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4. EFFLUENT CONTROL AND WASTE MANAGEMENT SYSTEMS

4.1 Airborne Effluent Control Systems

4.1.1 Non-Radioactive Airborne Effluents

Non-radioactive airborne effluents will be limited to fugitive dust from wellfield activities. As discussed in Chapter 3 Section 3.2.1.10, fugitive dust emissions will be minimal and will not require dust suppression.

4.1.2 Radioactive Airborne Effluents

Because there will be no yellowcake processing or drying at the facility, airborne hazards due to uranium dust will be negligible. Spills or leaks of uranium bearing fluids within the satellites will be cleaned up as soon as possible to prevent the potential for an airborne hazard from dried salts.

The most significant potential airborne radioactive effluent will be the release of radon-222 gas which is present in the orebody, concentrates in the lixiviant, and will be released into the atmosphere from the wellfields, satellites and, to a lesser degree, the evaporation ponds. Radon released to the atmosphere will disperse rapidly and will not represent a hazard to the public or employees (see Chapter 7 and Appendix 12). Sources of potential releases of radon inside the satellite buildings will be identified and removed by source specific and/or building ventilation systems. The primary sources of radon control are described below.

4.1.2.1 Tank Ventilation

All non-sealed tanks that could potentially release radon gas will be ventilated using high volume exhaust fans that will draw air across the top of each tank exhausting it to the outside atmosphere through ducts. The conceptual layout for this system is shown on Figures 3-2 and 3-3.

All entries into tanks and vessels that contain or have contained radioactive materials will be performed under a Radiation Work Permit (RWP), as described in Chapter 5, which will require special air sampling, protective equipment and increased exposure surveillance.

4.1.2.2 Resin Transfer Ventilation

When resin is transferred from the ion exchange vessels into the resin trailers, air containing radon gas will escape from the trailer hatches creating a potential for the buildup of radon daughters in the satellite buildings.

High volume exhaust fans, similar to those used at the Highland Uranium Project Satellite facilities, will be installed in close proximity to the resin trailer hatches and will be operated during resin transfer to remove radon gas to the outside atmosphere. The conceptual layout for this system is shown on Figure 3-2 and 3-3.

4.1.2.3 Sump Ventilation

Water released from the ion exchange vessels during resin transfer and from tanks during clean out, maintenance, etc. will be directed to a centrally located sump and pumped back into the process circuit. To prevent the buildup of radon decay products, the sump will be covered and ventilated to the outside atmosphere using forced air ventilation systems.

4.1.2.4 Building Ventilation

It is anticipated that the ventilation systems described above will be adequate to prevent radon buildup in the Satellite buildings. Should monitoring data indicate additional problem areas, these will be evaluated and corrected during the startup phase of the project.

4.2. Waste Management Systems

4.2.1 General

As discussed in Chapter 1, there will be at least three types of wastes generated at the Gas Hills Project. These will include domestic sewage, non-radiologically contaminated wastes and radiologically contaminated byproduct wastes. All wastes generated at the project will be treated and/or disposed in accordance with appropriate local, state, or federal requirements and regulations.

4.2.2 Domestic Sewage

Domestic wastes from the Satellites will be disposed of in conventional septic/leach field systems permitted by the WDEQ-WQD. Currently, a permitted septic/leach field system exists for the Carol Shop facility. An additional permit will be obtained prior to the construction of the alternate satellite facilities.

These systems will only receive solid and liquid wastes from restrooms, shower facilities and miscellaneous sinks located within the office/eating areas of the satellite facilities. Temporary chemical toilets will be used in wellfield and drilling areas where access to one of the satellite facilities will be time consuming or inconvenient.

4.2.3 Non-Radiologically contaminated wastes

Non-contaminated solid wastes generated at the project will include paper, wood products, office and food wastes, steel, etc. These materials will be temporarily stored in commercial bins and will be periodically disposed of in a municipal landfill by a contract waste disposal operator.

Waste oil from vehicle and equipment oil changes and hydraulic equipment repair will be stored in appropriately labeled above ground storage containers in accordance with MSHA and EPA requirements. These wastes will be periodically collected by a commercial used oil recycler for recycling or energy recovery purposes.

4.2.4 Byproduct Wastes

Byproduct wastes consist of equipment and materials that have become radiologically contaminated by the process of recovering uranium and will include items such as tanks, vessels, ion exchange resin, filter media , process pipe and equipment, the production and restoration waste water streams and the solid residue and liners from the evaporation ponds.

It is estimated that between 50 and 300 cubic yards of solid byproduct wastes will be generated each year at the project. Those materials that cannot be decontaminated for unrestricted release will be stored in labeled and covered containers and periodically transported for disposal at an NRC licensed disposal facility. Some material, such as pipe, will be stored in posted areas prior to volume reduction or decontamination prior to disposal. PRI currently has a contract disposal agreement with Pathfinder Mines Corporation to dispose of Gas Hills byproduct wastes at their Shirley Basin tailings facility.

The evaporation pond residues will remain in the ponds during the life of the facility and will be disposed of along with the liner and any contaminated underlying soil, at an NRC licensed disposal facility during decommissioning.

The primary liquid byproduct waste stream will be the process bleed stream. The production purge will range from 40 gpm to 160 gpm and will be treated by RO, or similar purification methods, to reduce the volume. The treated portion, or permeate, will be reinjected into the aquifer. The RO concentrate will be stored in lined evaporation ponds. The ground water produced during restoration will be generated during ground water sweep and RO activities. These activities are described in Chapter 6.

The restoration fluids will also be treated by RO, or other purification methods, to reduce the volume. The permeate will be reinjected into the aquifer or surface discharged under an NPDES permit which will be obtained if necessary prior to restoration activities in Mine Unit No. 1.

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5. OPERATIONS

5.1 Organizational Structure, Authority and Responsibilities

Figure 5-1 shows the Environmental and Radiation Safety organization and reporting responsibilities at the Gas Hills Project. The responsibilities of these personnel are as follows:

5.1.1 President and Chief Executive Officer

The President and Chief Executive Officer is responsible for interpreting and acting upon the Board of Directors' policy and procedural decisions. The President and Chief Executive Officer directly supervises the Director, Environment and Safety, and the Vice-President, Operations. The President and Chief Executive Officer has been empowered by the board to have the responsibility and authority for the radiation safety, environmental compliance and Quality Assurance programs. He is responsible for ensuring that operations staff are complying with all applicable regulations and permit/license conditions through direct supervision of the Vice-President, Operations. The President and Chief Executive Officer has the responsibility and authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

5.1.2 Director, Environment and Safety

The Director, Environment and Safety reports to the President and Chief Executive Officer and is responsible for ensuring that corporate policy and procedure is translated into appropriate corporate action and implemented. The Director, Environment and Safety, supervises the Manager of Environmental and Regulatory Affairs/Corporate Radiation Safety Officer to ensure that all radiation safety, environmental compliance and licensing programs are conducted in a responsible manner and in compliance with all applicable regulations, license conditions, and corporate policy. The Director, Environment and Safety has the responsibility and authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

5.1.3 Vice President, Operations

The Vice-President, Operations reports to the President and Chief Executive Officer and is directly responsible for ensuring that operations staff (including the Gas Hills Project) comply with industrial safety, radiation safety, and environmental protection programs. The Vice-President, Operations is also responsible for compliance with all regulatory license conditions/stipulations, regulations, and reporting requirements. The Vice-President, Operations has the responsibility and authority to immediately terminate, suspend, modify or

postpone any activity that is determined to be a threat to employees or public health, the environment or potentially a violation of state or federal regulations.

The Vice-President, Operations directly supervises the General Manager, Uranium Operations.

5.1.4 Manager of Environmental and Regulatory Affairs/Corporate Radiation Safety Officer (CRSO)

Reporting directly to the Director, Environment and Safety, the Manager of Environmental and Regulatory Affairs/Corporate Radiation Safety Officer (CRSO) is responsible for the development, administration and enforcement of all radiation protection, environmental and ground water monitoring programs at company operations, including the Gas Hills Project. The CRSO has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations.

The CRSO assists in the development, review and approval of sampling and analysis procedures and aids in the technical evaluation of laboratory data, as required. The CRSO is also responsible for routine auditing of quality assurance/quality control programs developed and used at the Project site.

The CRSO develops and administers corporate radiation protection programs to ensure that (1) employees are afforded the optimum practical protection against radiation hazards, (2) exposure of employees to radiation and radioactive materials is maintained "As Low As Reasonably Achievable," and (3) all applicable regulatory requirements are met.

The CRSO also provides technical guidance and assistance to site personnel in the matter of radiation protection. The Manager of Environmental and Regulatory Affairs/CRSO directly supervises the Radiation Safety Officer (RSO).

5.1.5 General Manager, Uranium Operations

The General Manager, Uranium Operations is responsible for managing the day to day operations at both the Gas Hills and Highland Uranium Projects, and reports directly to the Vice-President, Operations. The General Manager, Uranium Operations is responsible for ensuring that Project personnel comply with industrial safety, radiation safety and environmental protection programs, and all relevant state and federal regulations.

The General Manager, Uranium Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The General Manager, Uranium Operations cannot unilaterally override

a decision for suspension, postponement or modification if that decision is made by the President and Chief Executive Officer or the Vice-President, Operations

5.1.6 Operations Superintendent

The Operations Superintendent will report to the General Manager, Uranium Operations and will be directly responsible for all Gas Hills Project site operations, industrial and radiation safety, and environmental protection. This includes all operating procedures, radiation safety programs, industrial safety programs, environmental and ground water monitoring programs, associated quality assurance programs and routine and non-routine maintenance activities. The Operations Superintendent will also be responsible for compliance with all regulatory license conditions/stipulations and regulations and reporting requirements. The Operations Superintendent will have the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health or the environment or potentially a violation of state or federal regulations.

To prevent operational bias in matters related to radiation safety, environmental compliance and safety, the Operations Superintendent cannot unilaterally override a decision for suspension, postponement or modification of an operational activity if that decision is made by the Director, Environment and Safety or the Manager of Regulatory Affairs/CRSO, unless directed to do so by senior management after consultation with the initiator of the suspension, postponement or modification.

5.1.7 Radiation Safety Officer

The RSO will be responsible for the daily supervision of the radiation safety and environmental programs at the Gas Hills Project. Responsibilities will include the development and implementation of all radiation safety and environmental programs, ensuring that all records are correctly maintained and assisting the Operations Superintendent in ensuring compliance with NRC regulations and license conditions applicable to worker health protection.

The RSO will be designated as the Site QA Coordinator. The RSO will conduct training programs for the supervisors and employees with regard to the proper application of radiation protection and environmental control procedures. The RSO will personally inspect facilities to verify compliance with all applicable radiological health and safety requirements and the Quality Assurance Program. The RSO will report directly to the CRSO.

The RSO will have the responsibility, and the authority, to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employee or public health, the environment or potentially a violation of state or federal regulations.

5.2 Qualifications and Training

Minimum technical qualifications and experience required for personnel who are responsible for developing and administering the radiation and environmental protection programs and the Quality Assurance Program are as follows:

5.2.1 President and Chief Executive Officer

The position of President and Chief Executive Officer requires a Bachelors degree from an accredited college or university or equivalent work experience, plus a minimum of five years management experience in senior management.

5.2.2 Vice President, Operations

The Vice President, Operations will have at least a Bachelors degree in Engineering or associated science from an accredited college or university, or equivalent work experience, plus a minimum of five years of management experience in engineering and/or operations functions.

5.2.3 General Manager, Uranium Operations

The General Manager of Uranium Operations will have at least a Bachelors degree in Engineering or associated science from an accredited college or university or equivalent work experience, plus a minimum of five years supervisory experience. Work experience will include industrial process/production experience and industrial process/production management.

5.2.4 Director, Environment and Safety

The Director, Environment and Safety will have at least a Bachelors degree in Engineering or associated science from an accredited college or university, or equivalent work experience, and at least five years supervisory experience in environmental and/or radiation protection in the uranium industry.

5.2.5 Operations Superintendent

The position of Operations Superintendent requires a Bachelors degree in Engineering or associated science from an accredited college or university or equivalent work experience, plus a minimum of five years supervisory experience. Work experience will include industrial process/production experience and management.

5.2.6 Manager of Environmental and Regulatory Affairs/Corporate Radiation Safety Officer (CRSO)

The position of CRSO requires a Bachelor's degree in the physical or biological sciences, mathematics or engineering from an accredited college or university, and at least three years of experience in applied health physics and radiation protection. Experience will be industry related.

5.2.7 Radiation Safety Officer (RSO)

The RSO will have at least a Bachelors degree in physical or biological sciences, engineering or related discipline from an accredited college or university or an equivalent combination of training and experience in uranium radiation protection. This position also requires 40 hours of formal radiation protection training, and knowledge of radiation protection procedures, applications and instrumentation.

5.3 Management Control Program

Comprehensive written standard operating procedures (SOP's) exist for the Highland Uranium Project. As the Gas Hills Project will operate as a satellite to the Highland facility, all applicable Highland SOP's will also apply to the Gas Hills Project.

The SOP's will include appropriate radiation safety practices that must be followed as well as procedures for non-operational activities such as surface and ground water monitoring, environmental and radiation protection monitoring, bioassay sampling, and instrument calibration.

Prior to implementation and before a proposed change is made, all SOP's will be reviewed and approved in writing by at least the Operations Superintendent, the RSO, and the CRSO. All facility SOP's related to activities involving the handling, processing, storing or transporting of radioactive materials will be reviewed by the CRSO on an annual basis. The SOP's will be made available to employees at their work area and will be a part of the training program described in Chapter 5.5. and on-the-job training.

Non-routine work or maintenance activities which may result in significant personnel exposure to radioactive materials, and for which there is no SOP, will be performed in accordance with a Radiation Work Permit (RWP). RWP's will be issued by the radiation safety staff or a designate who is qualified by way of specialized radiation protection training. Each RWP will, at a minimum, describe the following:

1) The scope of the work to be performed,
2) Any precautions necessary to reduce exposure to radioactive material,

3) Any supplemental radiological monitoring and sampling necessary prior to, during and following completion of the work, and
4) Review and documentation by the radiation safety staff or qualified designate of all non-routine activities prior to initiation of the work.

5.4 Management Audit and Inspection Program

The RSO, or a qualified designate, will perform weekly inspections of all work and storage areas and document the inspection results. The inspection reports will be routed to site management, the CRSO , the Director, Environment and Safety, and the Vice President, Operations to insure that any deficiencies are corrected in a timely fashion.

Licensee management will perform an annual ALARA audit of the radiation safety program in accordance with USNRC Regulatory Guide 8.31. The audit results will be documented and reviewed by management. The audit report will be retained on site for NRC review during routine inspections.

In accordance with 10 CFR 20.1101 20.1101(b) and Regulatory Guides 8.10 and 8.31, PRI is committed to maintaining occupational exposures to radioactive materials as low as reasonably achievable (ALARA). The radiation protection program presented in Section 5.7 has been developed from operating experience gained from 1988 through the present at the Highland Uranium Project and uses the ALARA principle as its basis.

5.5 Training

Employee training will be designed to familiarize employees with the necessary precautions to be taken when performing their assigned duties. Radiation safety constitutes a significant portion of this training. New employee radiation safety training will include the topics outlined in Section 2.5 of Regulatory Guide 8.31.

Additionally, each female employee of child bearing age will be instructed concerning prenatal radiation exposure and will be provided a copy of Regulatory Guide 8.13. A written test covering the course topics will be given to each new employee at the conclusion of the course, and the results will be retained in the training files.

On an annual basis, each permanent employee will be provided with an abbreviated training course which will include relevant information that has become available during the past year, changes in regulations and license conditions, exposure trends and other relevant topics. Completion of the retraining will be documented and retained in the training file.

