannot conclude that the proposed reduced parameter sampling will yield a statistically valid background sample because the sampling methods do not conform to guidance criteria in SRP Section 5.7.8.3(1) for baseline water quality assessment, which suggests at least four independent sets of samples for all constituents. The NRC staff will therefore require a license condition that overlying and underlying wells be sampled four times for all water quality parameters, with the exception of “nondetects” if they are found in the first two samples.

The applicant stated in the application that chloride, total alkalinity, and conductivity will act as excursion indicators. The applicant will set UCLs and will develop separate overlying and underlying aquifer UCLs for each indicator for each license area as a means of detecting excursions. UCLs will be set at background mean concentration plus five standard deviations for alkalinity and conductivity. The UCL for chloride will be set at the background mean concentration and five standard deviations or by the background mean plus 15 mg/L, whichever is greater. Water levels will be measured but not used as an excursion indicator. The staff finds these proposed indicators and the method of setting UCLs acceptable for monitoring excursions in the overlying and underlying aquifers as they conform to the guidance criteria presented in SRP Section 5.7.8.3(2).

5.7.8.3.4 Pumping Tests

After installation of all wells and completion of all background sampling and well field characterization at both the Nichols Ranch and Hank Units, the applicant stated in application Section 5.7.8.4 that it would conduct multiwell pumping tests to verify communication between the well field and the monitoring well ring. The staff has determined that the applicant has developed an acceptable pumping test strategy to demonstrate communication with the monitoring well ring in the Nichols Ranch Unit “A sand” confined aquifer which conforms to the guidance criteria in SRP Section 5.7.8.3(4). As discussed in SER Section 3.1.3.4.4, the applicant did not provide a pumping test strategy to demonstrate communication across the unconfined “F sand” aquifer at the Hank Unit. However, the applicant stated in the application that it will develop a pumping test strategy for the Hank Unit “F sand” well fields. This strategy will be presented to the WDEQ for approval before conduct of the well pumping test. The NRC staff finds this approach acceptable as WDEQ has a long record of reviewing and approving the well pumping test plans for ISR operations in Wyoming, and therefore, WDEQ approval will be sufficient.

After well field testing is completed, the applicant stated in the application that it will prepare a production area pump test document for each license area. The content of this document, presented in application Section 5.7.8.4, will describe the production area geology, hydrogeology, and pumping tests results in detail. The applicant stated in the application that it will not include ground water quality data. As the applicant has not provided an acceptable approach to evaluating baseline water quality in the well field as discussed in this section, the NRC staff will require that these data be provided for review and approval. Therefore, by license condition listed in SER Section 5.7.8.4, the production area pump test reports will include all background ground water quality data discussed in SER Sections 5.7.8.1 through 5.7.8.4 to allow the staff to review and approve these data before the start of well field operations.

5.7.8.3.5 Excursions

In application Section 5.7.8.10, the applicant stated that once ISR operations are approved and begin at the Nichols Ranch ISR Project, operational monitoring will consist of sampling all of the ore zone aquifer monitoring ring wells and underlying and overlying aquifer monitoring wells twice monthly at intervals of approximately 2 weeks. Each monitoring well will have a dedicated submersible pump. The samples will be analyzed within 48 hours of collection for UCL parameters, which are the excursion indicators. Static water levels will also be collected and recorded. All static water levels and monitoring data will be submitted to WDEQ quarterly and kept on site for review by the NRC. The staff finds these proposed methods of monitoring for excursions in the surrounding, overlying, and underlying aquifers acceptable as they conform to the guidance criteria presented in SRP Section 5.7.8.3(5).

The applicant stated in application Section 5.7.8.10 that if concentrations of two of any three excursion indicators exceed UCLs, the well(s) will be resampled within 24 hours of the first analysis for verification of a possible excursion. The verification sample will be split and analyzed in duplicate to assess analytical error. If a second sample does not verify the excursion, a third sample will be taken within 48 hours. If neither the second nor third sample confirms an exceedance, the first sample will be considered in error. If either the second or third sample confirms an exceedance, the well in question will be placed on excursion status. The NRC project manager will be notified within 24 hours by phone or e-mail, and in writing within 7 days. The staff finds this approach to excursion verification and reporting acceptable because it conforms to the guidance criteria presented in SRP Section 5.7.8.3(5), is consistent with accepted industry practice, and is consistent with excursion verification practices at other NRC-licensed ISR facilities.

The applicant stated in application Section 5.7.8.10, that once an excursion is verified, it will implement corrective actions to recover it. These actions may involve modifying the injection and recovery rates in the affected area until the excursion is mitigated. Sampling will also be increased to every 7 days. If the UCLs do not begin to decline after 60 days, the applicant stated in the application that it will suspend all injection in the ore zone adjacent to the excursion and increase the net withdrawal from the excursion area. Injection will remain suspended, and the increased bleed will be maintained until all excursion indicators are returned to values less than UCLs. The applicant also stated in the application that when values below UCLs are established, normal injection and extraction operations will resume with net water withdrawals from the excursion area. The staff finds this approach to excursion corrective action acceptable because it conforms to the guidance criteria presented in SRP Section 5.7.8.3(5).

The applicant stated in the application that if injection of lixiviant is not stopped to correct an excursion, the surety will be increased to an amount that will cover the expected full cost of correcting and cleaning up the excursion. The NRC staff has included a standard license condition, listed in SER Appendix A, which requires that the licensee either (a) terminate injection of lixiviant within the production area until the excursion is corrected, or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The amount of the surety will remain in force until the excursion is corrected. The NRC staff finds this approach acceptable as it is consistent with the guidance criteria in SRP Section 5.7.8.3(5).

5.7.8.3.6 Other Sampling

In addition to well field monitoring, the applicant stated in application Section 5.7.8.10 that any private wells within 1 km (0.6 mi) of the Nichols Ranch and Hank Units well field area boundaries completed in the same sand as the ore will be sampled quarterly for natural U and Ra-226. For the Nichols Ranch Unit, these wells are identified as the Red Springs #4 Lower

(DW-4L), Pats Well #1, and Brown 20-9. For the Hank Unit, the wells were identified as BR-F, Dry Willow #1, and Means #1.

SRP Section 5.7.7.3 suggests that the intent of Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Regulatory Position C., 2.1, “Operational Sampling Program,” (NRC, 1980b) should be followed for environmental monitoring. Regulatory Guide 4.14 suggests sampling of all private wells within 2 km (1.2 mi) of a tailings impoundment. While an ISR well field is not a tailings impoundment, the staff agrees that sampling of private wells near a source of byproduct material, such as the ISR well field, is prudent and protective of public health and safety. The NRC staff finds the sampling distance of 1 km (0.6 mi) from the well field acceptable and consistent with those used by other NRC-licensed ISR facilities. However, the NRC staff finds unacceptable this sampling of only those wells completed in the same sand as the ore. Excursions at ISR facilities are possible in aquifers above, below, and adjacent to the ore zone, and the staff finds that poor private well completion may allow for constituents to move into wells completed below the ore zone. Likewise, excursions in the aquifer above the ore zone, or surface spills, may allow constituents to affect private wells. The staff therefore has required by license condition that all private wells, such as domestic and stock wells, within 1 km (0.6 mi) be sampled yearly for UCL parameters, natural uranium, and Ra-226.

The applicant stated in the application that surface water samples will be collected in the same locations that were used during the preoperational background sampling for both the Nichols Ranch and Hank Units. The surface water samples will be collected and measured for the constituents listed in application Table D6A1-1 whenever water is present. The measurements will be reported to the NRC in the semiannual monitoring report. The NRC staff finds this approach acceptable as it is consistent with the guidance criteria in SRP Section 5.7.8.3(6).

5.7.8.3.7 Water Quality Sampling and Procedures

The applicant provided an SOP for well sampling to be used at the Nichols Ranch ISR Project in license application Addendum 5A. The procedure addresses water level determination, well sampling techniques, sample preservation, sampling documentation, sample handling, and quality assurance/quality control (QA/QC). The applicant also provided a discussion of the methods for statistical assessment of background water quality including how the averages and variability of the data will be determined and how outliers would be addressed. These SOPs and statistical analysis methods are consistent with the guidance in the SRP and with practices found at other NRC-licensed facilities and, therefore, are acceptable.

5.7.8.4 Evaluation Findings

The staff reviewed the ground water and surface water monitoring programs of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.8.3. The applicant has defined a sampling program that addresses the following areas:

- surface water bodies that lie within the facility boundary, including downstream sampling locations.
- well field baseline water quality sampling, including the number and sampling interval, constituents sampled, and statistical methods

- operational ground water monitoring including identification of: appropriate monitoring well spacing, excursion parameters, UCL computational methods, excursion notification requirements, and corrective actions for excursions

As previously stated in the application and discussed in SER Sections 5.7.8.3.1, 5.7.8.3.2, and 5.7.8.3.3, a standard condition describes the monitoring for all background ore zone wells, as well as all the wells in the proposed monitoring network. As discussed in SER Section 5.7.8.3.6, a standard condition requiring monitoring of private wells within 1 km (0.6 mi) of the ore zone monitoring well ring is listed in SER Appendix A.

The applicant has provided initial pump tests showing that it is possible for ISR operations to be performed at the Nichols Ranch ISR Project. More detailed information will be available when the applicant prepares a production area pump test document for each license area, which will include a description of the production area geology, hydrogeology, and pumping test results in detail. As discussed in SER Section 5.7.8.3.4, the staff is imposing the following license condition related to the product area pump test reports to confirm the staff's review of the application:

> The licensee will provide the Production Area Pump Test (PAPT) document for the first production areas at the Nichols Ranch and Hank Units for NRC review and approval prior to lixiviant injection into the production area. The licensee will provide PAPT documents for each additional production area for NRC review. The PAPT document will provide all background ground water data, restoration target values, upper control limits at each monitoring well, as well as the information outlined in Section 5.7.8.4 of the license application.

As discussed in SER Section 5.7.8.3.5, a license condition related to surety adjustments if an excursion is uncontrolled for greater than 60 days where lixiviant is still being injected is listed as a standard condition in SER Appendix A.

Based on its review (described above) of the information provided in the application, as supplemented by the noted license conditions, the NRC staff concludes that the ground water and surface water monitoring programs meet the applicable acceptance criteria of SRP Section 5.7.8.3 and comply with the following regulations:

- 10 CFR 40.32(c), which requires the applicant's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life and property

- 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license

- 10 CFR Part 40, Appendix A, Criterion 5B(5), which provides concentration limits for hazardous constituents

- 10 CFR Part 40, Appendix A, Criterion 5D, which requires a ground water corrective action program

- 10 CFR Part 40, Appendix A, Criterion 7A, which requires a detection monitoring program

5.7.8.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 1980b. Regulatory Guide 4.14, Revision 1, “Radiological Effluent and Environmental Monitoring at Uranium Mills,” Washington, DC, April 1980.

Uranerz, 2010a. “Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application,” file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

WDEQ-LQD, 2000. Guideline No. 4, “In Situ Mining” (revised).

5.7.9 Quality Assurance

5.7.9.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed QAP for the Nichols Ranch ISR Project meets the requirements of 10 CFR 20.1101 and 10 CFR Part 20, Subparts L and M.

5.7.9.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in SRP Section 5.7.9.3 (NRC, 2003). Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination—Effluent Streams and the Environment” (NRC, 2007), provides guidance on demonstrating compliance with the applicable regulations.

5.7.9.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. This section discusses the proposed QA and QC programs for radiological and nonradiological monitoring activities. QA comprises all those planned and systematic actions that are necessary to provide adequate confidence in the assessment of monitoring results. QC, which is included in QA, comprises those actions that provide a means to measure and control the characteristics of measurement equipment and processes to meet established standards. QA is necessary to ensure that all radiological and nonradiological measurements that support the radiological and nonradiological monitoring programs are reasonably valid and of a defined quality.

5.7.9.3.1 Radiological and Nonradiological Monitoring Programs

Regulatory Guide 4.15 describes a method that is acceptable for use in designing and implementing programs to ensure the quality of the results of measurements of radioactive materials in the effluents from, and environment outside of, facilities that process, use, or store radioactive materials during all phases of the facility's life cycle. Section B of Regulatory Guide 4.15 states that every organization actually performing effluent and environmental monitoring, whether an NRC licensee or the licensee's contractors, should include the QAP elements in this guide. Section C of Regulatory Guide 4.15 recommends that, in addition to its own program, a licensee should require any contractor or subcontractor performing monitoring activities for the licensee to provide a QAP and to routinely provide program data summaries consistent with the provisions of this guide.

The applicant described in application Section 5.7.9 a proposed QAP to be implemented at the Nichols Ranch ISR Project for all relevant operational monitoring and analytical procedures. The applicant stated in application Section 5.7.9.8 that the QAP will be implemented consistent with NRC Regulatory Guide 4.15. The following sections discuss the various aspects of the applicant's QAP.

5.7.9.3.2 Organizational Structure and Responsibilities of Personnel

The applicant identified six key positions of the organization and their responsibilities in application Sections 5.1 and 5.2. These positions include the President and Chief Executive Officer, Executive Vice President and Chief Operating Officer, ESH Manager, RSO, Production Manager, and Mine Superintendent. The staff is unable to determine the organizational relationship between the RSO, who is designated to implement the QAP requirements, and the other individuals mentioned. The applicant needs to clarify the QA organization, how these individuals are organizationally integrated with the RSO, and who has ultimate authority for the QA program (QAP) at the site. Additionally, the staff is unable to determine whether the described QA-related organization and responsibilities are consistent with NRC Regulatory Guide 4.15. Therefore, the staff cannot determine whether the described QA-related organization and responsibilities are acceptable. To address these issues, the staff will require a license condition that a QAP be submitted to the NRC. The QAP will be subject to NRC inspection and written verification prior to operations. SER Section 5.7.9.4 describes this license condition.