Visitors and contractors will be required to sign in at the main office and receive hazard recognition and safety training appropriate for the activities they will be performing. Until

such training has been received and documented, visitors and contractors must be escorted by an employee who is properly trained and knowledgeable about the hazards in the facility.

5.6 Security

PRI will control access to the satellite and wellfield facilities. All visitors and contractors will be required to check in at the main office and receive appropriate safety and hazard training prior to proceeding to the Satellite or wellfield areas. The wellfields will be fenced to control access by livestock which could damage wellheads or wellfield buildings.

5.7 Radiation Safety Controls and Monitoring

In accordance with 10 CFR 20.1101(b), and Regulatory Guides 8.10 and 8.31, PRI is committed to maintaining personnel occupational exposures to radioactive materials "as low as reasonably achievable," or ALARA. The following Radiation Safety Program has been developed from operating experience gained during the period 1988 through the present at the Highland Uranium Project. Table 5-1 summarizes the types and locations of radiation surveys that will be performed at the Gas Hills Project.

5.7.1 Effluent Control Techniques

5.7.1.1 General

ISL results in significantly less air pollutants than conventional mining and milling operations. Since large heavy equipment, such as scrapers, loaders, and haul trucks will not be used, pollution from diesel internal combustion engines and dust from haul roads and ore and overburden piles will be negligible.

The hydrometallurgical processes employed by the ISL process also limits potential radioactive dusts and contaminants.

5.7.1.2 Non-Radioactive Airborne Effluents

Non-radioactive airborne effluents are regulated by the Air Quality Division of the Wyoming Department of Environmental Quality and will be limited to small quantities of fugitive dust from wellfield access roads. As there will not be yellowcake drying and packaging at the facility, these particulate emissions will not be present.

5.7.1.3 Radioactive Airborne Effluents

Since the Gas Hills Project will be operated only as a satellite ion exchange facility, the only potential for airborne radioactive effluent release will be from radon-222 which is present in the ore zone and mobilized by the solution. Radon will be released

inside the Satellite building during ion exchange resin transfer from the ion exchange columns into the resin transport trailers. Building contamination from this release will be controlled by operating exhaust fans at the trailer ports during resin transfers which will transport the radon out of the building into the atmosphere. These types of control techniques have been successful at controlling radon buildup within satellite ion exchange buildings at the Highland Uranium Project.

Radon may also be released into the building when ion exchange vessels or tanks are opened for maintenance. In accordance with approved procedures, all vessels and tanks will be vented prior to entry to reduce the potential radon exposure to workers. Building ventilation will be increased during these activities to avoid build-up of radon daughter products inside the building

Minor releases of radon will also occur at injection wellheads when excess oxygen is vented from the wells. These types of releases will be quite small and will quickly disperse into the atmosphere with no exposure potential.

The only other release of radon will be from the waste water evaporation ponds which will hold the RO concentrate produced by the treatment of wellfield purge and ground water restoration wastewater. Since this water will contain radium-226, minor quantities of radon gas will be released.

The radiological impacts of these releases have been evaluated by PRI in Chapter 7 and Appendix 12. Procedures developed at the Highland Uranium Project for handling safety equipment failures and spills will also be utilized at the Gas Hills Project to reduce potential employee exposure and environmental impacts caused by such incidents.

5.7.2 External Radiation Exposure Monitoring Program

External radiation exposure will be monitored utilizing thermoluminescent dosimeters (TLD). The TLD's will be supplied by a commercial vendor such as Thermo Nutech or Landauer, Inc. All Satellite employees will be issued TLD's which will be changed out on a quarterly basis. The data from these badges will be reviewed to ensure that annual exposures do not exceed five rem.

Additionally, quarterly gamma surveys will be performed at specified locations throughout the Satellite building to ensure that areas requiring posting as a "Radiation Area" are identified, posted and monitored to assess external radiation conditions. A "Radiation Area" is an area exhibiting 5 to 100 mrem per hour at a distance of 30 cm from the source. Based upon experience gained at the Highland Uranium Project, elevated gamma activity can be expected near ion exchange vessels, tanks, sumps, filters, and reverse osmosis equipment.

5.7.3 Airborne Radiation Monitoring Program

5.7.3.1 Airborne Uranium Particulate Monitoring

There will not be a potential for exposure to ore dust at the Gas Hills Project since it will be an ISL uranium facility. Also, since it will be an ion exchange facility only, with uranium bearing resin being transported to the Highland Uranium Project for eluting, precipitating, drying and packaging, there will be no potential for exposure to yellowcake dust. However, if non-routine work activities are performed in an area or manner that could result in exposure to uranium particulates, area air samples or breathing zone samples will be utilized to determine airborne uranium particulate levels. Time studies and/or actual occupancy times will be used to estimate employees' exposure times.

5.7.3.2 Radon Daughter Monitoring

Radon daughters will initially be monitored on a monthly basis at the Gas Hills Project. The method of analysis will be the modified Kusnetz method or other commonly accepted methods of measurement. Measurements will be performed in locations and at times when there is a potential for the release of radon or radon daughters (e.g , during resin transfer operations). If the monthly sampling data shows that radon daughter concentrations are routinely less than 10% of the regulatory limit (ie., 0.03 WL), then pursuant to Regulatory Guide 8.30, the sampling frequency will be reduced to quarterly.

5.7.4 Exposure Calculations

Employee exposures will be monitored in accordance with USNRC Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses."

Since the Satellite and associated wellfields are wet, closed systems, there will be no potential for routine exposure to uranium. Therefore, routine exposures to uranium will not be determined for employees.

Non-routine exposures to uranium may result from performing non-routine operations or maintenance tasks that have the potential for creating an exposure to airborne radioactive particulates. These types of exposures will be monitored utilizing a Radiation Work Permit (RWP). The RWP will specify the types of radiological monitoring required for the task and the protective equipment and clothing employees must wear while performing the task. The sampling results will be evaluated and documented. This data, together with the employee's time in the area, will be used to estimate the non-routine exposures. Each employee's routine exposure will be recorded weekly and summarized annually. Non-routine exposures will be determined within 48 hours after the non-routine task has been completed.

Routine employee exposure to radon daughters will be based upon the results of the routine monitoring program. Similar to non-routine uranium exposures, non-routine radon daughter exposures will be monitored utilizing an RWP. Routine exposure times will be determined by semi-annual time studies or actual occupancy times. Each employee's routine and non-routine exposure to radon daughters will be recorded on a weekly basis and summarized annually.

5.7.4.1 Airborne Uranium Exposure Calculation

Any non-routine exposures to soluble uranium will be estimated using the following equation:

$$I_u = \sum_{i=1}^{n} \frac{(x_i)(t_i)}{(DAC)(PF)}$$

Where:

I_u	=	uranium intake, DAC-hours
t_i	=	time that the worker is exposed to concentration x_i, in hours
x_i	=	average concentration of uranium in the air, μCi/ml
DAC	=	the derived air concentration value for uranium (5E-10 μCi/ml for soluble) from Appendix B Table 1 of 10 CFR Part 20
PF	=	respirator protection factor from Appendix A of 10 CFR Part 20
n	=	number of exposures during the period of evaluation

5.7.4.2 Radon Daughter Exposure Calculation

As discussed in Section 5.7.3.2, the modified Kusnetz or equivalent method for determining exposure to radon daughters will be utilized. From the monitoring data collected, the employees' routine exposure to radon daughters will be calculated using the following equation:

$$I_r = \sum_{i=1}^{n} \frac{(w_i)(T_i)}{(DAC)(PF)}$$

Where:

I_r	=	radon daughter intake, DAC-hours
t_i	=	time of exposure to concentration W_i, hr
w_i	=	average number of working levels in the air during time t_i
DAC	=	the derived air concentration value for radon daughters, (3E-8 μCi/ml or 0.33 WL) from Appendix B of 10 CFR Part 20
PF	=	respirator protection factor
n	=	number of exposure periods during the year

Section 20.2203 of 10 CFR requires that overexposure reports be made to the appropriate NRC Regional Office if the intake of uranium and/or radon exceeds the quantities specified in 10 CFR 20.1201. The following exposure limits require NRC notification:

1. Soluble Uranium - if an employee has an intake of more than 10 mg of soluble uranium in one week. This intake is in consideration of chemical toxicity.
2. Total Effective Dose Equivalent (TEDE) - if an employee exceeds the TEDE annual limit of 5 rem. The annual TEDE will initially be determined by summing annual doses for soluble uranium, radon and gamma.

5.7.4.3 Administrative Action Levels

An administrative action level is set at 3 mg of soluble uranium for any calendar week. An administrative action level is set at 130 DAC-hours for exposure to radon daughters for any calendar quarter. If the action level is exceeded, the RSO or qualified designee will initiate an investigation into the cause of the occurrence, determine any corrective actions that may reduce future exposures and document the corrective actions taken. Results of the investigation will be reported to management within one month of the action level being exceeded.

Results of the TLD's will be evaluated on a quarterly basis and compared against an administrative action level of 312 mrem per quarter. If an employee's exposure exceeds this level, the RSO, or other qualified designee, will investigate the reason for the exposure and initiate corrective measures to prevent a recurrence.

The results of the bioassay program (see Section 5.7.5) will also be used to evaluate the adequacy of the respiratory protection program at the facility. A urinalysis in excess of 15 μg/l uranium will be investigated both to determine the cause of the result and determine if the exposure records adequately reflect that such an exposure may have actually occurred.

5.7.4.4 Airborne Radioactivity Areas

Any area, room, or enclosure will be designated an "Airborne Radioactivity Area" as defined in 10 CFR 20.1003 (Appendix B, 10CFR20), if at any time, the uranium concentration exceeds 5E-10 μCi/ml for soluble uranium.

Additionally, areas will be posted as "Airborne Radioactivity Areas" in the case that an individual present in the area without respiratory protection could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the ALI or 12 DAC-hours. Airborne radioactivity areas will be posted in accordance with 10 CFR 20.1902. PRI will avoid posting radiation hazard signs in areas that do not require

them. Since the satellite facility will be handling only wet solutions and ion exchange resin, it is not anticipated that any area will have to be posted as an airborne radioactivity area.

5.7.5 Bioassay Program

Revision 1 of Regulatory Guide 8.22, "Bioassay at Uranium Mills", recommends monthly bioassays for employees who are (1) routinely exposed to airborne yellowcake or (2) are directly involved in maintenance tasks in which yellowcake dust may be produced. Since the Gas Hills Project will be an ion exchange facility only, there will be no potential for exposure to airborne yellowcake dust, and routine bioassays will not be necessary.

However, since there may be a potential for exposure to uranium from wellfield and satellite fluids, PRI will collect, on a random basis, monthly urine specimens from one employee from each work group (ie., Satellite operators, wellfield construction and pulling unit employees). Additionally, it is PRI's policy to require a urinalysis from all permanent Project employees at their time of hire and at termination of employment.

Employees potentially exposed to elevated concentrations of airborne uranium (eg., maintenance work on uranium production equipment) will be required to submit urine specimens for uranium analysis 2 to 4 days following the potential exposure. Sample collection and preparation will be performed in accordance with Regulatory Guide 8.22. Corrective actions to be taken, should any urinalysis exceed a regulatory action limit will be in accordance with Table 1 of Regulatory Guide 8.22.

5.7.6 Contamination Control Program

The primary sources of potential surface contamination at the Gas Hills Project will be associated with production and/or waste fluid. The primary method for control of surface contamination will be instruction in, and enforcement of, good housekeeping and personal hygiene practices. Any production or waste fluid spills will be cleaned up as soon as possible to prevent drying and possible suspension into the air which could pose an inhalation hazard. Employees will be instructed in the proper use of equipment and the prevention of spills and solution leaks at various stages of the process. Inadvertent contamination of designated clean areas will be controlled by instructing employees not to enter such areas with clothing or equipment contaminated with radioactive materials. If contamination is detected in a designated clean area, the RSO, or qualified designee, will be notified immediately, the area will be promptly cleaned and an investigation into the source of the contamination will be performed.

To ensure these administrative controls are effective in controlling surface contamination, alpha surface and personnel contamination surveys will be performed in accordance with the guidance provided in USNRC Regulatory Guide 8.30.

5.7.7 Airborne Effluent and Environmental Monitoring Program

As the proposed Gas Hills Project will not contain a yellowcake drying and packaging area, there will be no effluents of this type to be monitored.

Because there will not be a drying facility at the site, particulate air sampling will not be performed.

To ensure compliance with 10 CFR 20.1301, 20.1302 and 20.1501, PRI will maintain a continuous air monitoring program at upwind and downwind locations, which will contain passive gamma and radon monitoring devices that will be exchanged on a quarterly basis.

5.7.8 Ground Water and Surface Water Environmental Monitoring Program

Selected surface water and ground water locations will be sampled quarterly and analyzed for natural uranium and radium-226. This sampling program is described in Chapter 3, Section 3.2.1.12.

The ground water monitoring program that will be used to ensure that horizontal or vertical solution migration from wellfields does not occur is described in Chapter 3, section 3.4.6.3.

5.7.9 Radiation Survey Instrument Calibration

All radiation monitoring, sampling and detection equipment will be recalibrated at least annually and after each repair. Calibrations will be performed by the manufacturer or by a contract facility qualified to perform such calibrations. The calibration records will be maintained either at the Highland Uranium Project or at the Gas Hills Project.

5.7.10 Respiratory Protection Program

PRI has established an NRC approved Respiratory Protection Program at the Highland Uranium Project which permits PRI to make allowance for the use of respiratory protective equipment when estimating exposures of individuals to airborne radioactive materials (see Appendix A of the Highland Uranium Project Operations Plan, revised March, 1995, pages A-1 to A-14). Since the Gas Hills Project will be operated as a satellite to the Highland Uranium Project and under its license, this approved Respiratory Protection Program will also be utilized at the Gas Hills Project and is incorporated into this application by reference.

5.7.11 Quality Assurance

PRI has established an NRC and WDEQ approved Quality Assurance (QA) Program for radiological effluent, non-radiological effluent, and environmental (including ground water) monitoring programs at the Highland Uranium Project (see Section 9.10 of the Highland

Uranium Project Operations Plan, pages OP-75 - OP-97). Since the Gas Hills Project will be operated as a satellite to the Highland Uranium Project and under its license, this approved QA Plan will also be utilized at the Gas Hills Project and is incorporated into this application by reference.

This Quality Assurance Program addresses the elements discussed in USNRC Regulatory Guide 4.15. Since the Gas Hills Project will be operated as a satellite to the Highland Uranium Project, this approved QA program will also be utilized at the Gas Hills Project.

REFERENCES

1. Power Resources, Inc., 1995, "Respiratory Protection Plan", Appendix A to Operations Plan, Highland Uranium Project, Revised March, 1995, Pages A-1 through A-14.

2. Power Resources, Inc., 1996, "Quality Assurance Program", Section 9.10 of Operations Plan, Highland Uranium Project, Pages OP-75 through OP-97.

3. U.S. Nuclear Regulatory Commission, 1979, Regulatory Guide 4.15, "Quality Assurance For radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment".

4 U.S. Nuclear Regulatory Commission, 1975, Regulatory Guide 8.10, "Operating Philosophy For Maintaining Occupational Radiation Exposure As Low As Reasonably Achievable".

5. U.S. Nuclear Regulatory Commission, 1995, Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure".

6. U.S. Nuclear Regulatory Commission, 1987, Regulatory Guide 8.22, "Bioassay at Uranium Mills".

7. U.S. Nuclear Regulatory Commission, 1983, Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills".

8. U.S. Nuclear Regulatory Commission, 1983, Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Exposures at Uranium Mills Will be As Low As Reasonably Achievable".