5.7.9.3.3 Specification of Qualifications of Personnel

The applicant stated in the application that personnel will be qualified to perform their assigned jobs through meeting basic job description requirements, education standards, experience, and ongoing performance reviews. The applicant did not identify who is responsible for determining site-required training and communicating the requirements to appropriate managers. Nor did the applicant identify audits or certifications for laboratories that analyze samples collected for characterization, compliance, or other purposes. The applicant stated in the application that managers are responsible for determining training needs of their staff, and personnel and training will be consistent with NRC Regulatory Guide 4.15 (NRC, 2007). However, insufficient details were provided regarding the manner in which the recommendations in NRC Regulatory Guide 4.15 will be implemented. Therefore, the staff cannot conclude that the process used to determine the qualifications of personnel is acceptable. The staff will require a license condition that a QAP be developed consistent with the topics of Regulatory Guide 4.15, which includes specifications of qualifications of personnel. SER Section 5.7.9.4 describes this license condition. The QAP will be subject to NRC inspection and written verification prior to operations.

5.7.9.3.4 Operating Procedures and Instructions

The applicant stated in the license application that the measurement system design and implementation will ensure that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented. However, the measurement system was not described in sufficient detail to allow the staff to determine whether the measurement system is consistent with NRC Regulatory Guide 4.15. The applicant did not provide field quality objectives for field and analytical methods that are industry standards and laboratory quality objectives that will include precision, bias, accuracy, representativeness, comparability, and sensitivity. The staff cannot determine whether the quality objectives are consistent with Regulatory Guide 4.15.

The applicant did not state that it will ensure that field measurements and sample collections will follow procedures attached to nationally recognized consensus standards, such as EPA methods, American Society for Testing and Materials, or recommended procedures from instrument manufacturers. The staff is unable to determine whether the applicant will ensure that field measurements and sample collections will follow procedures attached to nationally recognized consensus standards. Therefore, the staff is unable to determine if the applicant's sampling methods are consistent with Regulatory Guide 4.15. Because the applicant did not state that it will include preparation and decontamination requirements for sampling equipment, the staff is unable to determine whether the applicant will prepare and decontaminate sampling equipment. Therefore, the staff cannot determine if this program is consistent with NRC Regulatory Guide 4.15.

The staff will require a license condition that a QAP be developed consistent with the topics of Regulatory Guide 4.15, which includes details on operating procedures and instructions. SER Section 5.7.9.4 describes this license condition. The QAP will be subject to NRC inspection and written verification prior to operations. Staff notes that ISR operating procedures are not required at the time of licensing. However, these SOPs are required by the standard license condition in SER Appendix A to be developed before the preoperational inspection and before operations can begin. These procedures are subject to NRC review and written verification during the preoperational inspection process.

5.7.9.3.5 Records

The applicant stated in application Section 5.2.1.3 that records will be maintained of receipt, transfer, and disposal of source or byproduct material processed or produced at the site. Records will also be maintained of the radiation safety and environmental monitoring programs to include surveys, sampling, and calibrations. These records will be maintained for the period described by regulation or license. Records of surveys and monitoring will also be maintained in accordance with 10 CFR Part 20, Subpart L.

The applicant stated in application Section 5.7.9.3 that records will be maintained to document the activities performed in the QAP. The records will be specified in the applicable operating procedure. These records will include field logs, chain-of-custody, measurement results, instrument performance checks, calibration, data reduction, and data review and approval. The applicant stated in application Section 5.7.9.4 that chain-of-custody records will be maintained for samples in accordance with an operating procedure. Staff will require as a standard license condition listed in SER Appendix A that site operating procedures are developed prior to operations and approved by the NRC. The staff finds acceptable the applicant's commitment to maintaining records of surveys and monitoring in accordance with 10 CFR Part 20, Subpart L, commitments made in application Section 5.2.1.3 to maintaining records, and commitment to developing a QAP in accordance with Regulatory Guide 4.15.

5.7.9.3.6 Quality Control

The applicant stated in the application that it will develop sampling handling and custody requirements to include identification of samples, sample handling and storage protocols, sample custody to ensure integrity of the sample(s), sample packaging, and shipping. The applicant did not state that it will ensure that subcontractor and laboratories maintain a QA/QC program; however; it did state in application Section 5.7.9.8 that the QAP will be implemented consistent with NRC Regulatory Guide 4.15. Regulatory Guide 4.15 suggests that "in addition to its own program, a licensee should require any contractor or subcontractor performing support program activities (e.g., sampling, analysis, evaluations, and records) [to] retain records sufficient for the licensee to develop and maintain a QAP covering the applicable program elements." The staff will require a license condition that a QAP be developed consistent with Regulatory Guide 4.15. The QAP program will be subject to NRC inspection and written verification.

The applicant stated in the application that it will ensure that proper maintenance, calibration, and use of equipment and instruments are implemented to ensure the quality of all collected data. The applicant stated in application Section 5.7.9.5.1 that requirements will include use of calibration standards or sources traceable to the National Institute of Standards and Technology. It will ensure that the sampling procedures specify field equipment, instruments, and associated supplies used to obtain field measurements and collect samples. Also, the onsite laboratory will maintain a schedule for servicing critical items and will perform routine maintenance, scheduled maintenance and repair, or coordinate with a vendor to arrange for maintenance and repair. The NRC staff finds these practices acceptable; however, the license condition necessitating the development of a QAP consistent with Regulatory Guide 4.15 will ensure that these practices are documented in SOPs and are subject to NRC review, written verification, and inspection.

The applicant has not provided any information or discussed the routine QC checks for acceptable performances, such as background checks, reference checks, and the use of control charts to track trends. The staff is unable to determine whether routine QC checks for acceptable performance will be conducted. The license condition necessitating the development of a QAP consistent with Regulatory Guide 4.15 will ensure that routine QC checks for acceptable performance are documented in SOPs and are subject to NRC review, written verification, and inspection.

5.7.9.3.7 Verification and Validation

The staff notes that verification and validation (V&V) of certain aspects and support activities of the radiological measurement process or monitoring program are essential to the QAP. These aspects and activities include data and computer software V&V and project method validation. Project method validation is the demonstration that a method using performance-based method selection is capable of providing analytical results to meet criteria in the analytical protocol specification. Acceptable method validation is necessary before the radiological analysis of samples or the taking of measurements in a monitoring program. The applicant did not discuss

V&V in the license application. Therefore, the staff will impose a license condition, as described in SER Section 5.7.9.4, that will require a QAP that discusses the V&V evaluation process and is consistent with Regulatory Guide 4.15. Staff finds this acceptable, as the V&V program will be subject to NRC review, written verification, and inspection prior to operations.

5.7.9.3.8 Assessments and Audits

The staff notes that assessments, audits, and surveillance are elements that can be used to evaluate the initial and ongoing effectiveness of the QAP to monitor and control the quality of a radiological monitoring program. Management having responsibility in the area being reviewed should document and review the results of these activities. The QAPs of contractors providing materials, supplies, or services affecting the quality of the laboratory's operations should be audited periodically.

The applicant did not describe an assessment, audit, and surveillance program that will be implemented at the Nichols Ranch ISR Project. Although the applicant stated in the application that qualified personnel will audit the QAP, the staff notes that no description of the auditor qualifications was provided. Therefore, the staff will require a license condition, as described in SER Section 5.7.9.4, that will require a QAP that discusses the elements of an assessment and audit program and is consistent with Regulatory Guide 4.15. Staff finds this acceptable as the assessment and audit program will be subject to NRC review, written verification, and inspection prior to operations.

5.7.9.3.9 Preventive and Corrective Actions

The staff notes that integral components of a QAP include identifying areas for improvement, defining performance or programmatic deficiencies, and initiating appropriate corrective or preventive actions. The QAP for effluent and environmental monitoring programs should contain both a program for continuous improvement and a program for implementing corrective actions when conditions adverse to quality are identified.

The applicant has not discussed or demonstrated a corrective action program or a continuous improvement program at the site that integrates components of the QAP. Therefore, the staff will include a license condition that will require the applicant to address preventive and corrective actions in the QAP consistent with Regulatory Guide 4.15 before operations begin. Staff finds this acceptable as the preventive and corrective action program will be subject to NRC review, written verification, and inspection prior to operations.

5.7.9.4 Evaluation Findings

The staff reviewed the QAP of the proposed Nichols Ranch ISR Project in accordance with SRP Section 5.7.9.3. The applicant has not adequately addressed organizational structure, management responsibilities, and personnel training and has not committed to providing written procedures and protocols for those activities that are important to QA, to using QC methods, and to providing for periodic management audits, as outlined in Regulatory Guide 4.15. Therefore, the staff is imposing the following license condition related to submission of a QAP before the start of uranium recovery operations:

> At least 30 days prior to the preoperational inspection, the licensee will submit a Quality Assurance Program (QAP) to the NRC for review to verify the license application statement that the QAP will be consistent with Regulatory Guide 4.15.

The staff notes that the applicant has committed in application Section 5.7.9.8 to implementing the QAP consistently with Regulatory Guide 4.15. The QAP will provide a clear designation of QA responsibilities to the NRC prior to operations. Regarding personnel training, the staff is imposing a standard condition related to radiation safety personnel qualifications which is listed in SER Appendix A. The staff finds that the license conditions developed will provide assurance that the applicant will have an acceptable NRC-approved QAP prior to operations and does not preclude the licensing of this facility at this time. The QAP will be subject to NRC review and written verification prior to operations in conjunction with NRC inspection. Based on its review (described above), the information provided in the application, as supplemented by information to be submitted in accordance with the noted license condition, and the commitments made by the applicant to develop a QAP in accordance with Regulatory Guide 4.15, the NRC staff concludes that the QAP will meet the applicable acceptance criteria of SRP Section 5.7.9.3 and the requirements of 10 CFR 20.1101 and 10 CFR Part 20, Subparts L and M, prior to operations.

5.7.9.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Standards for Protection Against Radiation.”

NRC, 2007. Regulatory Guide 4.15, Revision 2, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment,” Washington, DC, July 2007.

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

6.0 GROUND WATER RESTORATION, RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 Plans and Schedules for Ground Water Quality Restoration

6.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans and schedules for ground water quality restoration for the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.32(c); 10 CFR 40.42, “Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas”; and Criterion 5B(5) of Appendix A to 10 CFR Part 40.

6.1.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.1.3 (NRC, 2003).

6.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. This section discusses the plans for proposed ground water quality restoration activities at Nichols Ranch ISR Project. This includes proposed restoration standards, methods, effectiveness, estimates of the number of pore volumes needed to complete restoration, monitoring, wastewater disposal, well plugging and abandonment, and the preliminary restoration schedule.

6.1.3.1 Restoration Standards

Ground water quality (i.e., concentrations of hazardous constituents) must be restored to the standards identified in Criterion 5B(5) of Appendix A to 10 CFR Part 40. Those standards are background concentration or the maximum values for ground water protection in the Criterion 5C table, whichever level is higher; or an alternate concentration limit (ACL) established by the NRC in accordance with Criterion 5B(6) of Appendix A to 10 CFR Part 40. The applicant committed in application Section 6.1 to meeting the regulations in Criterion 5B(5) but openly disagreed in the application with the NRC’s position on the regulation. The staff reviewed the applicant’s discussion of restoration standards and finds this commitment to be consistent with the regulations. However, the staff will include the requirement that ground water quality must be restored to the standards identified in Criterion 5B(5) of Appendix A to 10 CFR Part 40 as a standard license condition listed in SER Appendix A to ensure its implementation.

As stated above, ACLs are one of the applicable ground water restoration standards. For a licensee to receive approval to use ACLs, it must first demonstrate that—for the constituents at issue in the well field being restored—it has made reasonable effort to return those constituents to background or to the Criterion 5C table values, whichever level is higher. A license amendment application must be submitted by the licensee to request establishment of ACLs and is subject to a safety and environmental review. A licensee can propose for the NRC’s consideration only ACLs that present no significant hazards. The NRC may establish a well-field-specific ACL for a constituent only if it finds that the proposed limit is ALARA and that the proposed limit would not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. The many factors that the NRC must consider in reviewing ACL applications are set forth in 10 CFR Part 40, Appendix A, Criterion 5B(6). For ISR facilities in Wyoming, the State's "class of use" standard is one factor that may be considered in evaluating ACL requests, in accordance with Criterion 5B(6)(a)(v–vi) and (b)(vi–vii).

Further, in considering ACL requests, the NRC places particular importance on protecting underground sources of drinking water (USDWs) in the area around the ISR facility, and the staff in this regard also considers, in accordance with Criterion 5B(4), the exempted aquifer determinations made by EPA. In this regard, before an ISR applicant or licensee is allowed to extract uranium, EPA, under 40 CFR 146.4, "Criteria for Exempted Aquifers," and in accordance with the Safe Drinking Water Act must issue an aquifer exemption covering the portion of the aquifer in which the uranium-bearing rock is located. EPA must find that the portion of the aquifer being exempted "does not currently serve as a source of drinking water" and "cannot now and will not in the future serve as a source of drinking water."

RTVs are the primary restoration standard at ISR facilities. The applicant stated in application Section 6.1.2 that, before extraction in each production area, RTVs will be set as the well field average plus two standard deviations of the background water quality for each parameter listed in application Table 5-1. The applicant stated that ground water RTVs in a production area will be based on the background water quality data collected for each well field production area. Background water quality will be collected and determined separately for wells completed in the ore zone production area (i.e., MP-Wells) and perimeter monitoring ring wells (i.e., MR-Wells). The NRC staff agrees with this method of sampling and setting RTVs as it is consistent with the guidance criteria provided in SRP Sections 5.7.8.3(1) and 6.1.3(4).

The applicant stated in the application that RTVs will not be changed unless the operational monitoring program shows that background water quality has changed in a production area, and that such a change justifies redetermination of the background water quality. If this were to occur, the applicant has stated that monitoring wells would be resampled, and the applicant would ask the WDEQ and the NRC to review and approve any change to RTVs. The NRC staff notes that background water quality is highly unlikely to change in the ore zone aquifer. However, if an applicant or licensee concludes that there is a significant change in background, the NRC will review the request. The NRC will approve a revision to the RTVs only if substantial temporal and spatial water quality data rigorously demonstrate that background water quality has changed as a consequence of natural events unrelated to ISR operations.

6.1.3.2 Restoration Methods

The applicant stated in application Section 6.1.3 that the ground water restoration program will consist of two stages, the restoration stage and the stability monitoring stage. The restoration stage will consist of three possible phases, including ground water transfer, ground water sweep, and ground water treatment

In the application, the applicant defined the ground water transfer phase as occurring when ground water from a well field entering production will be injected into a well field beginning restoration. However, the applicant noted that ground water transfer can occur within the same production area, if one section of the production area is in a more advanced state of restoration than another. The applicant identified the goal of the ground water transfer as to blend the water in the well field areas to reduce water consumption and waste water disposal. Water recovered from the restoration production area may be passed through IX columns and/or filtered during this phase if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens. The NRC staff agrees with the applicant's approach as it reflects accepted ISR industry practice, and it is consistent with the guidance criteria in SRP Section 6.1.3(3).

The applicant stated in application Section 6.1.3.2 that during the ground water sweep phase, ground water from a production area beginning restoration is pumped to the processing plant without any reinjection. This process results in an influx of the native ground water into the production area to flush contaminants from the extraction zone, thus "sweeping" the ore zone aquifer. Water produced during ground water sweep is usually sent to the processing plant for treatment and removal of any uranium and other constituents. After the treatment, the swept water will be disposed of as byproduct material by injection into a deep disposal well. The NRC staff agrees with the applicant's approach as it reflects successful ISR industry practice and is consistent with the guidance criteria in SRP Section 6.1.3(3).

The applicant stated in application Section 6.1.3.2 that the rate of sweep will depend on the capacity of the deep disposal wells and the ability of the production area to sustain the rate of withdrawal. Furthermore, a hydraulic barrier may be used during this step to prevent ground water from an adjacent operational production area from being drawn into the area undergoing restoration. The NRC staff agrees with the applicant's approach as it reflects successful ISR industry practice and is consistent with the guidance criteria in SRP Section 6.1.3(3).

Ground water treatment will occur either in conjunction with or following ground water sweep. In this step, water will be pumped from the extraction zone to treatment equipment at the surface including IX and RO. The NRC staff notes that RO is a high-pressure filtration process that reduces contaminants in the affected ground water, producing a permeate with reduced constituent concentrations and reject brine. Permeate will be reinjected into the ore zone aquifer or stored for use in the extraction process. The reject brine will be sent to the waste disposal system. The NRC staff agrees with the applicant's approach as it reflects successful ISR industry practice and is consistent with the guidance criteria in SRP Section 6.1.3(3).

The applicant has stated in application Section 6.1.3.3 that at any time during ground water treatment, a chemical reductant (sulfide or sulfite compound) might be added to create reducing zones in the extraction zone. The applicant indicated that the goal of reductant addition is to decrease the concentrations of elements sensitive to oxidation reduction (e.g., arsenic, molybdenum, selenium, uranium, and vanadium) through reduction of these elements. The applicant stated that the concentration and quantity of reductant injected into the ore zone undergoing restoration are determined by how the ground water reacts with the reductant. The NRC staff agrees with the applicant's approach as it is reflects successful ISR industry practice and is consistent with the guidance criteria in SRP Section 6.1.3(3).

The applicant committed in application Section 6.1.3.3 to developing a comprehensive safety plan and to implementing it before using any reductant. This safety plan is expected to address such issues as reductant use, proper personal protection equipment to be worn around the reductant, and the location of the reductant in relation to other chemicals in and around the plant. In addition, the applicant also stated that it may consider using a biological reduction method to achieve ground water restoration. The applicant has committed to submitting a detailed plan for review and approval to the NRC before using any reductant during ground water restoration (Uranerz, 2010a). The NRC agrees that both the safety and biological restoration plans may be submitted with a revised decommissioning plan (DP) before the restoration of a well field.

The applicant stated in application Section 6.1.3 that the sequence of the restoration methods discussed previously will be determined based on operating conditions and waste water system capacity. The need for specific restoration steps will depend on the progress of restoration based on monitoring results. The NRC staff has reviewed the applicant's proposed restoration methods and finds them acceptable as they reflect historically successful ISR industry restoration practices and are consistent with the guidance criteria in SRP Section 6.1.3(3).

6.1.3.3 Effectiveness of Ground Water Restoration Methods

The applicant stated in application Section 6.1.3.5 that the restoration methods proposed for the Nichols Ranch ISR Project have been successfully implemented at nearby ISR sites within 56 km (35 mi) with hydrological characteristics similar to those in the PRB. ISR sites identified included the Irigaray and Christensen Ranch ISR, Smith Ranch/Highlands ISR, Collins Draw Research and Development (R&D) Facility, Ruth R&D Facility, and the Reno Creek R&D Facility, all in the PRB, and the Bison Basin ISR located in the Great Divide Basin of Wyoming. The NRC staff is aware of these site restorations and agrees that they were successfully restored using the proposed restoration methods, with the exception of one well field at Reno Creek. This well field, however, used an acid lixiviant and is therefore not analogous to the restoration at the Hank and Nichols Units, which will use a bicarbonate and oxygen lixiviant. To further support its position, the applicant provided a table comparing the ore sand aquifer properties of the Nichols Ranch and Hank Units to the NRC-licensed North Butte, Ruth, Christensen Ranch, Reno Creek, Bison Basin, and Smith Ranch ISR operations. The NRC staff reviewed this table and concludes that it demonstrates that the Christensen Ranch and Bison Basin ISR production aquifer have hydrogeologic properties, including aquifer hydraulic conductivity, storativity, and lithology, similar to those of the Nichols Ranch Unit "A sand." The NRC staff also concludes that the similar hydrogeological properties of the Reno Creek ISR production aquifer demonstrates that it is an acceptable analog for the Hank Unit "F sand."

The staff notes that most successful production-scale restorations to date in Wyoming and neighboring States have occurred in confined aquifers where the ore zone aquifer is completely saturated with several hundred feet of hydrostatic head. These confined aquifer conditions exist at the Nichols Ranch Unit. The applicant stated that a successful restoration was completed with eight pore volumes at the commercial Bison Basin ISR, which is an analog for the Nichols Ranch Unit. Restoration was accomplished using a combination of ground water sweep, ground water transfer, and RO, which is the applicant's approach for the Nichols Ranch Unit. As these restoration methods have proven successful in a confined aquifer analog to Nichols Ranch ISR (the Bison Basin) and in the other ISR operations in Wyoming, the staff concludes that this is sufficient evidence that they are likely to be effective in the restoration of the confined aquifer at the Nichols Ranch Unit.

At the Hank Unit, the ore zone is located in an unconfined (unsaturated) aquifer. The staff notes that there is very little field information available on the success of traditional restoration methods in the unconfined (unsaturated) aquifer setting for NRC-licensed ISR facilities. To address this issue, the applicant reported in the application that the Reno Creek ISR was a good analog to the Hank Unit. Rocky Mountain Energy Corporation operated this facility in a location approximately 10 km (6 mi) to the southeast of the Nichols Ranch ISR Project. The applicant noted that the Reno Creek ore body is located in the same Wasatch Formation as the Hank Unit. The applicant provided information about the location's hydrogeologic characteristics. The applicant also provided a report on the operation of the Reno Creek facility that demonstrated successful ground water restoration of an unconfined (unsaturated) aquifer.

The NRC staff reviewed the information on the Reno Creek ISR and the report on the restoration of the Reno Creek pilot test ISR. The staff concludes that Reno Creek is a good analog to the Hank Unit as it is an ISR located in the same Wasatch aquifer and has similar hydrogeological characteristics. In addition, the staff concludes that a portion of the project, known as Pattern 2, was located in an unconfined (unsaturated) aquifer. The document stated that the restoration of Pattern 2 demonstrated that all ground water constituents, except uranium, were restored to levels below or within background ranges at the end of ground water restoration.

The staff has concerns about the use of the restoration of the Reno Creek operation as an analog for restoration of the Hank Unit. The main concern is that Reno Creek was an ISR pilot test demonstration project which was subjected to only 10 weeks of injection and only 1 month of ground water sweep for restoration. Therefore, it is not completely representative of the restoration methods proposed for the Hank Unit which include ground water sweep, transfer, and ground water treatment. Therefore, the NRC requested that the applicant provide additional information or discussion to demonstrate that the proposed restoration methods will succeed under conditions that are specific to unconfined (unsaturated) aquifers. These include (1) an examination of dewatering/mounding characteristics of the aquifer through field testing and/or ground water modeling to ensure that operations can be maintained, (2) the provision of a strategy that will ensure that restoration fluids will contact all parts of the ore zone in the unconfined (unsaturated) aquifer especially where it is dewatered, and (3) evaluation of conductivity impairment in the ore zone due to “gas lock” from the evolution of dissolved oxygen in the lixiviant under low hydrostatic head conditions which would cause restoration fluids to bypass the low conductivity zones.

For the first point, the NRC staff has determined that more information is needed on the unconfined flow aquifer behavior of the Hank Unit for reasons discussed in detail in SER Section 3.1.3.4. Therefore, by license condition, the NRC will require the applicant to perform a hydrologic field test to determine the unconfined aquifer behavior of the Hank Unit “F sand” aquifer during proposed operations. The NRC staff will review the results of this testing and decide whether operations can be safely conducted in the unconfined aquifer for the reasons stated in SER Section 3.1.3.4. For the second point, the applicant stated in the application that it will use pulsing of the extraction and injection wells to ensure contact of the restoration fluids with all parts of the “F sand” production zone at the Hank Unit (Uranerz, 2010a). It is the technical opinion of the staff that this approach will resaturate the dewatered portions of the aquifer, which will allow all regions of the aquifer to be contacted with restoration fluids as desired. For the third point, the applicant stated in the application that if “gas locking” occurs and reduces the conductivity of the “F sand,” it will use this same pulsing which has been shown to be effective in unconfined aquifers in Texas to restore conductivity to ensure contact of the restoration fluids with all parts of the aquifer (Uranerz, 2010a). Based on this information, the staff finds the pulsing approach acceptable to ensure contact of restoration fluids with the aquifer.

6.1.3.4 Pore Volume Estimates

The applicant estimated the pore volume for restoration as the product of affected ore zone area, average well completed thickness, flare factor, and porosity. The value reported in the surety estimate for Nichols Ranch Unit is 138,926,434 L (36,704,474 gal) per pore volume for the first year of operations based on 144,149 m^2 (35.62 ac) of well field in production. The staff estimated the total volume of extraction solution for the Nichols Ranch Unit as 258,227,571 L (68,223,929 gal) per pore volume and for the Hank Unit as 177,689,898 L (46,945,812 gal) per pore volume based on the 26.75 ha (66.21 ac) of total well field area for the Nichols Ranch Unit and 18.41 ha (45.56 ac) of total well field area for the Hank Unit proposed by the applicant. The porosity value used for estimating pore volume for both license areas was 0.3. The staff concludes that this value of porosity is appropriate, as it is consistent with the hydrological description evaluated in SER Section 2.5. The flare factors used for these pore volume calculations by the applicant were 1.45 for the Nichols Ranch Unit and 1.89 for the Hank Unit. SER Sections 3.1.3.3 and 3.1.3.4 discuss in detail the calculation of these flare factors. The NRC staff determined them to be acceptable.

The applicant estimated in application Section 6.2.8 that seven pore volumes will be needed to restore the partially operating PA #1 in the first year. Several examples were cited of nearby ISR facilities (Cogema, Bison Basin, and Reno Creek), which the NRC finds to be satisfactory analogs for restoration for the Nichols Ranch Unit and Hank Unit. At these sites, the restoration pore volumes ranged from 6 to 18.4, which the applicant stated supported the estimate of seven pore volumes. Based on this analysis, the staff finds this initial estimate of pore volumes to be acceptable.