9. U.S. Nuclear Regulatory Commission, 1992, Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses".

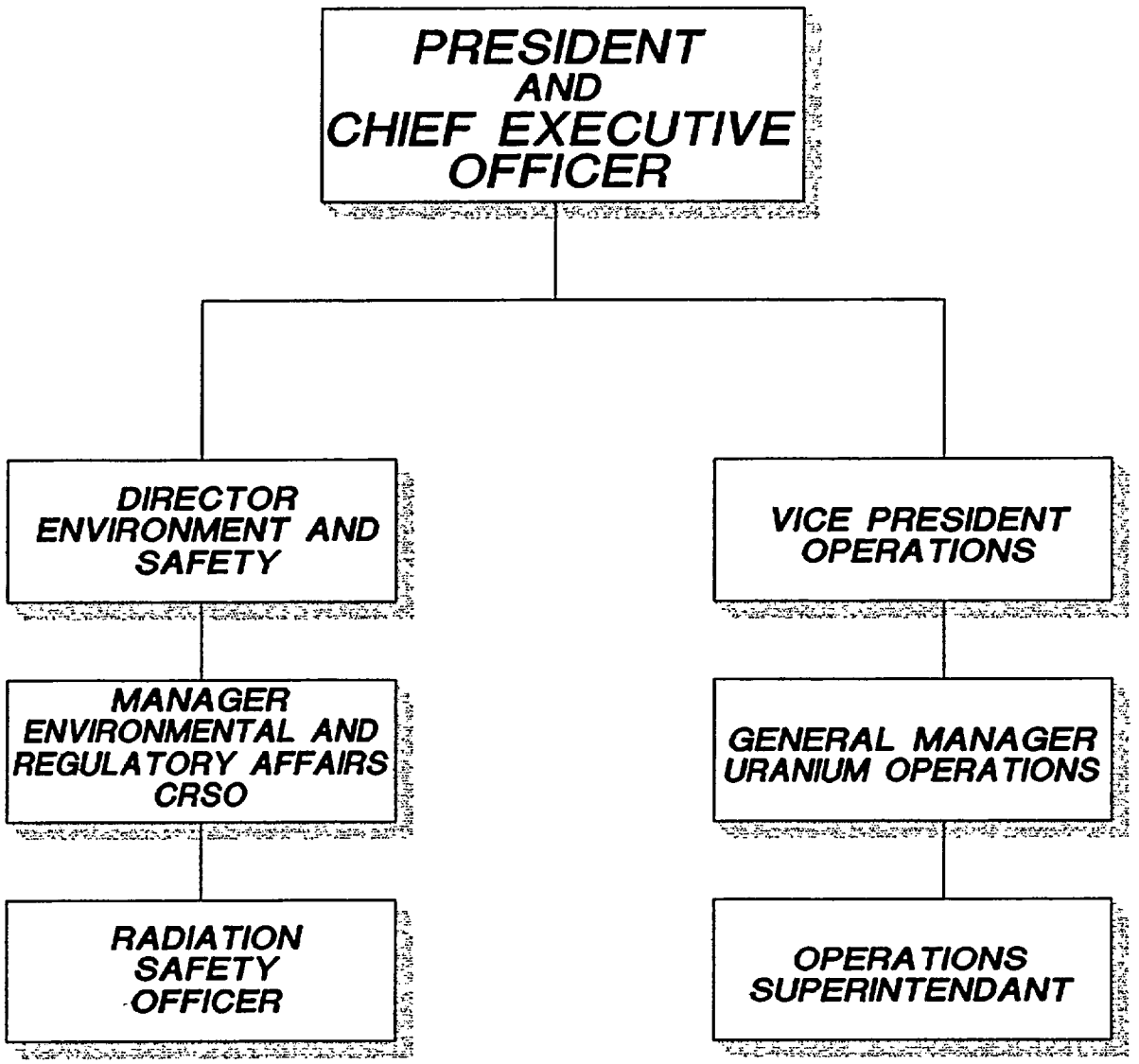
TABLE 5-1

PROCESS AREA RADIOACTIVITY MONITORING LOCATION AND DESCRIPTION

CHANGE ROOM/REST ROOM
Alpha, hand held - benches and floor and alpha swipe if total alpha exceeds 200 dpm/100 cm^2
Radon Daughter - low volume pump; one sample area

OFFICES, SHOPS, LAB AND WAREHOUSE
Radon Daughter - low volume pump; one sample area
Alpha, hand held - desk, counter tops, appliances and alpha swipe if total alpha exceeds 200 dpm/100 cm^2

PROCESS AREA
Alpha, hand held - base of each vessel/tank and or piece of equipment
Gamma, base of each vessel/tank or RO equipment and filters
Radon Daughter - low volume pump - process floor level and office/control rooms



NO.	REVISION	DATE	BY	ISSUED FOR	DATE	BY

POWER RESOURCES, INC.

FIG. 5-1

GAS HILLS PROJECT
ORGANIZATIONAL CHART
FREMONT & NATRONA COUNTIES, WY

REVISION DATE: 3/98
LAST PLOT DATE: NONE
CAD FILENAME: NRC5-1

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6. GROUND WATER RESTORATION, SURFACE RECLAMATION, AND PLANT DECOMMISSIONING.

6.1 Ground Water Restoration

6.1.1 Goal of Ground Water Restoration

Ground water restoration will occur concurrently with mining throughout the Gas Hills ISL operation. Once economic uranium recovery operations are completed in a mine unit, ground water restoration activities will commence.

The primary goal of ground water restoration will be to return the ground water within the production zone to its pre-mining average water quality, based on production zone average concentrations using best practicable technology (BPT). Should this primary goal not be attainable, a secondary restoration goal will be to restore all affected ground waters to at least the pre-mining class of use (Chancellor and Beach, 1997).

Prior to production activities, baseline water quality for the mineralized production zone monitor wells (MP-wells) and the perimeter production zone monitor wells (M-wells) will be determined as described in Section 3.3.4 of Chapter 3. These baseline averages will be utilized to determine the pre-mining Class of Use, Upper Control Limits (UCL's) and Restoration Target Values (RTV's).

6.1.2 Ground Water Restoration Methodology

6.1.2.1 General

The ISL process is essentially a continuous process from the installation of the wells through the restoration of the affected ground water. At some point in the ISL process, the uranium concentration in the lixiviant from a mine unit falls below the point of further economic extraction. Once this economic recovery has been reached, the mine unit is considered to be in the ground water restoration phase, rather than in the mining phase.

As many as four phases of ground water restoration may be necessary to return the quality of water to as near pre-operational conditions as practicable utilizing BPT, including:

1. Ground Water Sweep;
2. Ground Water Treatment and Re-injection to reduce TDS;
3. Chemical Reductant Treatment; and
4. Chemical Treatment for pH.

During operations and ground water restoration, all waste water will be treated at the Carol Shop facility.

6.1.2.2 Criteria for Determination of Completion of Economic Recovery Operations

A decision to stop injection and production from an area will be based upon consideration of several factors, both technical and economic. Technical factors include the percentage recovery of estimated ore reserves, the uranium concentration of the production fluid and the flow rate. From past experience, the typical average values for these thresholds will be: 80% recovery, 10-25 mg/L uranium concentration, and 5 gpm flow rate, applied on a pattern by pattern basis. Thus a production area of 10 or more patterns feeding a common header house may undergo progressive shut-down over a period of several months.

At ISL operations, annual production targets are set according to corporate financial objectives, the capability of the wellfields to produce uranium, and the price of uranium. If the monthly production rate is being maintained and the annual production target will be reached, then any unused water treatment capacity in the satellite can be filled by continued operation of wellfield patterns which are essentially depleted but will continue to supply a low grade production stream (eg., 20-25 mg/L U_3O_8).

Extended recovery operation of marginal, low grade patterns for periods of 3 to 12 months can have a benefit for subsequent ground water restoration, as more of the dissolved uranium will be removed. Control of the affected ground water in adjacent non-operating patterns is normally achieved via the wellfield production bleed. An additional bleed may be taken if special conditions, such as steep ground water gradients, require such measures.

In summary, the end of the primary economic recovery period for a mine unit, or a portion thereof, will occur when the flow rate and uranium concentration for all producers fall below respective threshold values. As outlined above, it can be advantageous, under certain circumstances, to continue operation of selected patterns for an additional period of time, even at low uranium concentrations. The end of this extended period of economic recovery will be reached when there is no longer sufficient treatment capacity for low concentration solutions in the satellite or the quantity of uranium recovered is insufficient to cover operating costs or any other costs incurred as a consequence of the deferral of ground water restoration.

6.1.2.3 Ground Water Restoration Strategy

Once the economic recovery limit of a mine unit has been reached, a strategy for restoring the ground water in the most efficient manner will be derived from an analysis of the following wellfield characteristics:

1. The volume, distribution and solute concentration of the affected ground water as determined by sampling a number of injection and production wells to provide data for the development of iso-concentration maps of those solutes most commonly found to be elevated after ISL (uranium, chloride, bicarbonate, conductivity, and sulfate). These maps and modeling, which are based upon actual production history data, will be used to estimate flare volumes and calculate the number of pore-volume (PV) displacements of ground water required to achieve the RTV's. The PV displacement numbers may vary between pattern groups depending upon their operating history and flare volume;

2. The hydrologic characteristics of the aquifer, including thickness, average length of well screen, ground water gradient, porosity and permeability which will be used to estimate the time required to remove the estimated number of PV displacements and any special action necessary to control local abnormal ground water gradients;

3. The stratigraphy of the aquifer and the positioning of screened intervals;

4. The general pattern geometry, because the utilization of pattern wells during ground water restoration is different than the production phase. Pumping and injection wells are selected for treatment of the entire volume of affected ground water and the varying concentration of solutes rather than systematic extraction of uranium from each pattern. The number of wells in use at any time is usually only a small proportion of the total number of wells available, and they must be chosen to balance flows and prevent affected ground water volumes from being moved away from existing pattern areas;

5. The location of any zones of previously affected or naturally degraded ground water outside of the wellfield monitor well ring so that ground water restoration activities can be designed to avoid drawing such water towards or into the wellfield pattern area; and

6. Other operational factors, such as pipeline availability and waste water treatment and disposal capacity which will dictate the maximum bleed volume from the wellfield and its seasonal variation .

Subsequent sections describe the five major phases of ground water restoration.

6 1.2.4 Ground Water Sweep (GWS)

The objective of this procedure is to pull back the edge of the affected water volume to the proximity of the peripheral wells in each pattern group. GWS creates a cone of depression which pulls in affected water and helps to ensure that the re-injection of treated water can begin without the risk of pushing affected water away from the patterns. Various steps and/or considerations during GWS include:

1. Selection of the number, location and operating time of the existing pattern wells to be used for GWS. The chosen wells will have screens positioned across the optimum stratigraphic interval within the aquifer for effective sweep. They will also have surface locations which will allow balanced pumping to prevent lateral drift of affected ground water volumes away from pattern areas and limit the incursion of any affected water that may lie outside the monitor well ring. Preference will also be given to wells located in zones with the highest concentration of dissolved solids (TDS);

2. Estimation of the quantity of water to be treated and disposed of, the quantity of TDS to be removed and the amount of waste generated. Migration of TDS towards the GWS pumping wells is assumed to occur by advective flow, although continuing interaction between the formation and the ground water may slowly change the pH and eH and may assist with TDS reduction through precipitation;

3. Identification of sites where the edge of the affected water volume may have already moved back close to or within the limits of some of the pattern wells and where the GWS stage can be shortened or the re-injection of treated water can begin immediately;

4. Identification of sites where it is suspected that volumes of affected ground water have already migrated a significant distance beyond the peripheral pattern wells, and retrieval of this water from existing pattern wells by GWS will involve pumping for an excessive period of time, possibly several years. In this situation, it may be more cost effective and desirable for ground water conservation to install a limited number of new wells solely for ground water restoration

purposes. These wells may be operated as GWS pumping wells or used immediately for ground water treatment and re-injection; and

5. Operation of the GWS pumping wells. The time taken to complete this phase for any particular section of a mine unit may last from 6 months to 2 years. A large proportion of the wellfield bleed volume may be applied to a single group of patterns while the remaining bleed capacity is distributed throughout the remainder of the wellfield to control migration of affected water volumes. In this way, GWS can be accelerated for that pattern group so that ground water treatment and re-injection can begin sooner. Groups of wellfield patterns undergoing GWS can then be operated simultaneously with other sections of the wellfield undergoing injection of treated water as restoration is advanced progressively around the mine unit, pattern group by pattern group. It is also likely that restoration of the earliest producing pattern groups in a mine unit may begin while pattern groups developed later are still in production. The advantages of such concurrent restoration is that the reverse osmosis (RO) permeate stream generated during treatment of production purge water can be utilized for re-injection as part of the restoration activities.

Completion of the GWS phase for any group of patterns will be determined by the reduction in concentration to the specified threshold values of selected water quality parameters at peripheral pattern wells. Chloride has historically been the most useful parameter for this purpose. At other ISL restoration projects, a reliable threshold concentration of 1/15 of the post-mining, pre-restoration value, typically in the range of 10-20 mg/l, has been applied It is anticipated that these ranges of values will be applicable for the Gas Hills Project. Residual volumes of affected water just beyond the peripheral pattern wells will be captured by setting the pumps in these wells during continuing restoration activities. The water withdrawn during the GWS phase will be treated by RO. The permeate will be reinjected and the brine concentrate will be sent to the evaporation ponds.

6.1.2.5 Ground Water Treatment and Re-injection

The second major phase in the ground water restoration process will be injection of treated water (RO permeate). Re-injection of treated water conserves ground water resources by helping to reduce the number of PV's of ground water to be treated and disposed of on the surface via evaporation ponds. The re-injection water is normally generated using the permeate stream from an RO water treatment unit. The combination of injection pressure and extremely clean water greatly improves the efficiency of ground water restoration by increasing flow rates and diluting the

dissolved solids rather than relying entirely on advective flow. Various steps and/or considerations during ground water treatment and re-injection will include:

1. Determination of the optimum configuration of injection and production wells required to utilize the available RO capacity and to systematically circulate permeate through the aquifer within the patterns Such well configurations may involve combinations of more than one mining pattern into larger arrays ("megapatterns") which require fewer header fittings and thus can be more easily moved as the treatment zone is advanced through the wellfield. Wells within the megapatterns are typically used for injection, with the production wells located on the periphery. Another advantage of this method is that any internal megapattern wells not used for injection can be used for sampling to monitor restoration progress;

2. Possible adjustment of pH of the permeate injection stream to a value approximating local native ground water by the addition of a chemical such as sodium hydroxide. The small quantities of sodium injected will be more than offset by the precipitation in the formation of dissolved iron and other metals at higher pH's;

3. Operation of the RO permeate injection system, typically for periods of 2 to 6 months in each megapattern or well group configuration, depending upon its displacement pore volume and the climatic season during which it is operated. It is generally more effective to direct the permeate injection stream to a limited number of megapatterns at one time to accelerate restoration there before moving to the next megapattern. In this way the restoration process can be advanced progressively around the wellfield and operate simultaneously with other phases of the restoration activities; and

4. Completion of the RO permeate injection phase in each megapattern is determined by the reduction in concentration of selected water quality parameters to their final restoration goal values. Once again, chloride concentration is typically a good indication of the effectiveness of the formation sweep. The reduction in concentration of bicarbonate and sulfate may be temporarily affected by re-solution and precipitation reactions caused by changing pH and eH values. A period of time may be required for these naturally occurring parameters to re-equilibrate with the formation The uranium concentration may be reduced to a low level (eg., 2-3 mg/l) but not completely eliminated until a chemical reductant is added to the injection stream.