6.1.3.5 Restoration Monitoring

The staff reviewed the design of the monitoring well network proposed for ground water restoration. The applicant stated in the application that the same production area monitoring wells and perimeter monitoring wells used during production will be used during ground water restoration. Proposed monitoring well density in the production area will be one well per 1.62 ha (4 ac) in the well field, which is the minimum density discussed in the SRP. In SER Section 5.7.8 the NRC staff discusses the design and location of these wells in detail and finds the information on these wells to be acceptable.

The applicant stated in application Section 6.1.2 that background water quality parameters from the MP-Wells will be used, on a well field basis, to monitor and evaluate restoration activities in returning the affected ground water to preoperational background quality, as reasonably as possible. MP-Wells will be sampled monthly during restoration to assess progress. The applicant stated that the sampling frequencies at the monitoring ring wells (MR-Wells), overlying aquifer wells (MO-Wells), and underlying aquifer wells (MU-Wells) will be changed from once every 2 weeks to once every 60 days during restoration. The NRC staff finds the reduced sampling frequency to be acceptable because during restoration, lixiviant injection is terminated, so the probability of an excursion is greatly reduced.

6.1.3.6 Restoration Wastewater Disposal

As the primary method to dispose of liquid byproduct material generated by restoration activities, the applicant plans to install up to eight deep disposal wells at the Nichols Ranch ISR Project. The staff reviewed an estimate of the concentrations of waste constituents in the waste injection stream in SER Section 4.2.3.1.1. SER Sections 3.1.3 and 4.2.3.1.1 further discuss in detail the number, location, and capacity of the proposed wells. The staff notes that use of deep disposal wells is contingent on the applicant obtaining UIC permits from WDEQ. If the permits are not approved, the applicant would have to submit a license amendment for another method of disposing of liquid byproduct material. Before operation, the amendment request would be subject to a safety and environmental review before the NRC could approve the alternate method.

6.1.3.7 Restoration Stability Monitoring

As discussed in SRP Section 6.1, the NRC staff notes that the purpose of a stability monitoring program is to ensure that chemical species of concern do not increase in concentration subsequent to restoration. The staff notes that stability monitoring must continue until four consecutive quarters of data indicate that constituent concentrations do not demonstrate any statistically significant increase. To demonstrate stability, the applicant in the application stated that it would conduct four sampling events of all constituents on a quarter-year basis during restoration stability monitoring. The sampling would include the production wells and the monitoring ring wells. The applicant indicated that the stability monitoring would continue until the data show no statistically significant increase. The NRC staff finds this stability sampling program consistent with the guidance criteria in SRP Sections 6.1.3(3) and (5) and thus acceptable.

6.1.3.8 Well Plugging and Abandonment

After ground water restoration is completed, the applicant will remove pumps and piping from the well fields, as described in application Section 6.1.5. All production, injection, and monitor wells and drill holes will be abandoned using W.S. 35-11-404 and Chapter 8 of the WDEQ LQD Rules and Regulations (2005). The NRC concludes that adherence to established WDEQ procedures will prevent adverse impacts to ground water quality or quantity and ensure the safety of people, livestock, wildlife, and machinery in the area. The staff concludes that the proposed methods for well abandonment are consistent with the guidance criteria in SRP Section 6.1.3(7) and are acceptable.

6.1.3.9 Restoration Schedule

Application Table 7-5A provides a preliminary well field restoration schedule. The applicant reported that it will take approximately 3 years to restore Nichols Ranch PA #1 and 1 year to restore Nichols Ranch PA #2. These initial estimates and schedule for the Nichols Ranch Unit are consistent with restoration performance at other NRC-licensed ISR facilities and are acceptable to the staff.

The applicant stated that it will take 5 years to restore the Hank Unit PA #1 and 1 year to restore Hank Unit PA #2. As discussed in detail in SER Section 3.1.3.4, the staff has significant concerns about the ability of the applicant to operate and restore the well fields at the Hank Unit. The NRC will therefore require by license condition a hydrologic test, also discussed in SER Section 3.1.3.4, to demonstrate that the applicant can safely operate and restore the Hank Unit. The NRC staff will review the results of this hydrologic test and approve operations only if the applicant can demonstrate the safe operation of the facility. The applicant will also use the results of the hydrologic test to refine the proposed restoration schedule for the Hank Unit. This license condition will require that the restoration schedules be provided to the NRC for review and approval of any alternate schedule when the hydrologic testing for the Hank Unit is completed and operations are approved by the NRC.

6.1.4 Evaluation Findings

The staff reviewed the plans and schedules for ground water quality restoration of the proposed Nichols Ranch ISR Project in accordance with SRP Section 6.1.3. The NRC staff concludes, based on regulatory guidance and standard ISR industry practice, that the applicant provided a reasonable restoration approach that includes a mix of ground water transfer and treatment to restore ground water quality. The applicant has committed in the application to adopting primary well field ground water restoration standards that match the regulatory requirements of 10 CFR Part 40, Appendix A, Criterion 5B(5). The staff will include a standard license condition, listed in SER Appendix A, stating this regulatory requirement to ensure that the facility meets the proper ground water restoration standards.

The NRC staff concludes, based on regulatory guidance and applicable regulations, that the applicant's method for estimating well field pore volume is acceptable, taking into account the estimated effective porosity of the contaminated region and the lateral and vertical extent of contamination through appropriate flare factors. With respect to the methodology for restoration, the applicant provided an acceptable approach that includes a mix of ground water sweep, transfer, and treatment. In addition, the applicant has presented an acceptable list of indicator constituents to be monitored and has specified acceptable criteria to determine the success of restoration on a well-field-average basis. The staff finds that the applicant's postrestoration stability monitoring program is acceptable.

The NRC staff concludes based on regulation, regulatory guidance, and standard industry practice that the applicant has committed to an acceptable schedule for complete restoration of both PA's after ore extraction ceases for the Nichols Ranch Unit. As discussed earlier, by license condition, the restoration schedule for the Hank Unit will be revised and presented to the NRC for review and approval. The NRC staff finds that the methods proposed for abandoning wells and sealing them are acceptable.

In summary, based on its review (described above) of the information provided in the application, as supplemented by the noted license conditions, the NRC staff concludes that the plans and schedules for ground water quality restoration meet the applicable acceptance criteria of SRP Section 6.1.3 and the requirements of 10 CFR 40.32(c), 10 CFR 40.42, and Criterion 5B(5) of Appendix A to 10 CFR Part 40.

6.1.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

40 CFR Part 146. *Code of Federal Regulations*, Title 40, Protection of Environment, Part 146, "Underground Injection Control Program: Criteria and Standards."
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NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2010a. “Text Revisions to the Open Issues to the Safety Evaluation Report for the Nichols Ranch ISR Project License Application,” file date September 23, 2010, ADAMS Accession Package No. ML102650554.

Safe Drinking Water Act, 42.U.S.C. §300f, (1976) Pub L. 93-523.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

WDEQ, 2005. Water Quality Rules and Regulations, Chapter 8, “Quality Standards for Wyoming Groundwaters,’’ April 27, 2005.

W.S. 35-11-404. Wyoming Statute, Title 35, Public Health and Safety, Chapter 11, “Environmental Quality,” Article 4, “Land Quality,” as amended.

6.2 Plans for Reclaiming Disturbed Lands

6.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans for reclaiming disturbed lands for the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.42 and Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.2.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.2.3 (NRC, 2003).

6.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant has committed in application Section 6.2.1 to returning all lands disturbed by the Nichols Ranch ISR Project to their preoperational land use for livestock grazing and wildlife habitat. Surface disturbance would consist of construction activities associated with the construction of the CPP, satellite plants, and well fields, including well drilling, pipeline installations, and road construction. The applicant stated in application Section 6.2.1 that it will submit a final DP to the NRC for review and approval at least 12 months before the planned start of the decommissioning of a well field or project area. With respect to cleanup of lands, the DP will describe the areas to be reclaimed, the planned reclamation activities, the methods to be used to ensure protection of workers and the environment against radiation hazards, and the planned final radiation survey including cleanup criteria for uranium in soil. If any soil cleanup is required at the well field or at the site facilities, the cleanup criteria for soils would be consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6).

The applicant stated in application Section 6.2.6 that it would use NUREG-1575, Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)” (NRC, 2000) to ensure acceptable survey methods for the decommissioning. The background soils, vegetation, and other radiological data provided in application Section 2.9 will be used in evaluating the final reclamation condition. The staff notes that NRC radiological soil cleanup criteria in 10 CFR Part 40 specify that the final soil condition cannot exceed background concentrations of radioactivity by a specified amount. The staff agrees that the commitment to developing decommissioning survey plans using NUREG-1575 recommended practices and using the soil cleanup criteria in 10 CFR Part 40, Appendix A, Criterion 6(6), is acceptable for achieving cleanup and for verifying the cleanup of reclaimed lands.

Topsoil would be stripped before construction of the facilities, in accordance with WDEQ-LQD requirements. An estimated 40.4 ha (100 ac) of topsoil would be salvaged, stockpiled, and reapplied during the life of the Nichols Ranch ISR Project. The applicant stated in application Section 6.23 that all revegetation practices would be conducted in accordance with the WDEQ-LQD regulations and the methods outlined in the WDEQ mining permit.

The applicant stated in application Section 6.2.2 that during operations, it plans to install two access roads to connect both the Nichols Ranch Unit CPP and the Hank Unit satellite plant with existing ranch roads. In addition, well field access roads would be built to allow vehicular traffic to move from the plants to the well fields and from one well field to another. If the landowner desires, the roads would be left in place when operations are complete. If not, the roads would be reclaimed.

However, the staff notes that the roads must be surveyed to detect any spilled radioactive material, reclaimed to regulatory standards, and reviewed accordingly by staff in the final site DP. The applicant addresses road surveys in application Section 6.2.6 in a commitment that states that postoperations or preremediation radiation surveys will identify the areas of the site that need to be remediated to meet applicable radiological criteria. The staff notes that the applicant has committed to applicable radiological surveys and cleanup criteria in application Section 6.2.6. The staff also notes that these surveys of preremediation conditions will be provided to the NRC with the final DP for review and approval as required by 10 CFR 40.42. The staff has specified a license condition in SER Section 6.2.4 that will require the applicant to provide a preremediation survey design prior to operations to address the evaluation of radiological events that could occur during operations.

The applicant stated in application Section 6.2.7 that because of the nature of ISR production, very little construction would occur that would require any major contouring during reclamation. Any surface disturbances that do occur would be contoured to blend in with the natural terrain. No final contour map has been included in the application, since the applicant stated that no significant changes in the topography would result from the ISR operation. The staff notes that the absence of significant changes to site topography is typical of standard ISR industry practice and has observed no significant topographical changes during visits to NRC-licensed sites. As no significant changes to site topography have been identified, the staff agrees with the applicant's proposal for postoperation land surface contouring.

In application Section 6.2.6, the applicant committed to establishing appropriate radiological cleanup criteria for soils and to appropriately documenting final radiological soil conditions. In application Section 6.2.6.2, the applicant committed to a health physics and radiation safety program to ensure worker protection. The applicant has committed in application Section 6.2.1 to providing a final DP for NRC review and approval at least 12 months before the planned decommissioning of a well field or project area. The staff notes that the applicant is required by 10 CFR 40.42 to identify the radiation safety program for worker and environmental protection in the DP. The staff has determined that the applicant has committed to providing a final DP at least 12 months before decommissioning actions in accordance with 10 CFR 40.42 requirements, and this commitment is acceptable. As the final site decommissioning is a critical part of the license termination process, the staff will include the commitment to provide a final DP as a license condition. Section 6.2.4 of this SER presents this condition.

The applicant stated in application Section 6.2.6.2 that nonradioactive hazardous wastes will be segregated and disposed of at a hazardous waste facility, and nonradiological, nonhazardous wastes will be disposed of as ordinary solid waste at a municipal solid waste facility. In addition, the applicant stated that closure of the site will be completed in accordance with 10 CFR Part 40, Appendix A, Criterion 6(7). The staff agrees that the applicant commitments are in accordance with applicable NRC requirements in 10 CFR Part 40, Appendix A, Criterion 6(7) for nonradiological hazardous and nonhazardous wastes.

The staff finds that the applicant has provided a commitment in application Section 6.2.6 for prereclamation radiation survey designs that use instrumentation and techniques similar to the preoperational survey used to establish background site conditions. The applicant stated that it will identify areas that need to be cleaned up in preremediation radiological surveys. The applicant has committed in application Section 6.2.6.1 to appropriate procedures for the prereclamation survey and the means used to identify areas for cleanup using the acquired data. Methods proposed for reclamation and an acceptable plan for surface restoration, including identification of any irreversible changes, have been provided. The staff has determined that the applicant has made appropriate commitments to the conduct of decommissioning activities in accordance with a final DP according to 10 CFR 40.42 and finds this acceptable.

6.2.4 Evaluation Findings

The staff reviewed the plans for reclaiming disturbed lands of the proposed Nichols Ranch ISR Project in accordance with SRP Section 6.2.3. The applicant has described in application Section 6.2 various aspects of reclamation activities at the site on a general, sitewide basis. The staff considers this current level of detail, the financial assurance information provided, and the commitment to providing a final DP at least 12 months before decommissioning to be appropriate at this stage of facility operations. The applicant has committed to meeting the soil cleanup criteria in 10 CFR Part 40, Appendix A, Criterion 6(6), and has committed to meeting NRC surface contamination guidance (NRC, 1993c) for the release of other material and process equipment. The applicant stated in application Section 6.2.6.2 that any materials or equipment that cannot be decontaminated to the applicable radiological contamination levels will be disposed of as radiological waste at an NRC-approved facility. The staff finds that these plans and commitments are consistent with 10 CFR 40.42 requirements.

The applicant has committed in application Sections 6.2.1 and 6.2.6.2 to provide a final DP at least 12 months before the planned start of decommissioning activities. The staff has determined that the applicant has provided applicable commitments in accordance with 10 CFR 40.42 for the development of final DPs and finds that this is acceptable. This commitment will be reinforced by the following license condition:

> At least 12 months prior to initiation of any planned final site decommissioning, the licensee shall submit a detailed decommissioning plan for NRC review and approval. The plan shall represent as-built conditions at the Nichols Ranch ISR Project.

The staff has determined that the applicant has not provided an adequate postreclamation survey and decommissioning verification surveys to demonstrate that the 10 CFR Part 40, Appendix A, Criterion 6(6), soil radiological criteria can be met. Therefore, the staff is imposing the following license condition to ensure that this decommissioning requirement is addressed:

> Prior to the preoperational inspection, the applicant will provide a survey plan for post-reclamation and decommissioning verification surveys that demonstrates that residual radioactivity in soil meets the criteria in 10 CFR Part 40, Appendix A, Criterion 6(6). The applicable cleanup criteria will be identified for radium-226, and soil cleanup criteria will be developed for natural uranium using the radium benchmark dose approach. Applicable criteria for thorium-230 will also be addressed in the plan.

Based on its review (described above), as supplemented by the information to be submitted in accordance with the noted license conditions, the NRC staff concludes that the plans for reclaiming disturbed lands meet the applicable acceptance criteria of SRP Section 6.2.3 and the requirements of 10 CFR 40.42 and Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.2.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 2000. NUREG-1575, Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” Washington, DC, August 2000.

NRC, 1993c. “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,” Washington, DC, April 1993, ADAMS Accession No. ML003745526.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

6.3 Removal and Disposal of Structures, Waste Material, and Equipment

6.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans for removal and disposal of structures, waste material, and equipment for the Nichols Ranch ISR Project meet the requirements of 10 CFR 40.42.

6.3.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.3.3 (NRC, 2003).

6.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated.

The applicant stated in application Section 6.2.6.2 that any buildings or structures would be decontaminated to NRC surface contamination guidance (NRC, 1993c) or be disposed of as radiological waste at an NRC-approved facility. Other nonradiological materials will be either demolished and trucked to a disposal facility or turned over to the landowner if desired. Following the successful conclusion of the aquifer restoration stability period in a particular production area, the well field piping, wellheads, and associated equipment will be removed and, if serviceable, taken to a new production area for continued service. Well field equipment that is no longer usable will be gamma surveyed and stored near the CPP for subsequent removal from the site.

During final production area reclamation, the applicant identified that nonsalvageable contaminated piping, wellheads, and associated equipment will be trucked from the site to an appropriate byproduct material disposal facility. After ground water restoration is complete in the final production area, decommissioning of the Nichols Ranch Unit CPP site and the Hank Unit satellite plant will commence. The Nichols Ranch CPP may continue to be used after completion of mining to process materials from other satellites.

The applicant will perform a preremediation radiological survey to identify structures and equipment that will require decontamination. The applicant stated in application Section 6.2.6.2 that all process equipment associated with the plants would be dismantled and either sold to another facility licensed by the NRC or an Agreement State or decontaminated in accordance with NRC surface contamination guidance (NRC, 1993c). Any material that cannot be decontaminated to an acceptable level would be disposed of as radiological waste at an NRC-approved facility. After decontamination, materials that would not be reused or that do not have any resale value, such as building foundations, would be removed and disposed of at an offsite facility. As discussed in application Sections 6.2.1 and 6.2.6, the applicant will submit a final DP to the NRC for review and approval at least 12 months before the planned start of final decommissioning. With respect to structures and equipment, the DP will include descriptions of the equipment and structures to be reclaimed, the planned decommissioning activities, the methods to be used to ensure protection of workers and the environment against radiation hazards, and the planned final radiation survey.

The staff finds that the applicant in Section 6.2.6.2 has committed to an acceptable program for the measurement and control of residual contamination on structures and equipment. Furthermore, the applicant stated in application Section 6.2.6.2 that all process equipment associated with the plants will be dismantled and either sold to another facility licensed by the NRC or an Agreement State or decontaminated to satisfy the surface contamination levels outlined in NRC surface contamination guidance (NRC, 1993c). All premises, equipment, or scrap likely to be contaminated, but that cannot be measured, will be assumed to be contaminated in excess of limits and will be treated as radiological waste. The applicant plans to conduct a comprehensive radiation survey to establish that any contamination is within limits specified before the release of the premises, equipment, or scrap. Any material that cannot be reused or recycled will be disposed of at a licensed byproduct material facility. The staff finds acceptable the applicant's commitment to providing a final DP in accordance with 10 CFR 40.42 and to verifying cleanup following the guidelines for recommended practices in NUREG-1575, “Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)” (NRC, 2000).

6.3.4 Evaluation Findings

The staff reviewed the plans for removal and disposal of structures, waste material, and equipment for the proposed Nichols Ranch ISR Project in accordance with SRP Section 6.3.3. The applicant described the activities associated with decommissioning buildings and equipment as well as disposal of materials. The NRC staff concludes that the plans for removal and disposal of structures, waste material, and equipment meet the applicable acceptance criteria of SRP Section 6.3.3 and 10 CFR 40.42 requirements. This conclusion is based on the review conducted by the staff as indicated above, the information provided in the application, and the license condition addressing the solid byproduct material disposal agreement as discussed in Section 4.2.4 of this SER.

6.3.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 2000. NUREG-1575, Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” August 2000.

NRC, 1993c. “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,” Washington, DC, April 1993, ADAMS Accession No. ML003745526.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

6.4 Methodologies for Conducting Post-Reclamation and Decommissioning Surveys

6.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed methodologies for conducting postreclamation and decommissioning radiological surveys for the Nichols Ranch ISR Project meet the requirements of Criterion 6(6) of Appendix A to 10 CFR Part 40, and if materials and equipment meet the NRC surface contamination guidance (NRC, 1993c) prior to unrestricted release.

6.4.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.4.3 (NRC, 2003).

6.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in its application (Uranerz, 2007) and as updated. The following sections discuss the procedures used by the applicant for establishing dose criteria for soil contaminated with Ra-226.

6.4.3.1 Radiological Cleanup Criteria

6.4.3.1.1 Radium-226 Benchmark Dose, Natural Uranium and Thorium-230 Soil Criteria

The applicant stated in application Section 6.2.6 that it will use the Ra-226 benchmark dose approach to calculate the natural uranium soil cleanup criteria in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6). The applicant also stated that the soil cleanup criteria for Th-230 will be that concentration in soil which, when combined with the residual concentration of Ra-226, will satisfy the Ra-226 soil cleanup standard in 10 CFR Part 40, Appendix A, Criterion 6(6). The staff has determined that the applicant's commitment to developing radiological soil criteria for natural uranium and Th-230 is consistent with 10 CFR Part 40, Appendix A, Criterion 6(6) and that these commitments are acceptable.

6.4.3.1.2 Uranium Chemical Toxicity Assessment

As discussed in SER Section 6.4.3.1.1, the applicant committed in application Section 6.2.6 to provide soil clean-up criteria based on the 10 CFR 40, Appendix A, Criterion 6(6). The SRP, Appendix E, provides guidance to the NRC staff on requirements found in 10 CFR Part 40, Appendix A, Criterion 6(6), commonly referred to as the radium benchmark dose approach. The 10 CFR Part 40, Appendix A, Criterion 6(6) requires that ALARA be considered in the development of the uranium soil clean-up criteria. The SRP, Appendix E, Acceptance Criteria E 2.2.3(1), recommends that the chemical toxicity be considered for the uranium soil clean-up criteria if soluble forms of uranium are present. The license condition discussed in SER Section 6.2.4 requires the applicant to develop soil cleanup criteria for natural uranium using the radium benchmark approach. Staff finds the license condition imposed in SER section 6.2.4 and the applicant's commitment to provide soil clean-up criteria as required in 10 CFR 40, Appendix A, Criterion 6(6) acceptable for the determination of uranium chemical toxicity at the Nichols Ranch ISR Project.

6.4.3.2 Survey Design for Verification of Soil Cleanup

The applicant has included a commitment in application Section 6.2.6 for survey methodology and to demonstrate 95-percent confidence that the soil survey unit meets the soil cleanup criteria in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6). The applicant stated in application Section 6.2.6.1 that a survey design will also be developed from NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (NRC, 2000) for verification of soil cleanup and will include statistical tests to provide 95-percent confidence that the survey units meet the cleanup criteria. The staff notes that NUREG-1575 provides information on planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. The applicant has committed to meeting the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6), concerning radiological soil criteria, but has not provided sufficient detail on radiological surveys to demonstrate how it will meet these criteria.

Therefore, the staff will impose a license condition, described in Section 6.2.4 of this SER, to address this issue.

6.4.4 Evaluation Findings

The staff reviewed the methodologies for conducting postreclamation and decommissioning radiological surveys for the proposed Nichols Ranch ISR Project in accordance with SRP Section 6.4.3. The applicant has made appropriate commitments to following the applicable regulations and NRC guidance. However, the applicant has not provided sufficient detail related to survey methodologies. Therefore, the staff will require a license condition that requires the applicant to develop a cleanup plan demonstrating that the applicable soil cleanup criteria can be met. This license condition appears in SER Section 6.2.4.

Based on its review (described above) of the information provided in the application, as supplemented by the license condition presented in SER Section 6.2.4, the NRC staff concludes that the proposed methodologies for conducting postreclamation and decommissioning radiological surveys meet the applicable acceptance criteria of SRP Section 6.4.3. Staff further concludes that the applicant will use NUREG-1575 recommended practices for development of survey plans and develop the radiological soil criteria using Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.4.5 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, ”Domestic Licensing of Source Material.”

NRC, 2003. NUREG-1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report,” Washington, DC, June 2003.

NRC, 2000. NUREG-1575, Revision 1, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” Washington, DC, August 2000.

NRC, 1993c. “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,” Washington, DC, April 1993, ADAMS Accession No. ML003745526.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

6.5 Financial Assurance

6.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed financial assurance for the Nichols Ranch ISR Project meets the requirements of Criterion 9 of Appendix A to 10 CFR Part 40.

6.5.2 Regulatory Acceptance Criteria

The application was reviewed for consistency with applicable requirements of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 6.5.3 (NRC, 2003).

6.5.3 Staff Review and Analysis

Unless otherwise stated, the staff's review and analysis are based on Section 6.2.8 of the application's technical report (Uranerz, 2007). Section 6.2.8 contains the applicant's plans related to financial assurance of the proposed facility.

The applicant stated that it would maintain surety instruments to cover the costs of reclamation for the Nichols Ranch ISR Project. Surety instruments would cover the costs of ground water restoration, decommissioning, dismantling, and disposal of all facilities including buildings and the well field, and the reclamation and revegetation of all affected mining areas. The applicant has provided a surety estimate of $5,938,866 (application Addendum 6B, February 2009), which was based on 2009 dollars (Uranerz, 2009b). This surety estimate includes a breakdown of costs; the basis for cost estimates; and a 25-percent factor for administration, overhead, and contingency. The proposed surety includes costs for ground water restoration, equipment removal and disposal, building demolition and disposal, soil removal and disposal, well abandonment, well field equipment removal and disposal, topsoil replacement and revegetation, and other miscellaneous reclamation costs. Ground water restoration costs are based on treatment of 1 pore volume for ground water sweep and 6 pore volumes for RO. Activities that have been included in the cost estimate are consistent with what is planned for and what is known about the site. Costs were determined by obtaining quotes from vendors, operating experience of other ISRs, and WDEQ Guideline No. 12 (WDEQ-LQD, 2009), as shown in application Addendum 6B. This approach is acceptable to the staff as the applicant has provided a basis for these costs.

Once the staff and the applicant have agreed to the estimated reclamation and restoration costs, a reclamation performance bond, irrevocable letter of credit, or other acceptable surety instrument would be submitted to the WDEQ-LQD with a copy to the NRC. Criterion 9 in Appendix A to 10 CFR Part 40 allows the surety instrument to be held by other Federal or State agencies such as the WDEQ. The applicant has submitted its calculations and estimate of the proposed surety bond for the first year of operation for the Nichols Ranch ISR Project. The first year surety estimate includes construction of the Nichols Ranch Unit CPP, startup of the first production area at the Nichols Ranch Unit, and construction of the Hank Unit satellite plant and the first Hank Unit production area. Although the first Hank Unit production area would be put in place, it would not be operational in the first year, and thus the initial surety bond would not include a cost estimate for restoring the ground water at the Hank Unit. This approach is consistent with the requirements of Appendix A to 10 CFR Part 40, which requires that the amount of the surety be adjusted to reflect the actual activities performed. Therefore, this is acceptable to the staff. Submittal of the first year estimate and subsequent annual updates will be required by a standard license condition (shown in SER Appendix A) to ensure compliance with Criterion 9 in Appendix A to 10 CFR Part 40.