6.1.2.6 Chemical Reductant and/or Oxygen Scavenger

The third major phase of ground water restoration will be addition of a chemical reductant or oxygen scavenger to the RO permeate injection stream. Typical reducing agents may include sodium sulfide, hydrogen sulfide gas, catalyst systems, and/or sodium bisulfide. This procedure is usually required to assist with the elimination of residual dissolved uranium in the ground water by re-precipitation in the formation Trace amounts of other dissolved heavy metals, such as iron or manganese, will be similarly reduced. Various steps and/or considerations during this phase of ground water restoration will include:

1. Selection of megapatterns or groups of wells to be used for injection of chemical reductant. The megapatterns will normally be located in areas of the wellfield where the TDS of the ground water has been sufficiently reduced by prior injection of RO permeate to avoid problems associated with well screen plugging due to instantaneous precipitation reactions. Reductant may be added to a megapattern currently undergoing RO permeate injection or to a previously disconnected megapattern array which reached the restoration goal values for major ions before the reductant injection system was available. Safety concerns on the ground surface will also play a role in well selection, as the use of such hazardous substances requires restricted access to that part of the wellfield;

2. Operation of the chemical reductant addition system, which may last from 1 to 3 months for each megapattern group, depending upon its displacement pore volume and the season during which it is operated; and

3. A final brief stage of RO permeate injection may be necessary if the conductivity and TDS concentration of the ground water was elevated during the addition of chemical reductant.

During the restoration process, the volume distribution and solute concentration of the affected ground water will be continuously reviewed on a well by well basis and via iso-concentration maps. Once restoration standards are achieved and WDEQ and NRC approval is received, active restoration will cease.

6.1.2.7 Chemical Addition for pH Adjustment

Adjustment of pH may assist in immobilizing certain parameters, particularly metals. Sodium hydroxide is a commercially available chemical which is commonly used for pH adjustment, although other pH adjusting chemicals may be used. This step may

be combined with ground water treatment and re-injection or as the final stage of injection.

6.1.3 Quantity of Ground Water Requiring Treatment During Ground Water Restoration

The volume of ground water within a mine unit which must be restored is in large part a function of the operating history of the mine unit. The critical parameters which affect this volume are the percentage of bleed taken during operations, the wellfield balance, the pattern configuration, well screen lengths, and the aquifer hydrologic conditions. For each mine unit, these volumes have been modeled and the results presented in Sections 3.4.3 and 3.4.4 of Chapter 3.

Based upon the flowpath modeling for each mine unit, the total contacted volume of affected ground water has been calculated for Mine Unit No. 1 through No. 4. The estimated total contacted volume includes the volume of ground water directly under the pattern areas as well as the affected ground water from flowpaths which are outside of the pattern areas, (ie., the "flare").

The PATH v.5 model was utilized to estimate the volume of ground water which must be recovered during GWS to recapture all of the flowpaths which are outside of the pattern area This model simulated 20 patterns in each mine unit, and the total ground water volumes were then calculated by increasing the volumes to reflect the estimated actual number of patterns in each mine unit.

This volume of ground water, the "Contacted Volume Outside of the Pattern Area", is presented for each mine unit on Table 6-1. The volume of ground water which must be recovered by GWS to recapture these flowpaths which are external to the pattern areas is the "Required GWS Volume" on Table 6-1. At the conclusion of GWS, all external flowpaths have been recaptured and the remaining volume of affected ground water is essentially within the area of the patterns.

At the conclusion of GWS, the affected ground water volume will have been returned to the area of the patterns, and the remaining water will be restored by treatment and re-injection. Based upon the estimated lixiviant composition, baseline ground water quality, and RO permeate water quality, the volume of RO treatment to restore the area under the patterns has been estimated. A mixing model was used where the water quality at the end of each pore volume of circulated permeate was estimated as the weighted average of the starting water quality and the quality of the water which was added. The results of this model indicate that approximately 3 pore volumes of RO or similar treatment are required to return the affected ground water under the patterns to baseline conditions. This volume is shown on Table 6-1 for each mine unit as the "Required RO Sweep Volume" based upon the estimated actual number of patterns in each mine unit.

6.1.4 Ground Water Quality During Ground Water Restoration

The rate of improvement in ground water quality during ground water restoration activities is related to the rate of removal of affected ground water during GWS and the effectiveness of the RO during the RO phase of ground water restoration. During GWS, the production wells will be pumped at the highest sustainable yield to draw the affected volume of ground water outside of the pattern area back to the edge of the pattern area. For the ground water restoration program summarized in this application, the ground water quality within the wellfield area during the GWS phase is estimated to remain the same as production fluids, with no credit being taken for dilution by flowpaths which are captured from fresh ground water. This conservatively estimates that the ground water quality does not start improving at the patterns until the RO phase is initiated. Table 6-2 summarizes the estimated ground water quality throughout the ground water sweep and RO phases and compares them to production lixiviant and baseline ground water.

At the start of the RO phase of the ground water restoration program, the quality of the water under the pattern areas is estimated to be that of lixiviant. For each successive pore volume produced, treated, and re-injected, the resulting water quality can be estimated from a mixing model which estimates that the ground water quality at the end of each pore volume is the average of the quality at the beginning of that pore volume and the quality of the purified RO permeate which has been injected. The estimated ground water quality for each pore volume is summarized in Table 6-2, which shows the ground water returned to acceptable quality after 3 pore volumes of RO treatment with re-injection of the permeate.

6.1.5 Ground Water Restoration Schedule

The ground water restoration schedule presented in Figure 1-4 of Chapter 1 includes:

1. The time required to complete the GWS phase (calculated from the required GWS volume and the estimated maximum sustainable yield of the aquifer); and

2. The time required to complete the RO phase of the ground water restoration (calculated from the "Required RO Sweep Volume" and the maximum sustainable yield of the aquifer during re-injection).

6.1.6 Monitoring During Ground Water Restoration

At the start of restoration, the MP-wells which were used for baseline will be sampled and analyzed for the parameters listed in Table 3-5 to characterize an "end of injection" water quality average. Additionally, the MP-wells will be sampled annually and analyzed for the parameters listed in Table 3-5. To track the progress of restoration, the MP-wells will be

sampled and analyzed for at least conductivity, chloride and uranium once every two months during periods of active restoration.

During ground water restoration, lixiviant injection will be discontinued and the quality of the ground water will constantly be improved back to its quality of use. This, together with the fact that during GWS, the cone of depression is significantly increased around the affected wellfields, greatly diminishes the possibility and relative impact of an excursion. M wells, MO wells (overlying aquifer) and MU-wells (underlying aquifer) will be sampled once every two months and analyzed for the excursion parameters. Water levels will be obtained at selected wells each month.

When it has been determined that restoration has been achieved, the M and MP wells will be sampled and analyzed for the parameters listed in Table 3-5 to verify restoration achievement. These data will be submitted to the WDEQ and NRC in a claim of restoration report.

6.1.7 Stability Monitoring after Ground Water Restoration

Following regulatory concurrence that restoration has been achieved in a particular mine unit, an initial six month stability period will take place to ensure that the restoration goal has been achieved. The following restoration stability monitoring program will be performed during the stability period.

1. The M wells will be sampled at the beginning of the stability period and once every two months thereafter. The samples will be analyzed for the UCL parameters.

2. Those MP wells designated as restoration stability monitoring wells will be sampled at the beginning of the stability period and once very two months thereafter. The samples will be analyzed for the UCL parameters and uranium, TDS and any problem parameters that may have been identified during restoration.

3. At the beginning, middle and end of the stability period, the restoration stability monitoring wells will be sampled and analyzed for the parameters listed in Table 3-5.

The end of the six month stability period will serve as a decision point for the WDEQ and NRC. Based on the stability data review, the agencies will determine whether restoration has been successful, more stability sampling is needed, or more active restoration is needed.

6.1.8 Well Plugging after Ground Water Restoration Sign Off

Following regulatory concurrence that ground water restoration has been successful, all wells will be abandoned in accordance with Chapter VIII of the WDEQ/LQD Rules and Regulations (1993) W.S. 35-11-404, WDEQ-WQD Rules and Regulations chapter XI, Section G and Wyoming State Engineer's Office (WSEO) Rules and Regulations Part III, Chapter VI, Section 5. A typical abandonment procedure would include the following:

a. A drill rig will be used for well abandonment to ensure that all wells are properly grouted from bottom to top;

b. Abandonment Fluid to be used will be Plug-Gel, or an equivalent abandonment material;

c. The volume of abandonment fluid needed will be determined based on the depth and diameter of the well and abandonment fluid characteristics which at a minimum will be a ten minute gel strength of at least 20 lbs./100 ft^2 and a filtrate volume not to exceed 13.5 cc;

d. The mixed abandonment fluid will be pumped through the drill pipe into the bottom of the well, filling the well from the bottom to the collar;

e. The well will remain open for at least 24 hours to allow for settling of the abandonment fluid;

f. After the fluid level has stabilized in the casing, the soil around the well collar will be excavated to a minimum depth of three feet;

g. The casing will be cut off at a minimum of three feet beneath the ground surface;

h. The well casing will be topped off with bentonite chips, pellets or similar material until full;

i. A concrete hole plug will be placed in the top of the casing;

j. The hole around the abandoned well will be backfilled to the original surface with the excavated soil material;

k. A written abandonment report will be completed for each abandoned well providing detailed documentation of the abandonment, which will be placed in the individual well file; and

l. An abandonment report will be filed with the WSEO under the appropriate ground water permit number.

In the event that a well has artesian flow, in addition to the above methodology, a concrete or cement plug will be placed at least from ten feet below to ten feet above the artesian aquifer to completely seal off the artesian zone from the well in accordance with Wyoming State Engineer regulations.

6.2. RADIOLOGICAL DECONTAMINATION

Prior to final reclamation, all radiologically contaminated buildings, process vessels and other structures and affected areas will be decontaminated, or, if decontamination is not possible, removed to a disposal facility licensed by the NRC to receive such material. All concrete floor and foundations will be removed or broken up and buried in place.

Chapter 2.9 discusses current baseline radiological conditions in the proposed affected areas. Areas of elevated radiological levels occur along the existing Carol Shop Road, within the existing area near the Carol Shop and in previously mined areas. Specifically, high levels were observed in the Two States/Blackstone Pit area and the Atlas Mine area. Mine disturbances in these areas are included in the State of Wyoming Abandoned Mine Lands (AML) Program. The Atlas mine is a former AML project site which was partially reclaimed and the Two States is a 1998 AML project.

10CFR40, Appendix A, Criterion 6(6) require site clean-up to no more than baseline plus 5 pci/gm radium-226 in the upper 15 cm and no more than baseline plus 15 pci/gm from 15 to 30 cm. In undisturbed portions of Mine Units No. 1 through No. 4, the evaporation pond area, and the satellite areas, baseline radium-226 concentrations are approximately 2 pci/gm from 0 - 15 and 15 - 30 cm, and the resulting clean-up criteria for these areas would be approximately 7 pci/gm from 0 - 15 cm, and 17 pci/gm from 15 - 30 cm. The baseline conditions at the Carol Shop Facility exceed 20 pci/gm, resulting in clean-up criteria of approximately 27 pci/gm from 0 - 15 cm, and 42 pci/gm from 15 - 30 cm. Similarly the Carol Shop Road is estimated to average 13 pci/gm radium-226 along the approximate 27,000 feet of the road which crosses the Amendment Area. Thus, the clean-up criteria for the Carol Shop Road would average 20 pci/gm from 0-15 cm and 30 pci/gm from 15 - 30 cm If disturbance and subsequent clean-up were required in areas of elevated radiological levels related to past mining, as documented in Chapter 2.9, clean-up criteria would be similarly based on current baseline conditions.

Radiological surveys and sampling programs will be conducted following site clean-up to verify that affected areas resulting from the proposed operations meet decommissioning criteria. This data will be compared to existing condition data as presented in Chapter 2.9.

6.3 FACILITY DECOMMISSIONING

6.3.1 General Requirements

The facilities which will require decommissioning include:

1. Buildings and structures including the Carol Shop facility, header houses, pump stations, and the additional satellite;

2. Process and water treatment facilities housed within these structures including all tanks, piping (above ground), pumps and related equipment;

3. Buried piping including all wellfield piping within and between mine units and process and water treatment facilities, and piping between the Carol Shop facility and the evaporation ponds; and

4. Evaporation ponds.

In all cases, it will be the goal of surface reclamation to return the disturbed sites to as close to their original condition and land use as possible by grading the sites to approximate the original contours, replacing all salvaged topsoil, and revegetating the sites with a native seed mixture.

6.3.2 Buildings and Structures

Prior to demolition of the buildings and structures, all equipment will be removed. Any contaminated materials will be decontaminated or removed for disposal at an NRC licensed facility. Buildings and structures will then be dismantled and removed from the site either for disposal at an appropriately licensed solid waste facility or salvaged. The remaining concrete floors will then be ripped and/or blasted to break up the concrete. The broken concrete will then be covered with overburden and topsoil.

6.3.2.1 Carol Shop Facility

The reclamation of the existing Carol Shop is currently bonded under WDEQ Mine Permit No. 438. Upon approval of the proposed Gas Hills WDEQ ISL permit and the NRC Amendment Application, this bond will be transferred to the Gas Hills Project. Surety arrangements are discussed in Section 6.5 of this chapter.

6.3.2.2 Header Houses and Pump Stations

The header houses and pump stations for Mine Unit No. 1 will disturb an estimated 12.5 acres from which an estimated 30,100 cubic yards of topsoil will be salvaged

(Table 3-11). This will provide a 1.5 foot average depth of topsoil placement over the disturbed areas related to the header houses.

6.3.2.3 Satellite Facility

The satellite facility will disturb approximately 2 acres of the Coalmont-Milren-Cragosen soil series with an average suitable depth of 1.4 feet. This will provide approximately 4,500 cubic yards of topsoil for placement over the site to return it to its approximate original contours during reclamation.

6.3.3 Process Equipment

All process and water treatment related equipment including tanks, filters, ion exchange columns, pumps and internal piping will be dismantled. Contaminated materials will be disposed of at an NRC licensed facility. Non contaminated material will be disposed of at an appropriately licensed facility and/or removed for salvage.

6.3.4 Buried Piping

Buried piping will be removed. Contaminated materials will be disposed at an NRC licensed facility. Non contaminated materials will be disposed at an appropriately licensed facility and/or removed for salvage. Removal of piping related to Mine Unit No. 1 will re-disturb approximately five acres which will then be reclaimed and revegetated.

6.3.5 Evaporation Ponds

Upon completion of use, and evaporation of excess liquid, the solid waste contained in the evaporation ponds will be disposed of at an NRC licensed disposal facility. The primary liner will then be removed and disposed of at an NRC licensed facility. The underlying leak detection system and secondary liner will be surveyed and tested for contamination. Any portion of the leak detection system, secondary liner, and/or underlying materials which do not meet NRC decommissioning criteria will be excavated and removed for disposal at an NRC licensed facility. Portions of the leak detection system which meet NRC criteria will be covered and reclaimed in place. Any uncontaminated solid waste material which may be detrimental to the site reclamation will be removed and disposed of at an appropriately licensed facility.

Following clean up of the site and removal of contaminated materials, the evaporation ponds will be graded to approximate original contours. Grading will include the replacement of approximately 56,400 cubic yards of material excavated during the construction of the evaporation ponds. Topsoil will then be replaced and the area revegetated as described in Section 6.4 of this chapter. Based on the estimated topsoil volume salvaged from the evaporation ponds area (Table 3-11) an estimated 8,400 cubic yards of topsoil will be

available for reclamation of Evaporation Ponds 1 and 2. Over the estimated 4.4 acres of disturbance the available topsoil volume equates to an average depth of topsoil placement of approximately 1.2 feet.