The applicant has committed to using one of the acceptable funding mechanisms identified in 10 CFR Part 40, Appendix A, and has committed to an annual adjustment of the surety value as stated in application Section 6.2.8. The applicant will automatically extend the surety if the NRC has not approved the proposed revision 30 days prior to the expiration date and will revise the surety arrangement within 3 months of NRC approval of a revised DP, if estimated costs exceed the amount of the existing financial surety. The staff agrees with this approach as the commitment to updating and the revision timeframes are consistent with the applicable criteria in 10 CFR Part 40, Appendix A.

The applicant has committed to submitting for NRC approval an updated surety to cover any planned expansion or operational change not included in the annual surety update at 90 days prior to beginning associated construction. The staff will also receive copies of surety-related information, the final surety arrangement submitted to WDEQ, and the State's surety review. Cost estimates provided by the applicant generally follow the outline in SRP Appendix C. This approach is consistent with the applicable regulations in 10 CFR Part 40, Appendix A, which require the financial assurance estimate to reflect changes in activities performed, be updated annually, be submitted a reasonable time before the anniversary date, and automatically renew. Therefore, the applicant's approach is acceptable to the staff. These commitments will be included as standard conditions in the license issued to the applicant.

6.5.4 Evaluation Findings

The staff reviewed the financial assurance aspects of the proposed Nichols Ranch ISR Project in accordance with SRP Section 6.5.3. The applicant has established a financial assurance cost estimate based on the requirements in 10 CFR Part 40, Appendix A, Criterion 9. The applicant has committed to having sufficient funds available for completion of the reclamation plan by an independent contractor. Furthermore, the applicant included in the initial financial analysis all the activities in the reclamation plan or activities noted in SRP Sections 6.1 through 6.4. Assumptions for financial surety analysis were based on site conditions, including experiences with generally accepted industry practices, research and development at the site, and previous operating experience. Compliance with the applicable regulations will be required through a standard license condition regarding financial assurance. Additionally, a financial assurance estimate for the first year of operations will be submitted for approval to the WDEQ and the NRC before the initiation of operations. The staff has included the standard license condition in SER Appendix A to address NRC review and approval of surety-related activities.

Based on its review (described above) of the information provided in the application, as supplemented by information to be submitted in accordance with the standard license conditions, the NRC staff concludes that the amount of the proposed financial surety and its methods of estimation meet the applicable acceptance criteria of SRP Section 6.5.3 and are consistent with Criterion 9 of Appendix A to 10 CFR Part 40.

6.5.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, "Domestic Licensing of Source Material."

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," Washington, DC, June 2003.

Uranerz, 2009b. "Nichols Ranch ISR Project, USNRC Source Material License Application, Volume 1 Technical Report," Docket No.: 040-09067-TAC J00553, Casper, WY: Uranerz Energy Corporation. Revisions to Chapter 6, February 28 2009, ADAMS Accession No. ML090850367.

Uranerz, 2007. “Submittal of Source Material License Application to Construct and Operate the Nichols Ranch ISR Project Located in Campbell and Johnson Counties, Wyoming,” November 30, 2007, ADAMS Accession Package No. ML080080594.

WDEQ-LQD, 2009. Guideline No. 12, “Standardized Reclamation Performance Bond Format and Cost Calculation Methods.”

7.0 ACCIDENTS

7.1 Regulatory Requirements

The staff determines if the applicant has addressed potential accidents at the Nichols Ranch ISR Project and demonstrated that the facility will meet the requirements of 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

7.2 Regulatory Acceptance Criteria

The application was reviewed for consistency with applicable regulations of 10 CFR Part 40 using the acceptance criteria outlined in SRP Section 7.5.3 (NRC, 2003).

7.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Uranerz in application Section 7.5 (Uranerz, 2007) and as updated.

This section addresses potential accidents that could occur at the Nichols Ranch ISR Project, the designs and measures proposed by the applicant to prevent accidents, and the plans and training proposed to cope with accidents. The applicant cites accident consequence analyses completed by the NRC of accidents at ISR uranium extraction facilities found in NUREG/CR-6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees” (NRC, 2001), which considered the likelihood of occurrence and the consequence of accidents. The applicant also referenced analyses completed by the NRC of transportation accidents in NUREG-0706, “Final Generic Environmental Impact Statement on Uranium Mining” (NRC, 1980a). Consequently, no independent consequence analyses of potential accidents were performed. As NUREG/CR-6733 considers the likelihood and consequences of accidents at ISR facilities and the applicant has proposed ISR activities that are similar and typical to those described in this NUREG, this approach is acceptable to the staff. The applicant has provided information for some specific and unique hazards, such as CBM activities. The staff understands that there likely will be active CBM operations at the site and CBM recovery pipelines likely will pass through the Nichols Ranch and Hank Units. The presence of CBM activities at the site was not considered in NUREG/CR-6733.

The applicant has indicated that the facility design, site features, and operating assumptions of the Nichols Ranch ISR Project are consistent with those of the above-referenced NUREG analyses. NUREG/CR-6733 analyses have indicated that radiological consequences from accidents can be mitigated through the use of effective emergency procedures and proper training of personnel implementing the procedures. The staff reviewed the design and operating characteristics of the facility and agrees that the Nichols Ranch ISR Project design, proposed operating assumptions, and general site features are similar to and consistent with those of other operating ISR uranium recovery facilities analyzed in NUREG/CR-6733. Although the applicant referenced the NUREG documents with respect to accident consequence analysis, the applicant considered different types of accidents that are unique to an ISR project, which are discussed in detail in application Chapter 7.0. The types of accidents considered by the applicant are discussed in the following sections of this SER.

The applicant stated that emergency response procedures will be provided for potential accidents and personnel will be trained to implement procedures to mitigate consequences. Emergency procedures and personnel training on emergency response procedures were not provided in the application, and the staff notes that they are not required as part of the application. The standard license condition related to development of SOPs will require development of emergency procedures by the applicant prior to operations. Emergency procedures will be reviewed as part of the NRC preoperational inspection.

7.3.1 Chemical Accidents

The applicant considered the potential for chemical accidents, and application Table 7-11 lists the following chemicals that will be used on the site:

- dry bulk chemicals
  - sodium bicarbonate
  - sodium carbonate
  - sodium hydroxide

- liquids or gases
  - hydrochloric acid
  - hydrogen peroxide
  - oxygen
  - carbon dioxide
  - diesel
  - gasoline
  - bottled gases
  - ammonia

The applicant stated that these process chemicals are common to many industries and present no abnormal risk. Most of these chemicals are listed in NUREG/CR-6733, and the staff is familiar with the use of these and similar chemicals at existing ISR facilities. The staff reviewed the list above and notes that the specific chemicals identified in the list have material safety data sheets, which outline well-established handling procedures. Therefore, the staff agrees with the applicant's statement that process chemicals present no abnormal risk. Application Section 3.3 and SER Section 3.2 provide additional information on chemical storage.

The applicant also stated that it may use anhydrous ammonia in the precipitation circuit and that adverse impacts could result if a truck carrying this chemical were in an accident. SER Section 7.3.5 also addresses a transportation accident involving anhydrous ammonia.

7.3.2 Radiological Release Accidents

The applicant identified tank and plant pipe failures at the CPP as potential accidents that could pose radiological risks. As discussed in Section 4.2.3.1.1 of this SER, the applicant has committed to including concrete curbs to contain spills from tanks and leaks from pipes in the CPP. Any fluids released would be collected in the floor sump system and then pumped to other plant process vessels or to the deep disposal well. The staff reviewed the sizing of the concrete berm and containment basins and agrees that they have been appropriately sized to contain spills or leaks. Additionally, the applicant committed in application Section 3.3 to including a containment basin around hydrochloric acid, gasoline, and diesel process vessels to holds spills outside the process buildings. Process chemicals would be pumped to other tanks or into a tanker truck for disposal in accordance with regulatory requirements.

The applicant stated in application Section 7.5.2 that plant concrete floors will be designed by registered civil engineers to support the full weight of the process tanks and contents with an added safety factor to ensure that the tanks will not collapse or rupture because of failure of the floors. Information regarding potential accidents involving a yellowcake and/or vacuum dryer was also provided. The applicant cites the analysis of NUREG-0706 for dry yellowcake released from a tornado event. As the proposed Nichols Ranch ISR project has characteristics similar to those of the scenarios considered in NUREG-0706, the staff agrees with the applicant's analysis and citation of this document.

Additionally, emergency response procedures will be developed to address tank and plant pipeline failures. These procedures will include instructions regarding immediate notifications, evacuation procedures, perimeter establishment, personal protective equipment requirements, site mitigation, neutralization, cleanup, and reporting. As stated previously, these procedures will be subject to NRC inspection prior to operation.

7.3.3 Ground Water Contamination

The applicant stated that excursions of lixiviant have the potential to contaminate adjacent aquifers with liquid byproduct material. The staff addressed monitoring and control of excursions in SER Section 5.7.8.3.5. As discussed in that section, the staff finds the applicant's proposed excursion monitoring program acceptable.

7.3.4 Process Pipeline Failures

The applicant provided information on the failure of process pipelines resulting in the release of pregnant or barren lixiviant for pipelines located in the well field. Measures such as high- and low-pressure alarms/shutdowns and flow meters will be used on the piping leading to and from the well field, CPP, and satellite plant to minimize the amount of process fluid lost if a failure were to occur. The applicant stated that a worst case scenario pipeline break would result in a loss of 794,850 L (210,000 gal) of lixiviant over 1 hour. The staff agrees with this estimate as it reflects a pipe at the facility flowing freely at the maximum licensed flow rate of 13,248 Lpm (3,500 gpm). This would be a complete pipeline break without timely detection by an operator. The applicant committed to inspecting and testing pipelines prior to burial to ensure that the pipelines are sound. Pressure test results will be documented. If the amount or concentration of the process fluid lost in a pipeline failure constitutes an environmental concern, the affected area would have the contaminated soil surveyed and removed for disposal according to a standard NRC license condition listed in SER Appendix A. The applicant stated in application Section 7.5.3.1 that a spill record will be made documenting the volume of the spill, the area affected, and the corrective action taken (sampling and results of analysis). Areas exceeding twice background gamma will receive additional soil sampling to determine whether radiological concentrations (Ra-226, Th-230, Pb-210) have increased significantly above background. Soils will also be analyzed for uranium. If soil sampling results show an increase from baseline (2.5–3 pCi/g, for example), the soil will be removed and placed in approved byproduct storage containers prior to shipping to a licensed site. As discussed in SER Section 4.2.3.2, this approach is acceptable to the staff.

7.3.5 Transportation Accidents

The applicant provided information on the types of accidents that might be expected to occur during the shipment of refined yellowcake from the Nichols Ranch CPP to a uranium conversion facility, the shipment of loaded resin from the Hank Unit to the Nichols Ranch CPP, the shipment of process chemicals from suppliers to the Hank and Nichols Ranch Units, and the shipments of byproduct material to an NRC-licensed facility for disposal. The following sections address these accidents in detail.

7.3.5.1 Shipments of Refined Yellowcake

The applicant stated in application Section 7.5.1.1 that refined yellowcake produced at the Nichols Ranch ISR Project would be shipped approximately 1,932 km (1,200 mi) to a conversion facility. Initially, the applicant expects to make 21 shipments per year, and this could increase to 53 shipments per year based on the production of 907,200 kg (2 million lb) of yellowcake per year. The applicant cited NUREG-0706 for transport accident statistics and stated that the overall probability of a truck accident based on the NUREG-0706 data is 2.2×10^{-6} per mile traveled. NUREG-0706 agrees with the statistics cited by the applicant.

If an accident were to occur during the shipping of yellowcake, the applicant stated that environmental impacts would be reduced by following instructions outlined in its Incident Response Guide. The applicant stated in application Section 7.5.1.1 that this guide will be required with every shipment of yellowcake that leaves the Nichols Ranch Unit CPP. Carriers will also be required to maintain accident response capability to specifically include spill response. Additionally, the applicant committed in application Section 7.5.1.1 to exclusive-use shipments for refined yellowcake. This is consistent with the approach used at other operating ISR facilities in Wyoming and is therefore acceptable to the staff.

7.3.5.2 Shipments of Loaded Resins

The applicant stated in application Section 7.5.1.2 that resins loaded with uranium will be transported approximately 9.7 km (6 mi) from the Hank Unit to the Nichols Ranch Unit CPP only in specially designed tanker trailers that will hold approximately 14 m^3 (500 ft^3) of loaded resins. No public roads will be used during resin shipments from the Hank Unit. In an accident resulting in a resin spill, the applicant expects the uranium to remain attached to the resin, so the spill will not result in an airborne release of uranium. The staff notes that resins are designed to retain uranium until the resin comes in contact with a brine solution. Therefore, the staff agrees with the applicant's statement that a spill of resin will not result in an airborne release of uranium. As required by a standard license condition listed in SER Appendix A, loaded resin and contaminated soil would be removed and processed or disposed of as byproduct material in an NRC-licensed facility.

7.3.5.3 Shipments of Process Chemicals

Truck shipments of process chemicals will be made to the Nichols Ranch ISR Project from Casper, WY, located 137 km (85 mi) to the southwest. Application Table 7-11 lists the process chemicals, which are also listed in SER Section 7.3.1 above. The applicant stated that anhydrous ammonia may be used in the precipitation circuit at the Nichols Ranch Unit CPP and that an accidental release of anhydrous ammonia could result in adverse health impacts in a populated area from the resultant ammonia "cloud." Approximately 10 to 12 bulk shipments per year of approximately 28,390 L (7,500 gal) per shipment are expected. The applicant stated that NUREG-0706 provides an accident rate of 4.8×10^{-7} shipments per mile. As the proposed Nichols Ranch ISR project has characteristics similar to those of the scenarios considered in NUREG-0706, the staff agrees with the applicant's analysis and citation of this document.