6.3.6 Roads

Those portions of roads utilized for access to the site, facilities and Mine Unit No.1 including the AML Road, the Carol Shop Road, and constructed access roads will be reclaimed unless landowners and lessees request that the roads be left for future access and accept the responsibility for their long term maintenance and ultimate reclamation.

Prior to reclamation, all roads will be surveyed for radiological contamination in excess of radiological levels documented as pre-existing baseline conditions (Section 2.9). Any contamination which resulted from the ISL operation will be cleaned up to appropriate NRC standards and the contaminated material disposed of at an NRC licensed facility.

Following clean up, the roads will be ripped and/or disced to relieve compaction. Excess imported gravel will be removed. Culverts will be removed and pre-existing drainages reestablished.

Topsoil is available for the portion of the Carol Shop Road within WDEQ Mine Permit No.438 (Refer to Plate 2-4E) but was not salvaged from the remaining portions of the Carol Shop Road. Topsoil was salvaged from the AML Road and will be salvaged from all newly constructed access roads. Available topsoil will be replaced in a uniform manner prior to revegetation. For that portion of the Carol Shop Road without salvaged topsoil available, suitable plant growth material which may have been bladed off the road will be replaced prior to revegetation.

6.4 RECLAMATION AND REVEGETATION

Surface reclamation areas for Mine Unit No.1 are designated on Plate 6-1. The wellfield pattern areas, access roads, header houses, and related facilities will be reclaimed at the completion of restoration of Mine Unit No. 1 with the exception of access roads and utility corridors required for the operation of Mine Unit No. 3. Wellfields will be reclaimed as soon as practical after ground water restoration is complete. Wells will be plugged and all surface structures and power lines removed.

Reclamation and fencing details and specifications are provided on Plate 6-2.

6.4.1 Seed Bed Preparation

Areas which have been compacted will be scarified, ripped, and/or disced as necessary to relieve compaction and prepare the subgrade for topsoil placement. Where needed, the

surface will be graded and contoured to approximate original contours and to blend with the surrounding topography. In areas that were stripped of topsoil, the salvaged topsoil will be re-applied in accordance with Section 6.4.2. As required, the replaced topsoil will be disced to create a proper seed bed. Seed bed preparation will only be performed under appropriate soil and climatic conditions.

6.4.2 Topsoil Placement

Topsoil will be placed in a single lift to avoid compaction. On slopes of 4:1 (horizontal to vertical) or steeper, topsoil will be placed along the contour. Topsoil will not be placed under conditions of wet or frozen ground which would cause excessive clod or frost chunks to form. Topsoil thicknesses will generally be uniform and reflect the approximate thicknesses of topsoil originally available at the locality being reclaimed. All salvaged topsoil will be utilized for reclamation purposes

6.4.3 Seed Mix

The permanent seed mix proposed for revegetation is provided in Table 6-3.

The proposed seed mix is comparable to what has been used on other reclamation projects in the area and will be adequate to reestablish a vegetative cover that will be consistent with the pre-ISL land use of livestock grazing and wildlife habitat.

6.4.4 Revegetation

The primary method of revegetation will be pitting and seeding. Pitting and seeding will be performed only under appropriate climatic and soil conditions. Generally, seeding will be completed only during spring or fall seeding windows. Pitting and seeding will be completed as a continuous operation On sloped terrain, pitting and seeding will be completed along the contour. On flat terrain, pitting and seeding will be completed perpendicular to the prevailing wind direction.

In limited areas, such as incised drainage channels, where pitting and seeding would potentially interrupt surface water flow, and in slope areas steeper than 3:1 (horizontal to vertical) broadcast seeding will be utilized. For those areas that are to be broadcast seeded, the seed will be distributed uniformly over the area utilizing a mechanical seeding device or spreader. Seeded areas will be raked or dragged immediately after seeding to cover the seed with approximately one-quarter inch of soil. Raking or dragging will be performed along the contour.

The seeding rates for either broadcast or pit and seed methods will be the same as specified in Table 6-3. Refer to Plate 6-2 for further pit and seed details and specifications.

6.4.5 Vegetative Success Criteria

The success of revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986) and Chapter III of the WDEQ-LQD Rules and Regulations. This method compares, on a statistical basis, the reclaimed area (percent vegetation cover, percent total ground cover, and total herbaceous production) with adjacent undisturbed areas of similar vegetation type (Refer to Appendix D8).

Appendix D8 and Plates D8-1E and D8-1W describe and illustrate the proposed extended reference areas. These areas were selected in coordination with WDEQ personnel (Refer to correspondence Addendum D8-1 of Appendix D8). Appendix D8 also provides baseline cover and productivity data for the proposed mine units and the extended reference areas.

Revegetation will be considered successful when such surveys, completed following reclamation, demonstrate equal or greater vegetative cover and productivity in the reclaimed areas when compared to the extended reference areas.

As discussed in Appendix D8, the number of trees is very limited within the Amendment Area and consists of a small group of cottonwoods (Populus angustifolia) along the upper portion of West Canyon Creek and scattered junipers (Juniperus scopulorum) and Limber Pines (Pinus flexilis) on ridges, hilltops and in steep draws. Because of the limited surface disturbance associated with the ISL technique, it is not anticipated that the proposed activities will adversely affect any trees. However, in the unlikely event that any trees are removed, they will be replaced.

6.4.6 Fencing

All fencing installed will be of a temporary nature to protect the wellfield areas during operations and to protect vegetated areas following reclamation. Fence design and specifications shown on Plate 6-2 follow BLM specifications as they are the dominant land owner within the Amendment Area. Upon demonstration of vegetative success and bond release, the temporary fencing will be removed.

6.5 SURETY ARRANGEMENTS

6.5.1 General

PRI will establish and maintain appropriate surety arrangements with the WDEQ covering the costs of ground water restoration, facility decommissioning and surface reclamation for the areas and facilities involved. This surety will be reviewed on an annual basis and adjusted as

appropriate to reflect changes in the project to adequately cover restoration, decommissioning and/or reclamation requirements.

6.5.2 Reclamation Cost Estimate Assumptions

The reclamation cost estimate calculations rely, to the extent possible, on actual operating cost data and WDEQ-LQD Guideline No. 12 (dated January 17, 1996). The primary unit cost elements used in the estimate are given in the following sections. The costs are all given in 1997 dollars.

6.5.2.1 Existing Facilities Permit to Mine 438

All existing disturbances related to the Carol Shop area including buildings, surface disturbance, and haul roads within existing WDEQ Permit to Mine No.438 are currently bonded for reclamation. Table 6-4 summarizes these remaining work and cost items.

PRI proposes to transfer these costs from the WDEQ Permit to Mine No.438 to the proposed Gas Hills Project bond upon approval. These costs are shown as a line item in the reclamation cost estimate presented in Table 6-5.

Contingencies included in the WDEQ Permit to Mine No.438 bond are included in the total cost in accordance with WDEQ-LQD Guideline 12. Cost items which will remain bonded under WDEQ Permit to Mine No.438 would include the reclaimed lands retainer for 457 acres at $200/acre ($91,400) and a lump sum amount for rip rap structures ($50,000) for a total of $141,400.00. This work has been completed and bond release requested for a substantial portion of the costs.

Decommissioning costs for facilities to be installed within the existing Carol Shop are itemized on Table 6-5.

6.5.2.2 Ground Water Restoration

The ground water restoration cost estimate is based upon the volumes of affected ground water for Mine Unit No. 1 for the first year of operation. These ground water volumes are based on the number of planned patterns to be installed, which will have had lixiviant injected into them, and the estimated ground water restoration volumes based on flow models presented in Chapter 3 and summarized on Table 6-1. The unit costs for water treatment and disposal have been calculated from existing operations. Reverse osmosis treatment costs are based on 1997 actual operating costs and verified by Hydranautics RO System Design Software, version 6.0 (1995), and are as follows:

Electricity	$0.17/1000 gallons
Chemical	$0.26/1000 gallons
Membrane Replacement	$0.15/1000 gallons
Maintenance	$0.26/1000 gallons
Labor	$0.76/1000 gallons
Pumping From Wellfield	$0.37/1000 gallons
TOTAL RO COSTS	$1.97/1000 gallons

These costs are based on a membrane life of 4 years, cost of $695/element, no salvage value for the RO at completion of the project, and electricity costs of $0.03/kWh. These costs do not include the cost of the expansion of the evaporation ponds for the RO reject which is included separately in the cost estimate.

Chemical Reductant Costs - Chemical reductant cost is based on introduction of reductant to the pattern area at a concentration of 400 ppm H_2S, with total H_2S costs of $0.353/lb, for cost per pattern of $245.

6.5.2.3 Labor

Labor costs, including benefits and payroll taxes, are PRI 1997 actual costs, as follows:

General Labor - $14.00 per hour, or $112 per 8 hour day
Plant Operators - $28 k per year
Environmental Technicians - $28 k per year
Environmental Manager/RSO - $60 k per year

The labor costs include 7 operators, which provides for round the clock coverage with one operator (total of 4 of the 7 operators), two additional day operators (for a total of three operators on day shift, Monday through Friday), and one replacement operator to cover vacation, holiday, and sick leave. In addition, there is one project manager/RSO and two environmental technicians for sampling and operations support. These labor costs for the seven operators, the two technicians, and the manager total $312 K annually. These costs are fully contained within the RO operating costs as $0.76 per 1000 gallons, and are provided separately for Year 5 when ground water restoration is complete. The general labor costs are included as separate line items where appropriate.

6.5.2.4 Demolition, Well Plugging and Disposal Costs

Building Demolition and Disposal - WDEQ-LQD Guideline No. 12, Appendix K is used for building demolition and disposal costs.

Electric Utilities Removal - WDEQ-LQD Guideline No. 12, Appendix H, transmission and utility lines removed at no credit for salvage value.

Piping Disposal Costs - Assumes that all piping except the 14 inch polyethylene piping is contaminated and will be disposed of at an NRC licensed facility. The 14 inch piping is cleaned and shredded and disposed of at a landfill. All other piping disposal costs include the labor to remove, shred and dispose of the shredded pipe at an NRC licensed facility. The volumes of shredded pipe are based on the following:

Process Facility - Most pipe is PVC with an average diameter of 3 inches. Therefore, the O.D. = 3.5 inches, I.D. = 3.068 inches. Given a 10% void factor there is .018 ft^3 of shredded PVC pipe per foot of pipe.

Wellfields - Most pipe is HDPE with an average diameter of 5 inches. Therefore, the O.D. = 5.563 inches, I.D. = 4.551 inches. Given a 10% void factor there is .06 ft^3 of shredded HDPE pipe per foot of pipe.

14 inch pipe - With a O.D. of 14 inches and I.D. of 11.46 inches, the volume per foot is 0.353 ft^3 of shredded pipe per foot of pipe.

Contaminated Tanks - Tanks will be removed, cut up into pieces, and disposed of at an NRC licensed facility. The number and dimensions (width x length x wall thickness) of each fiberglass and steel tank are listed for the Satellite. The total volume of tank material from each site is based on the volume of tank material, including a 10% void space to account for the cut-up volume.

Well Plugging - Based on PRI operating experience, the cost estimate includes disposal of wellhead piping and covers at $195 per well in this estimate. The actual number of planned wells installed has been used in this estimate.

Byproduct Waste and Contaminated Equipment Disposal - Actual 1997 PRI costs based on transportation to and disposal at an NRC licensed disposal facility. These actual costs, which include the profit of the transporter and disposal facility, are as follows:

Type of Waste Disposal	$/yd³ Transportation	$/yd³ Transportation	Total, Transport $/yd³	Total, $/ft³
Sludges, By Product	$425	$44	$469	$17.37
Soil, Concrete	$141	$44	$185	$6.85

6.2.5 Revegetation Costs Estimates

Revegetation cost estimates included ripping and/or scarifying, discing, pitting and seeding. An all inclusive cost of $500.00 per acre has been assumed for all surface revegetation. This assumption is conservative based on WDEQ-LQD Guideline 12 which shows scarification costs at $60.00 per acre, and current contracted costs for discing and seeding at $150.00 per acre.

6.2.6 Monitoring Costs

Based on actual PRI costs for electricity and contract laboratory analysis.

6.2.7 Salvage Value

No salvage value is taken for buildings, process equipment, switchgear, utilities, electrical equipment, motors, rolling stock, or other uncontaminated facilities although these items have significant salvage value.

6.2.8 Contingency and Overhead

Based on WDEQ-LQD Guideline No. 12.

The reclamation cost estimate is attached as Table 6-5.

REFERENCES

Chancellor, Richard and Gary Beach, WDEQ, Letter to Wyoming Mining Association Re: Ground Water Classification at In situ Uranium Mines, June 17, 1997.

Buss Reclamation Plan, Permit to Mine 438-A2, November, 1993.

Wyoming Department of Environmental Quality, Land Quality Division, Guideline 12, 1996.

TABLE 6-1

GROUND WATER RESTORATION VOLUMES
GAS HILLS PROJECT

	MINE UNITS			
	No. 1	No. 2	No. 3	No. 4
SIMULATION RESULTS				
Number of Patterns	20	20	20	20
Total Contacted Volume (Mgal)	12.0	9.4	9.9	8.6
Required GWS Volume (Mgal)	12.96	9.44	10.38	11.53
Required RO Sweep Volume (Mgal)	15.5	15.5	15.5	15.5
ESTIMATED ACTUAL				
Number of Patterns	300	624	300	372
Total Contacted Volume (Mgal)	180.0	293.3	148.5	160.0
Required GWS Volume (Mgal)	194.4	294.5	155.7	214.5
Required RO Sweep Volume (Mgal)	232.5	483.6	232.5	288.3

Mgal = million gallons
GWS = Ground Water Sweep Phase
RO Sweep = Reverse Osmosis and Reinjection Phase

TABLE 6-2

ESTIMATED WATER QUALITY DURING RESTORATION
GAS HILLS PROJECT

	Production	Ground Water (baseline)	RO Permeate	GWS	RO PV #1	RO PV#2	RO PV #3
Ca	200	67	6	200	106	59	35
Mg	78	13	2	78	41	22	13
Na	400	120	96	400	248	173	135
K	34	14	10	34	22	16	13
NH4	0	0.1	0.1	0	0.1	0.1	0.1
Ba	0	0	0	0	0	0	0
Sr	0	0	0	0	0	0	0
CO3	0.2	0	0	0.2	0.1	0.1	0
HCO3	725	251	31	725	378	205	118
SO4	800	265	14	800	407	210	112
Cl	220	12	144	220	182	163	154
F	0.6	0.8	0.1	0.6	0.4	0.2	0.2
NO3	0	0	0	0	0	0	0
SiO2	16	24	7	16	12	10	8
TDS	2474	630	310	2474	1392	851	580
pH	7.0	8.0	6	7.0	6.3	6.1	6.1

Units in mg/l except pH in standard units
GWS = Quality of water drawn in during Ground Water Sweep Phase
RO = Reverse Osmosis Phase
PV = Pore Volume

TABLE 6-3

PERMANENT SEED MIXTURE

COMMON NAME	SCIENTIFIC NAME	VARIETY	LBS. PLS
Western Wheatgrass	(Agropyron smithii)	Rosana	5.00
Thickspike Wheatgrass	(Agropyron dasystacum)	Critana	5.00
Slender Wheatgrass	(Agropyron trachycaulum)	Pryor	5.00
Ricegrass	(Oryzopsis hymenoides)	Nespar	2.00
Green Needlegrass	(Stipa viridula)	Lodorm	2.00
Gardner Saltbush	(Atriplex gardneri)		0.75
Cicer Milkvetch	(Astragalus cicer)	Lutana	0.50
Yellow Sweetclover	(Melilotus officinalis)		0.50
Shadscale Saltbush	(Atriplex confertifolia)		0.50
TOTAL POUNDS PLS			21.25

The seeding rates stated are for Pure Live Seed (PLS). Percent PLS is the total of multiplying germination plus dormant or hard seed times the percent purity.