7.3.5.4 Shipments of Solid Byproduct Material for Disposal

The applicant stated in application Section 7.5.1.4 that all solid byproduct generated at the Nichols Ranch ISR Project will be transported to an offsite NRC-licensed disposal facility. Risk of accidents for shipments of byproduct material will be minimized by use of proper packaging and exclusive-use shipments. Impacts from an accident will be reduced by following the applicant's Incident Response Guide, which will be included with each shipment that leaves the site. Carriers will be required to maintain accident response capability. This is consistent with the approach used at other operating ISR facilities in Wyoming and is therefore acceptable to the staff.

7.3.6 Fire and Explosions

The applicant stated in application Section 7.5.4 that propane will be used as the energy source for heating yellowcake vacuum dryer oil and that propane would be the primary source of a potential fire hazard at the Nichols Ranch Unit CPP. Electric heaters will provide building heat at the Hank and Nichols Ranch Units. The applicant identified that most of the radioactive material in the facility is in wet form and would not be readily dispersed in an explosion, which minimizes the risk of the spread of radioactive material. Additionally, the risk of the spread of dried yellowcake will also be minimized since drums of yellowcake will be contained in the process building or in their containment area. The applicant's approach of keeping radioactive material in wet form and storing dried yellowcake in drums is consistent with the staff's observations of general industry practices and is therefore acceptable.

The applicant stated that potential fires and explosions for the well fields could be from gaseous oxygen in a header house. Oxygen is used in the ISR process, and therefore, where oxygen is injected into the injection wells in header house, it can potentially accumulate there. To minimize the risk of an explosion in a header house caused by an accumulation of gaseous oxygen, each header house is equipped with a continuously operating exhaust fan. In addition to potential personnel injuries, any resultant explosions could rupture pipelines containing lixiviant and release lixiviant to the area surrounding the header house. The applicant committed to equipping gaseous oxygen and primary extraction solution lines entering the header house with automatic low-pressure shutoff valves that will minimize any release of the oxygen or extraction solution if the lines are ruptured. The applicant's proposed use of exhaust fans in header houses and low-pressure shutoff valves in solution lines is consistent with general industry practices. The staff has observed these practices in use and finds them acceptable.

7.3.7 Coal Bed Methane Accidents

As discussed in Section 2.4.3.1.1 of this SER, CBM production will be ongoing in the Hank and Nichols Ranch Units. The applicant stated that CBM pipelines are typically buried 1.8 m (6 ft) under the surface and are clearly identified with signs. The applicant noted that a rupture of one of these pipelines could result in the escape of flammable and explosive methane gas. Planned emergency measure would include evacuation of the area and shutdown of equipment and, if necessary, a total plant shutdown and evacuation of the Nichols Ranch ISR Project. The CBM pipeline would be isolated and repaired before personnel could return.

The applicant has committed to minimizing the possibility of a drilling rig accidentally drilling into the CBM pipeline located in the Nichols Ranch ISR Project by clearly identifying the pipeline locations with signs. In addition to the signage, methods will be developed to minimize accidents when drilling occurs near CBM pipelines. These measures will include verifying the location of the pipeline, flagging off the pipeline corridor, and maintaining a set distance from the CBM pipeline when drilling wells. These activities are consistent with standard drilling practices for avoiding underground utilities and are acceptable to the staff.

7.3.8 Natural Events

The applicant stated in application Section 7.5.5 that the Nichols Ranch ISR Project could be impacted by tornadoes. Johnson Country and Campbell County, WY, have experienced tornado activity in the past. For example, during 1950–2003, 17 tornadoes struck Johnson County, and 69 tornadoes struck Campbell County. The most recent tornado occurred in 2005 when an F2 tornado with winds in the range of 182–253 km per hour (113–157 mph) struck a town 35.4 km (22 mi) from the project, resulting in property damage, numerous injuries, and two deaths.

The applicant cites the NUREG-0706 statement that the probability of occurrence of a tornado in the Nichols Ranch ISR Project area is approximately 3.2×10^{-4} per year. Also, the applicant cited NUREG-0706 as the basis for information on the radiological consequence of the release of 11,385 kg (25,100 lb) or approximately twenty-six 208-L (55-gal) drums of dried yellowcake being picked up and dispersed by a tornado. The staff agrees with the applicant's assessment and notes that a standard license condition, listed in SER Appendix A, will require that the applicant prepare emergency procedures to address natural disasters.

7.3.9 Well Casing Failure

The applicant stated that the failure of an injection well casing may result in lixiviant entry into a USDW aquifer that is not an exempted aquifer. However, the applicant stated that the failure of a recovery well causing an impact to a USDW is not likely since these wells generally operate at lower pressures than the aquifers, and casing failures at recovery wells are likely to result in aquifer water flowing into the failed recovery well casing. The staff agrees with this statement and notes that flow from high pressure to low pressure is a basic principle of fluid mechanics.

The applicant stated that measures to minimize such failures are described in the application. The staff notes that measures are also discussed in SER Sections 3 and 5.7.8. Some of those measures are proper well construction procedures and well testing procedures, including the verification of well casing integrity and proper cementing of the wells. Additionally, monitor wells are completed in the aquifers above and below the ore zone and are routinely sampled for excursions of lixiviant. As discussed in SER Sections 3 and 5.7.8, the staff finds these methods acceptable for detecting well casing failures. If a well casing failure occurs, the applicant will be required to clean up contamination in a USDW to regulatory standards.

7.3.10 Old Exploration Holes

The applicant stated that aquifer communication through old exploration holes is always a possibility in an area that has been used in the past for mineral exploration, but it is unlikely at the Nichols Ranch ISR Project. The applicant stated that performance of pump tests before startup of a production area will provide an opportunity to verify that no communication exists between aquifers and prior exploration holes. The applicant stated that if communication from old exploration holes is observed, the old holes would be replugged. As discussed in SER Section 5.7.8.3.4, pump tests are required before startup of a production area. These reports are subject to review by the staff to verify that no communication exists between aquifers and old exploration holes. This approach is acceptable to the staff.

7.3.11 Communication through Coal Bed Methane and Oil/Gas Wells

The applicant stated that the likelihood of lixiviant communicating from the ore zone aquifer to another aquifer through a CBM well or an oil/gas well is minimal. The cementing of the oil/gas wells occurs from the surface to at least 305 m (1,000 ft) deep. A cement bond log is run after the wells are completed to ensure that the cementing job used for completion has been completed properly. Pressure monitoring on the oil/gas wells also ensures that the oil/gas wells are working properly and that the well integrity is intact. CBM wells are completed in the same manner as the oil/gas wells. Production area pumping tests conducted before uranium recovery operations, along with monitor wells installed in the overlying and underlying aquifers, will be able to detect if any CBM wells are causing aquifer communication. Additionally, bimonthly water sampling will be ongoing above and below the production zone, as required by a standard license condition, listed in SER Appendix A, that will minimize this accident scenario. As discussed in SER Section 5.7.8.3.4, pump tests are required before startup of a production area. The staff notes that improper cementation of CBM or oil/gas wells may result in communication between aquifers. The production area pump test would reflect this improper communication. Therefore, this approach is acceptable to the staff.

7.3.12 Occupational Incidents

In application Section 7.5.9, the applicant discussed the possibility of occupational accidents and planned preventive measures. Such preventive measures will include following all building and construction codes during construction to prevent tank and pipeline failures, proper containment of fluid-containing vessels, and emergency response procedures. The applicant stated that employees will be trained on company safety and environmental policies that will cover topics ranging from Occupational Safety and Health Administration rules and regulations, company vehicle policy, enforcement of speed limits both on site and off site, and the proper use of personal protective equipment. Workers will receive training on these policies, procedures, and practices before beginning work and annually. The applicant stated that, before beginning work, personnel will be trained in correct plant operations, including regular inspections of all well field and plant lines, equipment, and operations. The applicant’s plans for addressing occupational incidents are consistent with the approach used at other operating ISR facilities in Wyoming and represent the standard of practice in the ISR industry. Therefore, this approach is acceptable to the staff.

7.4 Evaluation Findings

The staff reviewed accidents that could occur at the Nichols Ranch ISR Project in accordance with SRP Section 7.5.3. The applicant addressed accidents involving chemicals, radiological releases, ground water contamination, pipeline failures, transportation, fires and explosions, CBM operations, natural events, well casing failures, communication through old exploration holes, and communication through CBM or oil/gas wells. The applicant provided an analysis of probable accidents and cited information in NUREG-0706 and NUREG/CR-6733 as the bases for the accident consequences at the Nichols Ranch ISR Project. As discussed in detail in the previous sections, the staff concludes that these accident consequence analyses are applicable to the Nichols Ranch ISR Project.

Based on its review described above, the NRC staff concludes that the information provided in the application concerning potential accidents meets the applicable acceptance criteria of SRP Section 7.5.3 and the requirements of 10 CFR 40.32(c).

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10 CFR Part 40. *Code of Federal Regulations*, Title 10, Energy, Part 40, “Domestic Licensing of Source Material.”

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APPENDIX A

Table of Standard License Conditions

Administrative Conditions
The authorized place of use shall be the licensee's Nichols Ranch in situ recovery (ISR) Project in Johnson and Campbell Counties, Wyoming. The licensee shall conduct operations within the license area boundaries shown in Figures 1-2 and 1-3 of the approved license application.
The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated November 30, 2007, as amended by submissions dated August 21, 2008, March 11, 2009, February 24, 2010, September 15, 2010 , and September 22, 2010, which are hereby incorporated by reference, except where superseded by specific conditions in this license. The licensee's approved license application must be maintained on site. Whenever the word "will" or "shall" is used in the above referenced documents, it shall denote a requirement.
All written notices and reports sent to the U.S. Nuclear Regulatory Commission (NRC) as required under this license and by regulation shall be addressed as follows: ATTN: Document Control Desk, Director, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. An additional copy shall be submitted to: Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Mail Stop T-8F5, 11545 Rockville Pike, Two White Flint North, Rockville, MD 20852-2738. Incidents and events that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100 (collect calls accepted).
Change, Test, and Experiment License Condition A. The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition: i Make changes in the facility as described in the license application (as updated); ii Make changes in the procedures as described in the license application (as updated); and iii Conduct tests or experiments not described in the license application (as updated). B. The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would: i Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);

ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application (as updated);

iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application (as updated);

iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application (as updated);

v Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);

vi Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application (as updated);

vii Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or technical evaluation reports (TERs) or other analysis and evaluations for license amendments.

viii For purposes of this paragraph as applied to this license, SEMS means any SEMS which has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof.

C. Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with the NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

D. The licensee's determinations concerning (B) and (C) of this condition, shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management (e.g., Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address technical aspects such as ground water or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

E. The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with (B) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC changed pages, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

Financial Assurance. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR Part 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, which includes offsite disposal of radioactive solid process or evaporation pond residues, and ground-water restoration as warranted. The surety shall also include the costs associated with all soil and water sampling analyses necessary to confirm the accomplishment of decontamination.

Proposed annual updates to the financial assurance amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to the NRC 90 days prior to the anniversary date (e.g., renewal date of the financial assurance instrument/vehicle). The financial assurance update renewal date for Nichols Ranch ISR Project will be determined following consultation with the licensee and the State of Wyoming. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing financial assurance arrangement, the licensee shall extend the existing arrangement, prior to expiration, for 1 year. Along with each proposed revision or annual update of the financial assurance estimate, the licensee shall submit supporting documentation, showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15-percent contingency, changes in engineering plans, activities performed, and any other conditions affecting the estimated costs for site closure.

Within 90 days of NRC approval of a revised closure (decommissioning) plan and its cost estimate, the licensee shall submit, for NRC review and approval, a proposed revision to the financial assurance arrangement if estimated costs exceed the amount covered in the existing arrangement. The revised financial assurance instrument shall then be in effect within 30 days of written NRC approval of the documents.

At least 90 days prior to beginning construction associated with any planned expansion or operational change that was not included in the annual financial assurance update, the licensee shall provide, for NRC review and approval, an updated estimate to cover the expansion or change. The licensee shall also provide the NRC with copies of financial assurance-related correspondence submitted to the State of Wyoming, a copy of the State's financial assurance review, and the final approved financial assurance arrangement. The licensee also must ensure that the financial assurance instrument, where authorized to be held by the State, identifies the NRC-related portion of the instrument and covers the aboveground decommissioning and decontamination, the cost of offsite disposal of solid byproduct material, soil, and water sample analyses, and ground water restoration associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation or decommissioning plan cost estimates and annual updates should follow the outline in Appendix C, "Recommended Outline for Site-Specific In Situ Leach Facility Reclamation and Stabilization Cost Estimates," to NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report."

The licensee shall continuously maintain an approved surety instrument for the Nichols Ranch ISR Project, in favor of the State of Wyoming. The initial surety estimate shall be submitted for NRC review and approval within 90 days of license issuance, and the surety instrument shall be submitted for NRC review and approval 90 days prior to commencing operations.