If any of the above seed is unavailable or prohibitive in cost at the time of seeding, reasonable substitutions may be made, with prior approval of WDEQ-LQD and BLM.

If more locally adapted varieties of certified seed become available, they may be substituted with prior approval of WDEQ-LQD and BLM.

TABLE 6-4

PERMIT TO MINE 438
REMAINING WORK/COST SUMMARY

RECLAMATION TASKS REMAINING	COST
TREE PLANTING AND ESTABLISHMENT (39 TREES @ $100 EA)	$3,900
CAROL SHOP AREA	
- SHOP DEMOLITION	
- - large truck shop (70'W x 400'L x 40'H @ $0.15/ft^3)	168,000
- - small truck shop (35'W x 200'L x 30'H @ $0.15/ft^3)	31,500
- - warehouse section (35'W x 200'L x 20'H @ $0.15/ft^3)	21,000
- - concrete floor demo (140'W x 200'L x 0.5'H @ $0.19/ft^3)	2,660
- TIRE SHOP DEMOLITION	
- - building removal (30'W x 30'L x 15'H @ $0.15/ft^3)	2,025
- - concrete floor demo (30'W x 30'L x 0.5'H @ $0.19/ft^3)	86
- CHANGE HOUSE DEMOLITION	
- - building removal (25'W x 40'L x 12'H @ $0.15/ft^3)	1,800
- - concrete floor demo (25'W x 40'L x 0.5'H @ $0.19/ft^3)	95
- UTILITY BUILDING DEMOLITION	
- - building removal (12'W x 12'L x 10'H @ $0.15/ft^3)	216
- - concrete floor demo (12'W x 12'L x 0.5'H @ $0.19/ft^3)	14
- BURY CONCRETE (4 acres x 4' = 25,600 yd^3 @ $0.80/yd^3)	20,480
- SCARIFY/RECONTOUR (21 acres @ $60/acre)	1,260
- TOPSOIL (16,941 yd^3 @ $0.80/yd^3)	13,553
- REVEGETATION (21 acres @ $172/acre)	3,612
HAUL ROAD	
- SCARIFY/RECONTOUR (7.1 acres @ $60/acre)	426
- TOPSOIL (5,728 yd^3 @ $0.80/yd^3)	4,582
- REVEGETATION (7.1 acres @ $172 acre)	1,221
TOTAL	$276,430

TABLE 6-5

RECLAMATION COST ESTIMATE

							TOTAL COSTS
1.	**TRANSFER OF 438 BOND FOR EXISTING DISTURBANCES AND FACILITIES**						**$276,430.00**
2.	**BUILDINGS AND STRUCTURES**						**$105,236.00**
	2.1	MINE UNIT NO. 1 BUILDINGS					
		BUILDING DEMOLITION					
			Ft^3	$\$/Ft^3$		$/Total	
		Remote Satellite	320,000	0.173		55,360.00	
		IC Pump Station	6,912	0.173		1,196.00	
		CONCRETE DEMOLITION					
			Ft^2	$\$/Ft^2$		$/Total	
		Remote Satellite	12,800	3,030		38,784.00	
		IC Pump Station	576	3,030		1,745.00	
		CONCRETE DISPOSAL - ONSITE					
			Yd^3	$\$/Yd^3$		$/Total	
		Total Volume	248	4,970		1,231.00	
	2.2	MINE UNIT NO. 1 HEADERHOUSES					
		No.	Ft^3/House	$\$/Ft^3$		$/Total	
		25	1,600	0.173		6,920.00	
3.	**TANKAGE, EQUIPMENT AND PIPING**						**$48,694.00**
	3.1	PROCESS FACILITY EQUIPMENT					
			Number	Ft^3/each	Ft^3/Total	$/Total	
		IX Cols	10	51.1	511		
		RSV	2	21.6	43		
		Guard IX	1	21.6	22		
		T-400/407	3	34.6	104		
		T-406	3	18.3	55		
		Filters	4	51.1	204		

TABLE 6-5 (cont'd)
RECLAMATION COST ESTIMATES

		RO Units	4	57.6	230		
		Pumps	12	4.9	59		
		Piping, ft	2,000	0.018	36		
		Total Volume			1,264		
		Total Volume Ft^3 110% of Total Volume			1,391		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				24,153.00	
			No. Tanks	Man Days/Tank	$/Man Day	$/Total	
		Labor	23	3	112.00	7,728.00	
			Days	$/Days		$/Total	
		Equipment Rental (3 man crew)	23	336.00		7,728.00	
	3.2	PROCESS FACILITY PIPING					
			Feet	Ft^3/Ft	$Ft^3/Total$	$/Total	
		Piping, Ft	8,000	0.018	144		
		Total Volume Ft^3 110% of Total Volume			158.4		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				2,751.00	
			Feet	Man Day @ 500'/day	$/Man Day	$/Total	
		Labor	8,000	16	112.00	1,792.00	
			Days	$/Days		$/Total	
		Equipment Rental (3 man crew)	5.33	336.00		1,792.00	
	3.3	Booster Station No. 1					
			Number	$Ft^3/Each$	$Ft^3/Total$	$/Total	
		Pumps	3	4.9	15		
		Piping/Ft	75	0.55	41.25		

TABLE 6-5 (cont'd)
RECLAMATION COST ESTIMATES

		Total Volume Ft^3 110% of Total Volume			61.55		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				1,069.00	
			Number	Man Days	$/Man Day	$/Total	
		Labor	2	3	112.00	672.00	
			Days	Days/$		$/Total	
		Equipment Rental (3 man crew)	3	336.00		1,008.00	
4.	**BURIED PIPING - MINE UNIT NO. 1**						**$598,049.00**
	4.1	PATTERN PIPING					
			Ft/Pattern	Ft^3/Ft	Ft^3/Total	$/Total	
		276 Patterns	200	0.06	3,312		
		Total Volume Ft^3 110% of Total Volume			3,643.2		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				63,282.00	
			Feet	Man Days @ 500'/day	$/Man Day	$/Total	
		Labor	55,200	110.4	112.00	12,365.00	
			Days	$/Days		$/Total	
		Equipment Rental (3 man crew)	37	336.00		12,365.00	
	4.2	IC/PC PIPING					
			Feet	Ft^3/Feet	Ft^3/Total	$/Total	
		14" Piping, Ft	51,200	0.353	18,073.6		
		Total Volume Ft^3 110% of Total Volume			19,880.96		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				345,332 00	

TABLE 6-5 (cont'd)
RECLAMATION COST ESTIMATES

			Feet	Man Days @ 500'/day	$/Man Day	$/Total	
		Labor	51,200	512	112.00	57,344.00	
			Days	$/Days		$/Total	
		Equipment Rental (3 man crew)	170.67	336.00		57,344.00	
			Feet	Ft^3/Feet	Ft^3/Total	$/Total	
		3" and 4" Piping, ft	33,800	0.054	1,825.2		
		Total Volume Ft^3 110% of Total Volume			2,007.72		
		Disposal Cost per Ft^3		17.37			
		Total Disposal Cost				34,874.00	
			Feet	Man Days @ 500'/day	$/Man Day	$/Total	
		Labor	33,800	67.6	112.00	7,571.00	
			Days	$/Days		$/Total	
		Equipment Rental (3 man crew)	22.53	336.00		7,571.00	
5.	**GROUND WATER RESTORATION**						**$1,641,625.00**
			Number	RO$/K Gal		$/Total	
		Patterns	276				
		GWS Volume, K Gals	178,800	1.97		352,236.00	
		RP Sweep, K Gals	213,900	1.97		421,383.00	
			$/Pattern			$/Total	
		Reductant	245.00			67,620.00	
			Wells	Samples/Yr (4 years)	$/Sample	$/Total	
		Monitoring MP Wells	39	1	150.00	23,400.00	
		Monitoring M Wells (UCL's)	100	6	34.00	81,600.00	

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

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DRAWING NO. PLATE 6-1
GAS HILLS PROJECT
MINE UNIT #1 WELL FIELD DEVELOPMENT
FREMONT AND NATRONA COUNTIES, WY,
REV. 1/98

WITHIN THIS PACKAGE... OR BY SEARCHING USING THE DOCUMENT/REPORT NO. PLATE 6-1, REV. 1/98

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D-01

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DRAWING NO. PLATE 6-2 RECLAMATION DETAILS

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D-02

TABLE 6-5 (cont'd)
RECLAMATION COST ESTIMATES

7.	**ADMINISTRATIVE OVERHEAD**						**$540,233.00**
						$/Total	
		Bid Package Prep.				83,113.00	
		Contr. Mob/Demob				83,113.00	
		Field Mgmt & Security				83,113.00	
		Admin & Acct.				83,113.00	
		Unknowns				207,781.00	
GRAND TOTAL SURETY							**$4,695,869.00**

DISPOSAL COSTS	$17.37 PER Ft^3	INCLUDES HAULING
$/MAN-DAY	$112.00 PER DAY	1997 PRI LABOR COSTS
RO COSTS	$1.97 PER 1,000 GALLONS	SEE SECTION 6.2.2
SURF RECL	$500.00 ($/ACRE)	SEE SECTION 6.2.5
BUILDING DEMO & DISP.	$0.173 ($/Ft^3)	GUIDELINE 12
CONCRETE DEMO	$3.03 ($/Ft^2)	GUIDELINE 12
CONCRETE DISP - ON-SITE	$4.97 ($/Yd^3)	GUIDELINE 12
TOPSOIL	$0.80 ($/Yd^3)	GUIDELINE 12
OVERBURDEN	$0.50 ($/Yd^3)	GUIDELINE 12
WELL PLUGGING	$195.00 ($/WELL)	SEE SECTION 6.2.4

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7. ENVIRONMENTAL EFFECTS

7.1 General

The ISL process is a proven extraction methodology that currently is commercially utilized in several western states. It has many environmental advantages over conventional open pit and underground uranium mining. These are outlined below:

1. ISL results in significantly less permanent surface disturbance since pits, shafts, overburden and waste piles, haul roads and tailings disposal facilities are not needed;

2. ISL has a much smaller impact on water resources since pit or underground dewatering, conventional milling and tailings transport are avoided. Water consumption is significantly less than conventional mining and milling;

3. ISL results in virtually no air quality impacts due to windblown dusts because there are no large haul roads, ore and overburden stockpiles or tailings piles, or ore crushing and grinding operations;

4. ISL requires fewer employees than conventional mining and milling activities, thereby reducing adverse transportation and socioeconomic impacts;

5. Since ISL does not require sub-surface excavation of the ore body, there are no open shafts, pits or surface subsidence at the end of the project as can occur at conventional mine sites;

6. ISL is fairly selective for uranium, leaving many radionuclides where they naturally occur instead of moving them to tailings ponds. Employee radiological exposures, as well as the potential for exposure of the public to radionuclides, is greatly reduced; and

7. No mill tailings are produced, thereby significantly reducing the volume of solid wastes produced.

Although the ISL technology proposed for use at the Gas Hills Project will result in minimal adverse environmental impacts, PRI will perform activities in a manner that will minimize, to the extent practicable, impacts to the environment, its employees and the public.

7.2 Construction and Operational Effects

7.2.1 Land Impacts

Of the approximately 8500 acres within the Amendment Area, less than 1275 acres are proposed to be disturbed by buildings, roads, ponds, and wellfield development (i.e., 15% of the total Amendment Area). Approximately 140 acres of the Amendment Area have been previously disturbed by conventional mining activities.

The main office will be located in the existing 21 acre Carol Shop complex. Additional surface disturbance is not anticipated to accommodate planned facilities at this location. A second satellite facility will be located at one of the two locations shown on Plate 1-1W, and will disturb approximately two acres. The proposed solar evaporation ponds will disturb approximately 15 acres.

Main site access to the Project site is discussed in Chapter 2, and shown on Plate 2-3. Approximately 3300 linear feet of main access road will be constructed to allow access to the alternate satellite location described above. Plate 3-3 shows design and maintenance requirements for all main and secondary access roads.

To control access and to prevent livestock damage to wells and facilities, all wellfields, evaporation ponds and Satellite facilities will be fenced. With the exception of the evaporation ponds, fence construction will be such that wildlife migration and grazing activities will not be affected. Because of the potential damage to pond liners by deer and antelope and the radionuclide content of the waste water, deer and antelope proof fencing will be constructed around the evaporation ponds.

Topsoil and wetlands protection erosion control and wildlife monitoring and mitigation measures are discussed in section 3.2.1 of Chapter 3. Waste disposal procedures are discussed in Chapter 4.

7.2.2 Vegetation Impacts

The greatest impact to vegetation will be in the wellfield areas during wellfield construction. This impact will be of a temporary nature as each wellfield will be reseeded after construction activities are completed. Experience at other ISL projects shows that these areas provide as good or better wildlife habitat after reclamation as native areas. Proposed revegetation practices are provided in section 3.2.1.9 of Chapter 3, and Section 5 of Chapter 6.

7.2.3 Cultural Resources Impacts

As discussed in Chapter 2, class III cultural resource surveys have been performed over the Amendment Area and submitted to the USBLM and WDEQ for review. Proposed mitigation

actions for cultural resource impacts are provided in section 3 of chapter 2, and will be in accordance with US BLM and Wyoming State Historic Preservation Office (SHPO) requirements.

7.2.4 Air Impacts

Air quality impacts which may result from construction and operation activities will be primarily fugitive dust and engine exhaust emissions. Based on experience at other ISL facilities, these types of emissions are not expected to be significant.

Exhaust from diesel drilling rigs and gasoline powered service vehicles will produce small amounts of carbon monoxide, sulfur dioxide and other internal combustion engine emissions. These will be dispersed rapidly and will not exceed air quality standards.

Travel on unpaved roads and wellfield construction activities will result in minor emissions of fugitive dust. These will be intermittent and should not represent significant air emission impacts. The proposed wellfield reclamation/revegetation practices will minimize fugitive dust releases from these areas. Fugitive dust control measures are also discussed in Section 3.2.1 of Chapter 3.

During operations, small amounts of gaseous oxygen, carbon dioxide and/or radon may be emitted from the wellfields and the satellites. These emissions will be readily dispersed in the atmosphere and will not create an adverse impact.

7.2.5 Water Impacts

Impacts on surface and ground water by the proposed ISL activities will be temporary and short term in nature, unlike conventional mining when large and permanent alterations to the hydrologic regime are common.

7.2.5.1 Surface Water

Proposed ISL activities will have negligible effect on surface water resources in the area Additionally, unlike conventional surface mining activities, few, if any, stream diversions will be needed, and stream channels will not be significantly impacted. Additionally, all streams in the vicinity of planned activities are ephemeral in nature and only flow in direct response to infrequent large precipitation events or large snowmelt events.

It will be necessary to cross small ephemeral stream channels with wellfield piping and light use wellfield roads. All piping will be buried under the stream channel, thereby minimizing any impacts. The pre-existing stream channel configuration will be re-established and vegetation seeding will occur as soon as possible after construction

Culverts will be installed in all road crossings where fill material is utilized. Conventional erosion control methods such as mulching, straw bale dikes, and porous rock check dams will be utilized in these areas if necessary. No stock ponds should be affected by the proposed activities. Surface water monitoring is discussed in Section 3.2.1 of Chapter 3. Pollution control measures are discussed in Section 3.4 and 3.5 of Chapter 3.

7.2.5.2 Ground Water

Potential impacts to ground water systems within and near the wellfields will be minimal and short term. Unlike conventional mining activities, which often result in massive dewatering or total elimination of intersected aquifers, ground water levels at the Gas Hills Project will only be minimally affected within and near operating wellfields. Although ISL activities will change the quality of the ground water within the production zone of operating wellfields, operational controls and ground water monitoring will insure that injection fluids stay within the identified production zone (see Chapter 3).

Additionally, existing regulatory requirements for ground water restoration will adequately protect the quality of affected ground water resources. Wellfield ground water restoration is discussed in Chapter 6. In summary, after ISL and ground water restoration activities are completed, the ground water quality will be similar to pre-existing conditions and will be suitable for the same pre-existing uses, or potential uses.

7.2.6 Impacts to Human Populations

As discussed in Chapter 2, the nearest permanent residence is located approximately 12 miles northeast of the Project site on the graded county road. Impacts due to noise from the project and movement of people and equipment will be minimal. Noise caused by drilling and operations activities will have a negligible impact on the nearest resident.

It is anticipated that a large portion of the work force will live in Riverton and commute using Wyoming State Highway No. 136. Therefore, traffic disturbance on the county road should be minimal. Disruption of grazing patterns will be minimal, and only a small portion of the Amendment Area acreage will be fenced to restrict livestock use. At the end of the project, all of the land will be returned to livestock grazing and wildlife habitat use.

7.2.7 Beneficial Impacts

The beneficial effects of constructing and operating the Gas Hills Project are discussed in Section 9.2 of Chapter 9 and include upgrading and additional maintenance of existing roadways, additional employment in Fremont County, additional income to local distributers,

contractors and suppliers, and an increase in local and county revenues through taxes paid by the Project.

7.3 Radiological Effects

ISL facility exposure pathways to radiological materials are considerably different from pathways associated with conventional uranium mining methods. First, the majority of the uranium radioactive daughter products are not removed from the ore body, but remain underground within the ore zone. Additionally, no precipitation or drying of the uranium product will be performed at the Gas Hills Project. This eliminates the radiological air particulate pathway typically associated with conventional uranium ore milling or those ISL facilities which produce dried product.

Radon will be released from the solutions at the wellfields and vented from the satellite building to the atmosphere during resin transfer or when vessels are opened for maintenance. Experience from other ISL projects show that these releases will only be a small fraction of the natural background dose contribution and will not result in a significant offsite impact.

Specific radiological impacts expected by ISL activities at the Gas Hills Project have been evaluated utilizing the MILDOS-Area computer code and its associated calculated exposures. This evaluation shows that the expected radon-222 concentrations at the site boundaries and downwind human receptors will be less than the effluent release limit in 10 CFR 20, Appendix B. Based upon the evaluation and experience at other ISL projects, it is anticipated that the effluent limits in 10 CFR 20 and 40 CFR 190, and the dose to the public limit in 10 CFR 20 will not be exceeded. The MILDOS evaluation including all applicable information as requested by NRC in Appendix A of Regulatory Guide 3.46 is included as Appendix 12.

The MILDOS evaluation provided in Appendix 12 does not include Mine Unit No. 5 because there is currently insufficient data available to determine whether it will contain economically recoverable reserves. Because it is a potential resource area, it has been included in the application. Once sufficient data is available, and prior to production development in Mine Unit No. 5, a MILDOS evaluation will be performed to include the Mine Unit No. 5 area as a source location.

7.4 Nonradiological Effects

7.4.1 Nonradioactive Airborne Effluents

Section 4.1.1 of Chapter 4 describes the type of nonradioactive airborne effluents expected at the Project. It is not anticipated that there will be a significant environmental impact from the nonradioactive airborne effluent releases

7.4.2 Nonradioactive liquid effluents

It is not anticipated that there will be any nonradioactive liquid effluents discharged to the environment during the operation of the Gas Hills Project other than those discussed in Section 4.2 of Chapter 4. The RO treated wellfield bleed stream will be reinjected into the aquifer. During ground water restoration, the RO treated water may be surface discharged. This will take place under a National Pollutant Discharge Elimination (NPDES) permit. The discharged RO treated water will be monitored to ensure the NPDES discharge limits are not exceeded.

7.5 Effects of Accidents and System Failures

7.5.1 Storage Tank Failure

Storage tanks and vessels will be located both inside and outside of the satellite buildings. These storage vessels will include tanks for waste water treatment and storage of hydrochloric acid, and bulk dry chemicals (e.g., sodium bicarbonate). Pressurized vessels will be used to contain the ion exchange resin, carbon dioxide, oxygen, hydrogen peroxide and propane. There will also be small tanks containing diesel fuel and gasoline. The acid, fuel, carbon dioxide, oxygen, hydrogen peroxide and propane will be located outside and away from the building. Tanks containing liquid fuels and acids will be bermed to contain potential leaks or spills. Overflows or leaks from tanks located inside the buildings will drain to a sump and will be returned to either the process or the waste water circuit.

7.5.2 Pipeline Failure

All wellfield pipelines will be buried to prevent freeze damage. Materials of construction will be high density polyethelene (HDPE) or similar materials. Well heads will be insulated to prevent freezing. Prior to burial, pipelines with field fusion welds will be pressure tested to ensure integrity.

To minimize the impacts of a potential pipeline leak, all pipeline systems will be equipped with high and low pressure and flow sensors that will shut down the system should the pipeline pressure or flow deviate from a pre-set range. These systems will also be equipped with alarms to alert the operator of a malfunction. Operating procedures will require investigating and reporting of such leaks or failures (see section 3.4.7 of Chapter 3). The use of manual pipeline valve boxes will allow the isolation of a pipeline rupture and prevent complete drainage of a long section of pipeline.

7.5.3 Fires and Explosions

Fire or explosion hazard inside the satellite facilities will be minimal, because flammable liquids are not used in the uranium dissolution, complexing or ion exchange process. The

uranium will be in a water solution, and adsorbed onto ion exchange resin. Therefore, a fire or explosion would not significantly disperse any uranium to the environment.

If propane is used, it will be stored in pressure tanks at a safe distance away from the Satellite building. Diesel and gasoline will be stored on-site to fuel back-up electrical generators and field equipment. These fuels will be stored and protected in accordance with MSHA requirements.

Oxygen gas or hydrogen peroxide will be injected into the injection fluid to mobilize the uranium. Being strong oxidizers, there is the potential for fire or explosion if the service piping is not properly cleaned or if the system develops a leak in the presence of an ignition source. To minimize the potential of fires or explosions caused by oxygen or hydrogen peroxide, they will be handled in accordance with the vendor's safety instructions and site operating procedures. Service lines and facilities will be constructed in accordance with established procedures to ensure proper cleaning and construction techniques are utilized. Additionally, smoking will not be permitted in the wellfield header houses, valve boxes, around the storage vessels, or during any maintenance or repair activities on the oxidant supply system.

7.5.4 Injection Well Failure

A casing failure would be most significant in the injection wells where the lixiviant is being injected under pressure. It is possible that this type of failure could occur and continue for several days before being detected. For a very conservative estimate, a failure of this type, assuming it was not detected for 30 days, could result in a total of 380,000 gallons of fluid lost to another formation. However, with proper casing, cementing and testing procedures, the probability of such a failure is very low.

To minimize the risk of such a failure, casing integrity tests will be performed on all injection wells after completion and after any work that includes entering the well with a cutting tool, such as a drill bit or under reamer, to detect any damage that may have occurred. Additionally, Underground Injection Control (UIC) regulations require casing integrity testing of all injection wells every five years while they are in operation (see Section 3.2.10 of Chapter 3).

7.5.5 Hydraulic Fracturing

If the injection pressure exceeds the fracture pressure of the formation, formation fractures could be produced that could result in undetected excursions or loss of solution to overlying units. Such an event will be highly unlikely because injection pressures will be maintained at levels below the formation fracture pressure (see Section 3.4.2.5 of Chapter 3).

7.5.6 Leakage Through Old Exploration Drill Holes

As discussed in Chapter 3, approximately 5,750 drill holes were completed prior to the 1977 Wyoming drill hole abandonment regulations which present a potential for leakage and excursions during operations. The proposed procedure for locating and abandoning old drill holes is presented in Section 3.2.7.2 of Chapter 3, and will minimize the potential for leakage of solution through old abandoned drill holes.

The mud column is an effective seal against fluid interchange between the various aquifer units penetrated by drilling. Additional natural sealing is caused by the rapid swelling and bridging of the isolating shales and clays between the sandstone aquifer units. One of the purposes of the individual mine unit pump tests will be to investigate effects that may be caused by leaking drill holes. If such leakage is found, the suspect drill hole(s) will be located and properly abandoned prior to any injection activities.

7.5.7 Resin Transportation Accidents

Approximately 500 cubic feet of resin loaded with uranium will be transported from the Gas Hills Project to the Highland Uranium Project approximately once per day for processing. Eluted resin, from which the majority of the uranium has been removed, will be returned to the Gas Hills Project for further use in the extraction process.

The most significant potential effect would be an accident involving loaded resin. It is anticipated that each trailer load of resin will contain approximately 3400 pounds of uranium chemically adsorbed onto the resin beads. Should a load of resin be spilled, the environmental effect would be minimal. Since the resin is a solid material, it will not spread into surface waters or into the ground surface. Additionally, since the uranium is ionically attached to the resin, there is no potential for airborne particulate contamination PRI will have contingency procedures in place to address actions to be taken should such an incident occur, including cleaning up the spill and any contaminated soil as quickly as possible.

7.5.8 Lixiviant Excursions

Lixiviant excursions can occur vertically or horizontally. Vertical excursions may be caused by improperly completed wells, well casing failure, improperly or unplugged drill holes or because of thin or discontinuous confining units Horizontal excursions are typically caused by a loss of control of the lixiviant allowing it to migrate horizontally away from the production zone.

Vertical excursions due to improperly completed wells are uncommon and can be prevented by following established well completion and testing procedures and QA/QC principles. The casing integrity testing procedures described in Chapter 3 will detect well casing problems before a problem occurs.

The drill hole abandonment procedures described in Chapter 3 should prevent potential vertical excursions through unplugged drill holes. Prior to producing from each mine unit, the geologic nature of the production zone will be thoroughly characterized to ensure that confining layers occur over and under the production zone. Additionally, pre-operational hydrologic testing will be performed to determine any potential hydrologic problems. This process is described in Chapter 3.

Should an excursion occur, operating procedures have been developed to address regulatory reporting and corrective actions as described in Section 3.4.6 of Chapter 3.

7.6 Sustainable Development and Ecosystem Impacts

If the Gas Hills Project can sustain the future use of resources, it minimizes the impact on future generations. The Brundtland Commission report of 1987 (WCED, 1987) brought the term "sustainable development" into the modern lexicon and made the following statement regarding extraction of non-renewable resources:

1. "...the rate of depletion of non-renewable resources should foreclose as few options as possible";

2. Such development "requires the conservation of plant and animal species";

3. "...impacts on the quality of air and water, and other natural elements are minimized so as to sustain the ecosystem's overall integrity"; and

4. The project should not interfere with local land use or an individual's right to make a living, by traditional means if need be.

In other words, recognizing that resource extraction is a transient land user, but is fundamental to modern civilization, these activities should not adversely impact the integrity of the ecosystem or the ability of future generations to use that ecosystem. The Gas Hills Project will satisfy these criteria as follows:

1. The economic extraction of the resource will be maximized with the rate of mining set according to uranium sales to utility customers around the world, helping them meet the growing demand for electricity. While at present, uranium is single pass through the energy cycle, future changes in technology or economics could see the reprocessing and reuse of uranium as a fuel stock, thereby maximizing the use of the resource;

2. Surface and subsurface disturbance at ISL operations is minimal relative to other forms of mineral extraction. Studies performed for the project indicate that there is no danger to rare or endangered species, and that upon

decommissioning, the project area can be returned to its former use of wildlife habitat and livestock grazing;

3. Given the minimal impacts to the air, land and water, no long term adverse impacts to ecosystems are predicted. Any impacts will be local and short term, and not likely to significantly impact any given population; and

4. Although small portions of the project area will be fenced to exclude livestock (eg., production wellfields), the overall amount of land use should not adversely affect anybody's ability to make a living or carry out traditional land use activities. In addition, the project itself will provide economic benefits through employment, taxes and the purchase of supplies.

Based upon the above, the Gas Hills project meets the criteria for sustainable development as applied to a non-renewable resource. Furthermore, the project will not contribute significantly to global warming, the depletion of natural habitats, or the net deterioration of global air or water quality.

REFERENCES

Shepherd Miller, Inc., 1997, "MILDOS-AREA Model Results for the PRI Gas Hills Project".

U.S. Nuclear Regulatory Commission, 1982, Regulatory Guide 3.46, "Standard Format and Content for License Applications, Including Environmental Reports, For In Situ Uranium Solution Mining".

WCED, 1987; Our Common Future, World Commission Environment and Development, G.H. Brundtland, Chairman, Oxford University Press, 400 pp.

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8. ALTERNATIVES

8.1 Alternative Processing Methods

The two primary processing alternatives considered for the Gas Hills Project were 1) a facility capable of precipitating and drying yellowcake on-site, and 2) operating the Project as a Satellite to the Highland Uranium Project. There are several advantages to operating the Project as a satellite to Highland. These are as follows:

1. Although the throughput at the Highland facility from the Gas Hills production will increase, it will serve to centralize all of PRI's processing operations, and associated monitoring activities, and will avoid creating a potential impact to the Gas Hills environment from air particulate emissions;

2. Substantially less capital investment is required if a processing plant containing an elution, precipitation and drying circuit is not required;

3. Potential additional exposure of employees and the public and impacts to the environment will be avoided without the precipitation and drying of yellowcake at the Project. Exposure to uranium particulates will be negligible. Additionally, without a drying facility, the release of contaminants to the atmosphere will result only from radon released from the wellfields and satellite facilities. The radiological evaluation discussed in Chapter 7 shows that doses to the public from radon emissions will be minimal; and

4. The potential environmental impacts arising from an accident involving the transportation of ion exchange resin loaded with uranium are much less than for accidents involving yellowcake slurry or dried yellowcake. The concentration of the uranium is much less than either slurry or dried product, therefore, potential doses to the public or cleanup personnel will be much reduced in the event of an accident resulting in a release of material. Additionally, since the uranium is ionically attached to the surface of the resin, it will be much easier to clean up than slurry or yellowcake spills, and will be less likely to be distributed by wind or water.

8.2 Alternative Extraction Methods

Conventional underground and open pit mining represent the two most common alternatives for recovering the uranium reserve at the Gas Hills Project.

From an economic viewpoint, the relatively low grade and moderate depth of the Gas Hills orebody precludes the much larger investment necessary for either an open pit or underground mine in today's market. Conventional mining methods would require an initial

investment in heavy equipment to perform the earthwork necessary to expose the orebody. Each method would require a large mill and a large tailings pond for the mill wastes.

For an underground mine, the conventional mill that would be required would involve higher risks of spillage and radiological exposure to both personnel and the environment than that associated with the proposed alternative. Rock waste dumps generated by shaft sinking and development excavations would result in changes in surface topography, even after landscaping. The overall size of the facilities would necessarily be larger because of greater manpower and material handling requirements.

Workers would be exposed to the normal hazards of underground mining and, additionally, to radiation exposures from radon gas if not continually vented to the atmosphere. The personnel injury rate is traditionally much higher in underground mines than in ISL uranium operations.

Operation of an underground mine could result in higher operating costs and would lead to abandonment of much of the lower grade mineralization, resulting in a lower overall recovery of an important energy resource. After mining, the land surface could vary and will be subject to surface subsidence.

When one considers the alternative of open pit mining, the economic and environmental disadvantages closely parallel those of an underground mine. As in the case of an underground mine, a mill would be required with the problems mentioned above. Permanent changes in topography would result, with an excavated and/or disturbed area approximately three times the area of the orebody mined in order to maintain slope stability. The site facilities would be larger than those needed for an ISL operation or an underground mine.