Release or removal of surficially contaminated equipment, materials, or packages from restricted areas shall be in accordance with the NRC guidance document entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," dated April 1993, or suitable alternative procedures approved by the NRC prior to any such release. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently.
The licensee shall follow the guidance set forth in NRC Regulatory Guides 8.22, "Bioassay at Uranium Mills" (as revised) and 8.30, "Health Physics Surveys in Uranium Recovery Facilities" (as revised), or NRC-approved equivalent. The licensee shall follow the guidance set forth in Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable" (as revised), or NRC-approved equivalent. Any proposed exceptions to the guidance are subject to review and written verification by the NRC that the proposed exception does not require a license amendment.
Cultural Resources. Before engaging in any developmental activity not previously assessed by the NRC, the licensee shall administer a cultural resource inventory if such survey has not been previously conducted and submitted to the NRC. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act (NHPA) (as amended) and its implementing regulations (36 CFR Part 800), and the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR Part 7). In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance of the area shall occur until the licensee has received authorization from the NRC, Wyoming State Historic Preservation Officer, or Bureau of Land Management to proceed. The licensee shall comply with the terms and conditions regarding cultural resource protection in the Memorandum of Agreement regarding the Nichols Ranch ISR Project dated July 8, 2011.
The licensee shall dispose of solid byproduct material from the Nichols Ranch ISR Project operations at a site that is authorized by the NRC or an NRC Agreement State to receive byproduct material. The licensee's approved solid byproduct material disposal agreement must be maintained on site. In the event that the agreement expires or is terminated, the licensee shall notify the NRC within 7 working days after the date of expiration or termination. A new agreement shall be submitted for NRC review within 90 days after expiration or termination, or the licensee will be prohibited from further lixiviant injection.

The results of the following activities, operations, or actions shall be documented: sampling; analyses; surveys or monitoring; survey/monitoring equipment calibrations; reports on audits and inspections; all meetings and training courses; and any subsequent reviews, investigations, or corrective actions required by NRC regulation or this license. Unless otherwise specified in a license condition or applicable NRC regulation, all documentation required by this license shall be maintained until license termination and is subject to NRC review and inspection.
The licensee is hereby exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted with the words, "CAUTION: ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."
Operations, Controls, Limits, and Restrictions
The licensee shall use a lixiviant composed of native ground water and a combination of one or more of the following: carbon dioxide gas, sodium carbonate, sodium bicarbonate, dissolved oxygen, or hydrogen peroxide as specified in the licensee's approved license application. For the Hank Unit, hydrogen peroxide will not be used.
Facility Throughput. The Nichols Unit plant throughput shall not exceed a daily averaged flow rate of 3,500 gallons per minute, excluding restoration flow. Annual dried yellowcake production shall not exceed 2.0 million pounds. The Hank Unit satellite plant shall not exceed a daily averaged flow rate of 2,500 gallons per minute, excluding restoration flow.
Emission controls (dryer). The licensee shall maintain effluent control systems as specified in Section 4.1 of the licensee's approved license application.
The licensee shall develop and implement written standard operating procedures (SOPs) prior to operation for: (1) all operational activities involving radioactive and nonradioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees, (2) all nonoperational activities involving radioactive materials including in-plant radiation protection and environmental monitoring, and (3) emergency procedures for potential accidents/unusual occurrences including significant equipment or facility damage, pipe breaks and spills, loss or theft of yellowcake or sealed sources, significant fires, and other natural disasters. The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. A copy of the current written procedures shall be kept in the area(s) of the production facility where they are utilized. The licensee shall also develop and implement SOPs prior to operation for the following: A. Maintenance of surveys and monitoring records in accordance with 10 CFR Part 20, Subpart L, to demonstrate compliance with 10 CFR Part 20 requirements.

B. Internal exposure calculation methods and applicable equations for determining the dose (committed effective dose equivalent (CEDE)) from airborne sampling and bioassay data. This methodology will be in accordance with 10 CFR 20.1201, 10 CFR 20.1204, and Regulatory Guides 8.30, (as revised), 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” (as revised), and 8.36, “Radiation Dose to the Embryo/Fetus,” (as revised).

C. Conduct of its bioassay program and the determination of internal dose (e.g., CEDE) from bioassay data 60 days prior to commencing operations. The licensee will provide a plan or operating procedures to limit the soluble intake to 10 mg per week for uranium.

D. Procedures for emergencies identified in Section 7.0 of the licensee’s approved application.

These SOPs are subject to all inspections, including the preoperational inspection specified in LC 12.3.

Mechanical Integrity Tests (MITs). The licensee shall construct all wells in accordance with methods described in Section 3.4.6 of the licensee’s approved license application. The licensee shall perform well MITs 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 the well casing. Additionally, each well shall be retested at least once every 5 years. MITs shall be performed in accordance with Section 3.4.6 of the licensee’s approved license application. Any failed well casing that cannot be repaired to pass the MIT shall be appropriately plugged and abandoned in accordance with Section 6.1.5 of the approved license application.

Ground Water Restoration. The licensee shall conduct ground water restoration activities in accordance with the approved license application. Permanent cessation of lixiviant injection in a production area would signify the licensee’s intent to shift from the principal activity of uranium production to the initiation of ground water restoration and decommissioning for any particular production area. If the licensee determines that these activities are expected to exceed 24 months for any particular production area, then the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42.

Hazardous constituents in the ground water shall be restored to the numerical ground water protection standards as required by 10 CFR Part 40, Appendix A, Criterion 5(B)(5). In submitting any license amendment application requesting review and license amendment approval of proposed alternate concentration limits (ACLs) pursuant to Criterion 5(B)(6), the licensee must also show that it has first made reasonable effort to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater).

Changes to ground water restoration or postrestoration monitoring plans shall be submitted to the NRC for review and written verification by the NRC that the proposed changes do not require a license amendment at least 60 days prior to commencement of ground water restoration in a production area.

Monitoring, Recording, and Bookkeeping Requirements
In addition to reports required to be submitted to the NRC or maintained on site by Title 10 of the *Code of Federal Regulations*, the licensee shall prepare the following reports related to operations at the facility: A. A quarterly report that includes a summary of the weekly excursion indicator parameter values, corrective actions taken, and the results obtained for all wells that were on excursion status during that quarter. This report shall be submitted to the NRC within 30 days following completion of the reporting period. B. A semiannual report that discusses: status of production areas in operation (including last date of lixiviant injection), status of production areas in restoration, status of any long-term excursions and a summary of MITs during the reporting period. This report shall be submitted to the NRC within 30 days following completion of the reporting period. C. A quarterly report summarizing daily flow rates for each injection and production well and injection manifold pressures on the entire system. The flow rates should be measured and recorded daily for each injection and production well and injection manifold pressures on the entire system. This report shall be kept on site and made available for inspection upon request. D. Consistent with Regulatory Position 2 of Regulatory Guide 4.14 (as revised), a semiannual report that summarizes the results of the operational effluent and environmental monitoring program.
The licensee shall submit the results of the annual review of the radiation protection program content and implementation performed in accordance with 10 CFR 20.1101(c). These results shall include an analysis of dose to individual members of the public consistent with 10 CFR 20.1301 and 10 CFR 20.1302.
<u>Establishment of Background Water Quality.</u> Prior to injection of lixiviant for each production area, the licensee shall establish background ground water quality data for the ore zone and overlying and underlying aquifers. The background water quality will be used to define the background ground water protection standards required to be met in 10 CFR Part 40, Appendix A, Criterion 5B(5) for the ore zone aquifer and surrounding aquifers. Water quality sampling shall provide representative background ground water quality data and restoration criteria as described in Section 5.7.8.5 of the approved license application. The data for each production area shall consist, at a minimum, of the following sampling and analyses: A. Ore Zone. Samples shall be collected from ore zone monitoring production (MP) wells at a minimum density of one MP well per 4 acres of production area. These samples shall be analyzed for the parameters listed in Table D6-6a of the licensee's approved application. Samples shall also be collected from all ore zone perimeter monitoring wells.

B. Overlying and Underlying Aquifers. Samples shall be collected from all monitoring wells in the first overlying and first underlying aquifer at a minimum density of one well per 4 acres of production area. The samples shall be analyzed for those parameters listed in Table D6-6a of the approved license application. C. Surficial Aquifer. One surficial well shall be located and sampled in each production area. The samples shall be analyzed for those parameters listed in Table D6-6a of the approved license application. D. Sampling and Analysis. Four samples shall be collected from each well to establish background levels. Consecutive sampling events shall be at least 14 days apart. The third and fourth sample events can be analyzed for a reduced list of parameters. The parameters that can be deleted from the third and fourth sampling events are those that are below the minimum analytical detection limits during the first and second sampling events. E. Ground water RTVs for the ore zone aquifer shall be established on a parameter-by-parameter basis using either a production area or well-specific basis for all constituents.
<u>Establishment of Upper Control Limits (UCLs).</u> Prior to injection of lixiviant into a production area, the licensee shall establish UCLs in designated overlying and underlying aquifer and perimeter monitoring wells. The UCLs for the indicator parameters chloride, conductivity, and total alkalinity shall be established by analyzing background monitoring data collected to satisfy LC 11.3. The concentrations of these UCLs shall be established for each production area by calculating the background mean concentration and adding five standard deviations. The UCL for chloride can be set at the background mean concentration and adding either five standard deviations or 15 mg/L, whichever is higher.
<u>Excursion Monitoring.</u> Monitoring for excursions shall occur twice monthly and at least 10 days apart for all wells with a UCL. An excursion shall have occurred if, in any monitor well, any two UCL parameters exceed their respective UCLs. A verification sample shall be taken within 48 hours after results of the first analyses are received. If the second sample shows that the excursion criterion is exceeded, an excursion shall be confirmed. If the second sample does not show that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after the second set of sampling data was acquired. If the third sample shows that the excursion criterion is exceeded, an excursion shall be confirmed. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered to be an error and the well is removed from excursion status. Upon confirmation of an excursion, the licensee shall notify the NRC, as discussed below, implement corrective action, and increase the sampling frequency for the indicator parameters at the excursion well to once every 7 days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8.10.3 of the approved license application. An excursion is considered corrected when the concentrations of the indicator parameters are below the concentration levels defining an excursion for three consecutive weekly samples. If an excursion is not corrected within 60 days of confirmation, the licensee shall either: (a) terminate injection of lixiviant within the production area until the excursion is corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and

cleaning up the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and cleaned up. The written 60-day excursion report shall identify which course of action the licensee is taking. Under no circumstances does this condition eliminate the requirement that the licensee must remediate the excursion to meet ground water protection standards as required by LC 10.6 for all constituents established per LC 11.3. The licensee shall notify the NRC Project Manager by telephone or e-mail within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 11.6. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on excursion after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).
Until license termination, the licensee shall maintain documentation on unplanned releases of source or byproduct materials (including process solutions) and process chemicals. Documented information shall include, but not be limited to: date, spill volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of postremediation surveys (if taken), a map showing the spill location and the impacted area, and an evaluation of NRC reporting criteria. The licensee shall have written procedures for evaluating consequences of the spill or incident/event against 10 CFR Part 20, Subpart M, and 10 CFR 40.60 reporting criteria. If the criteria are met, then the licensee shall report to the NRC Operations Center as required. If the licensee is required to report any production area excursions and spills of source material, byproduct material, or process chemicals that may have an impact on the environment, or any other incidents/events, to any State or other Federal agency, a report shall be made to the NRC Headquarters Project Manager by telephone or electronic mail (e-mail) within 24 hours. This notification shall be followed, within 30 days of the notification, by submittal of a written report to NRC Headquarters, as per LC 9.3, detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved.
The licensee shall identify the location, screen depth, and estimated pumping rate of any new ground water wells or new use of an existing well within the license area and within 2 kilometers of any production area. The licensee shall evaluate the impact of ISR operations on potential ground water users and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted as part of the annual reporting to the NRC for review. After the commencement of uranium recovery operations, the licensee will sample all domestic and livestock wells that are located within 1 kilometer of the production area monitoring ring wells (MR-wells) of the Nichols Ranch and Hank Units. Samples shall be collected annually and submitted as part of annual reporting to the NRC until ground water restoration is approved at the production area. Samples shall be analyzed for the UCL parameters in Section 5.7.8.9 of the approved license application and for natural uranium and radium-226.

Preoperational Conditions
Prior to commencement of operations in any production area, the licensee shall obtain all necessary permits and licenses from the appropriate regulatory authorities. The licensee shall also submit a copy of all permits for its Class I and Class III underground injection wells.
Prior to commencement of operations, the licensee shall coordinate critical emergency response requirements with local authorities, fire department, medical facilities, and other emergency services. The licensee shall document these coordination activities and maintain such documentation on site.
The licensee shall not commence operations until the NRC performs a preoperational inspection to confirm, in part, that operating procedures and approved radiation safety and environmental monitoring programs are in place and that preoperational testing is complete. The licensee should inform the NRC at least 90 days prior to the expected commencement of operations to allow the NRC sufficient time to plan and perform the preoperational inspection.
The licensee shall identify the location, screen depth, and estimated pumping rate of any new ground water wells or new use of an existing well within the license area and within 2 kilometers of any proposed production area since the application was submitted to the NRC. The licensee shall evaluate the impact of ISR operations to potential ground water users and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted to the NRC for review within 6 months of discovery of such well use.
Prior to commencement of operations, the licensee shall submit the qualifications of radiation safety staff members for NRC review.
Prior to the commencement of operations, the licensee shall submit a copy of the solid byproduct material disposal agreement to the NRC.