Both open pit and underground methods would require substantial dewatering to depress the potentiometric surface of all local aquifers. Large quantities of ground water would be discharged to the surface. In this instance, the ground water, naturally containing Ra-226 and other trace elements, would have to be treated and the solid residue disposed of as a radioactive solid waste. A mill tailings pond would be required to contain the millions of tons of waste produced from the uranium mill. This tonnage would represent a radioactive pile containing more than a million cubic yards of tailings slurry covering several hundred acres of ground surface.

The economic costs and environmental problems associated with conventional mining clearly show that ISL is the more viable technique to use. The initial investment is lower, the tailings problem is completely eliminated, radiation exposure and environmental impacts are minimized, and the local ground water resource is preserved.

8.3 Alternative Sites for Surface Structures

Proposed siting of the satellites, wellfields, and ponds is shown on Plate 1-1W and 1-1E.

For economic reasons, all facilities, including the satellites and evaporation ponds, must be located as close as possible to the wellfield area. Because of the nature of the topography and the physical characteristics of the deposit, there are few, if any, alternative sites for the surface facilities other than those proposed.

The satellites will be located close to the wellfield areas, but situated near access roads to allow access of supply and transport trailers. The ponds will be situated at a lower elevation than the satellite buildings to facilitate drainage in the event of a catastrophic tank failure.

The evaporation ponds will be placed near the wellfield areas to minimize piping and to contain all surface disturbance within a limited surface area. An additional constraint is that, to the extent practicable, all ponding should be kept out of any ephemeral drainage to avoid flooding problems during major precipitation events.

The surface structures as proposed appear to be the most efficient and environmentally responsible approach to the operation design and layout.

8.4 Alternative Lixiviants

An ISL lixiviant must 1) effectively mobilize and complex the uranium, 2) be readily available and relatively inexpensive, 3) have a minimal reactivity potential with other minerals that may be present with the uranium, and 4) have a minimal impact on the geochemistry of the ore sand and adjacent units relative to the timely completion of ground water restoration. Therefore, lixiviant selection must be specific to each ore body to ensure maximum uranium recovery while minimizing adverse geochemical reactions.

Acidic lixiviants have been found to be best suited for ore deposits containing low concentrations of carbonate minerals. However, strong acidic solutions (pH<4) tend to dissolve other trace minerals present in the ore along with the uranium presenting yellowcake contamination and ground water restoration problems. Additionally, use of sulfuric acid as a lixiviant can cause precipitation of calcium sulfate in the ore zone which can lower the formation permeability. The most common acidic lixiviants contain sulfuric acid, nitric acid or carbonic acid.

Alkaline lixiviants have been used on deposits containing high concentrations of carbonate minerals. These types of lixiviants generally result in lower uranium recovery rates than acidic solutions but do not as readily dissolve trace mineral contaminants. Alkaline lixiviants commonly contain sodium bicarbonate. Ammonium bicarbonate was widely used at ISL

facilities in the 1970's but was discontinued when it was found that the ammonia compounds ion exchanged onto the clays, and severely impeded ground water restoration.

The proposed lixiviant is a weak carbonic acid formed by the reaction of the carbon dioxide with the formation calcium carbonate. It is fairly selective for uranium with minor mobilization of contaminant trace minerals. The slightly acidic pH inhibits the formation of calcium carbonate in the ore zone formation which could lead to formation plugging. In areas where natural calcium carbonate concentrations are low, additional carbonate may have to be added to the lixiviant in the form of sodium carbonate or sodium bicarbonate.

The proposed choice of oxidant is based primarily on cost. Hydrogen peroxide is more expensive than oxygen. However, hydrogen peroxide is a stronger oxidant and may be more effective at mobilizing the uranium from the formation.

8 5 Alternative Waste Disposal Methods

As discussed in Chapter 7, no mill tailings are produced during ISL. Therefore, large tailings disposal facilities and the environmental effects of such facilities are not needed. As discussed in Chapter 4, a relatively small volume of contaminated solid wastes will be produced from the treatment of the production and restoration waste water streams. These solid wastes, together with any contaminated equipment will be disposed of at a NRC licensed disposal facility in accordance with 10CFR40, Appendix A, Criterion 2.

Various liquid waste disposal methods have been used by the ISL industry and include evaporation ponds, deep well injection, land application and surface discharge under a National Pollution Discharge Elimination System (NPDES) permit. To date, a suitable deep well injection receiver has not been identified within a reasonable distance of the Project site. Topographic conditions do not readily lend themselves to the construction of purge storage reservoirs and irrigation facilities. NPDES discharge of process waste water streams is currently prohibited by 40CFR440.34 but can be used as a disposal method for restoration waste water. This option will be considered for use and a permit obtained prior to commencing ground water restoration activities.

For the process waste water stream disposal, PRI will utilize volume reduction by RO or other purification methods with reinjection of the purified stream and evaporation of the reject portion of the purification stream (see Section 4.2.4 of Chapter 4).

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9. BENEFIT - COST ANALYSIS

9.1 General

The local communities within Fremont and Natrona Counties will receive significant economic benefits from the development, construction and operation of the Gas Hills Project, including the direct employment of approximately 30 people, most of whom will reside in a local community. Additionally, contractors will be hired locally to provide wellfield drilling services, resulting in an additional 12 to 24 persons being employed at the Project. The Project will purchase the supplies and equipment needed to construct and operate the facility from local suppliers and vendors thereby benefitting the local economy. The Project will pay State sales, ad valorem, and severance taxes which will benefit the economy of the entire State of Wyoming. Because of the relatively small workforce that will be involved with the Project, socio-economic impacts to the local community related to schools, recreation, public protection and other community services will be negligible. Perhaps the greatest benefit that will be derived from the Project will be the production of uranium which will provide the nation with a secure, low-cost electric power supply with less adverse environmental impacts than any other power generation technology.

The analysis of the costs versus the benefits for constructing and operating a fuel cycle facility such as the Gas Hills Project rests entirely on a comparison between the societal benefit of an assured U_3O_8 supply (ultimately providing electrical energy) and local environmental costs. For the Project, these environmental costs will include minor impacts to ground water, the land surface and radiological releases in an area which has previously received significant impact by conventional mining activities. Radiological effluent releases will be small and restricted only to radon gas which, based upon the analysis provided in Appendix 12, will be acceptable under current standards and regulations. Radioactive waste generation will be small in comparison to the wastes generated by a conventional mine/mill complex and will be disposed of at an NRC licensed disposal facility. The disturbed land surface will comprise a small percentage of the licensed area and will be reclaimed and available for pre-project uses. Impacted ground water will be restored to its pre-existing use condition.

9.2 Benefits

9.2.1 U.S. and World Energy Requirements

The primary benefit to be realized from the Gas Hills Project is the electric power that will be derived from the uranium recovered over the life of the Project. Assuming that each pound of uranium produced is equivalent to 16 kilowatt-hours of electric power, the Gas Hills Project has the potential of providing the equivalent of 640 million kilowatt-hours of clean electrical power.

The recently ratified "Kyoto Protocol" calls for significant world-wide emissions reductions to reduce pollutants responsible for global warming. Nuclear power is a virtually non-greenhouse gas emitting technology which currently supplies approximately 17 per cent of the world's electricity. It has been estimated that world-wide energy requirements could at least double by the year 2050. This means that nuclear power could be providing about four times its present output. On an annual basis, electricity generation by nuclear power prevents the emission of 2.3 billion metric tons of carbon dioxide, 5.3 million metric tons of sulfur dioxide and 2.5 million metric tons of nitrogen oxides. It is readily apparent that nuclear power can and will play an major role in producing additional non-global warming electricity in the future as the world-wide demand continues to increase.

9.2.2 Employment and Income

The Gas Hills Project payroll will represent a direct benefit to the employees and the community. The payroll and equipment/supplies expenditures will have a multiplier effect as the money is turned over throughout the local economy. The estimated community benefit resulting from the Gas Hills Project employee payroll is shown on Table 9-1.

9.2.3 Taxes

Federal, state and local governments will receive various revenues from employee income taxes, royalty owners taxes, severance taxes, ad valorem taxes and sales taxes. The estimated benefit from taxes is shown on Table 9-1.

9.3 Costs

9.3.1 Internal Costs

The primary internal costs associated with the Gas Hills Project will include (1) the capital costs of land acquisition, (2) the capital costs of facility construction, (3) operating and maintenance costs, and (4) the costs of ground water restoration, site reclamation and facility decommissioning. These estimated costs are provided in Table 9-1.

9.3.2 External Costs

External costs are those costs that directly impact the economy of the local community, and are more difficult to quantify than internal costs.

9.3.2.1 Public Facilities and Services

The adverse impact on public facilities and services, such as congestion of streets and highways, overloading of water supply and sewage systems, and the overtaxing of schools, hospitals and police and fire protection will be negligible because of the small

population increase that will result from the project construction and operational work force and the existence of an adequate work force availability in Riverton and other nearby communities.

9.3.2.2 Housing

Because of the small work force that will be involved with the project, and the fact that Riverton and other nearby communities have experienced a population decrease since 1980, housing shortages resulting from the construction and operation of the project are not anticipated.

9.3.2.3 Impairment of Historical, Scenic and Recreational Values

Of the historical sites identified within the license Amendment Area, only one has the potential for being disturbed by future wellfield development activities. The location and mitigative action plan for sites of historical significance are described in Chapter 2.

By the nature of the ISL process, surface and subsurface disturbance will be minimized. Therefore, impairment of recreational values, such as the reduction of wildlife and sport animals, will be negligible.

Only a small portion of the Amendment Area (approximately 15 per cent) will be temporarily fenced during the life of the project. The fences will be constructed in a manner that will keep livestock out, but will allow wildlife access. At the completion of reclamation/decommissioning, the fences will be removed and the entire area will again be available for livestock grazing and wildlife habitat.

9.3.2.4 Resources Committed

The irretrievable resource commitment of greatest significance will be the recovery of approximately 30 to 40 million pounds of uranium over the life of the project, which ultimately will be converted into electric power which will benefit thousands of households throughout the country. Other irretrievable resources that will be utilized by the project include fuel, building materials, well casing, piping, cement and other non-recyclable materials. Because ISL has a low net adverse effect on the surface and subsurface environment, the long-term net effects of the operation on the environment will be minimal.

REFERENCES

Fox, Gail J., 1997, "The Kyoto Climate Conference-Global Commitment to Clean Air," The Nuclear Review, December, 1997, Number 352.

TABLE 9-1

SUMMARY OF COSTS AND BENEFITS

BENEFIT	PRESENT WORTH (x 1,000)
Payroll	$25,600
Equipment/Supplies	$61,150
Royalty Owners	$30,400
Taxes	$21,811
COSTS	
Project Capital	$86,450
Project Operating	$36,020
Project Decommissioning	$3,230

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10. ENVIRONMENTAL APPROVALS AND CONSULTATIONS 10-1

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Table 10-1 Required Permits and Licenses

10. ENVIRONMENTAL APPROVALS AND CONSULTATIONS

Prior to commencing operation of an ISL project in Wyoming, the operator must obtain a license to mine and permit to mine from the Wyoming Department of Environmental Quality (WDEQ). Additionally, because Wyoming is not a Nuclear Regulatory Commission (NRC) Agreement State, a Source Material License or an amendment to an existing license must be obtained from that agency. Other State of Wyoming permits such as an Air Quality Permit, an NPDES discharge permit, a Storm Water Discharge Permit, etc. are also required and must be obtained prior to project start-up. A listing of required permits and licenses is provided in Table 10-1.

During the licensing/permitting process, PRI intends to conduct informational meetings with local political and citizen groups to describe the plans for the project and solicit and respond to queries and recommendations.

TABLE 10-1
REQUIRED PERMITS AND LICENSES

PERMIT OR LICENSE	REGULATORY AUTHORITY	STATUS
Source Material License Amendment	US NRC	Application Submitted
Permit to Mine	WDEQ; US BLM	Application Submitted
License to Mine	WDEQ	Application Submitted
UIC Aquifer Exemption	WDEQ; US EPA	Application Submitted
Permit to Construct Solar Evaporation Ponds	WDEQ; WSEO	Application Submitted to WDEQ. Submit to WSEO after WDEQ Approval of Design
Permit to Construct Additional Ponds	WDEQ; WSEO	Future Application As Needed
Permit to Appropriate Groundwater For Wellfield Mine Units	WSEO	To Be Prepared prior to wellfield installation
NPDES Discharge Permit	WDEQ	To Be Prepared and Submitted Prior to Ground Water Restoration
Permit To Construct Sanitary Leach Field	WDEQ	To Be Prepared As Needed for Additional Satellite
Air Quality Permit (Fugitive Dust)	WDEQ	To Be Prepared
Storm Water Discharge Permit	WDEQ	To Be Prepared
County Development Permits	Natrona & Fremont Counties Planning Commission	To Be Prepared
Radio Communications License	US FCC	To Be Prepared

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11.1 Technical References

Technical documents used in the application are referenced at the end of each chapter.

11.2 Application Preparation Acknowledgments

Table 11-1 provides a list of PRI employees and outside contractors, together with their contributions to and qualifications for preparation of the application document.

TABLE 11-1
PERSONS PRIMARILY RESPONSIBLE FOR APPLICATION PREPARATION

NAME	QUALIFICATIONS
POWER RESOURCES, INC.	
Crew Schmitt	President and CEO; reviewer
Paul Hildenbrand	Manager of Regulatory Affairs, primary author; Registered Professional Geologist; expertise includes geology, ISL production, regulatory and environmental compliance, permitting and radiation safety
Mark Wittrup	Director of Environment, Health and Safety; reviewer; Registered Professional Engineer; expertise in geology, environmental and regulatory compliance and permitting
Mark Chalmers	Vice President of Operations; reviewer, Registered Professional Engineer; expertise in mining engineering, mine operations and permitting
Larry McGonagle	Manager of Uranium Operations; reviewer, expertise in process chemistry, mine operations, environmental and regulatory compliance and radiation safety
Ron Hoover	Manager of Engineering; reviewer and contributor; expertise in production facility construction, operations engineering, wellfield control and ground water restoration
Bonnie Percy	Reservoir Engineer; contributor; Registered Professional Engineer; expertise in ground water hydrology, wellfield configuration, reservoir engineering and ground water restoration
John Hunter	Manager of Ground Water Restoration; Registered Professional Geologist; expertise in geology, ground water restoration and ISL production

NAME	QUALIFICATIONS
Steve Payne	Manager of Development; reviewer and contributor; Registered Professional Geologist; expertise in geology, wellfield operation and construction and wellfield production
Debbie Hasty	Technical Assistant; typist
Mark Knoll	ACAD Technician; drafting of figures and plates
BRS ENGINEERING, INC.	
Doug Beahm	Registered Professional Geologist; Registered Professional Engineer; coordinated environmental baseline data collection, radiological site characterization, and assisted in operations plan
LIDSTONE AND ANDERSON, INC.	
Chris Lidstone	Registered Professional Geologist; provided surface water, ground water geochemistry and climate evaluation
Kate Laudon	Registered Professional Geologist; Registered Professional Engineer; provided ground water, hydrogeology and water rights evaluation
BKS ENVIRONMENTAL, INC.	
Brenda Schadweiler	Provided baseline vegetation and soils surveys
INTERMOUNTAIN RESOURCES	
Jim Orpet	Provided baseline wildlife surveys
PRONGHORN ANTHROPOLOGICAL SERVICES, INC.	
Marvin Hatcher	Provided cultural resource surveys and resulting reports

NAME	QUALIFICATIONS
SHEPHERD MILLER, INC.	
Dr. Jan Johnson	Radiological dose assessment - MILDOS model
ENERGY LABS	
Roger and Cheryl Garling	EPA certified; provided soil and water analytical testing