Red-line Version of Replacement Pages

5 OPERATIONS

Crow Butte Resources, Inc. (CBR) operates a commercial scale in-situ leach uranium mine (the Crow Butte Uranium Project) near Crawford, Nebraska. Required NRC licenses and amendments, as well as surety agreements, are issued in the name of Crow Butte Resources, Inc. All CBR operations, including the Crow Butte Uranium Project operations, are conducted in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to ensure compliance and further implement the CBR's policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

CBR will maintain a performance-based approach to the management of the environment and employee health and safety, including radiation safety. The Safety, Environmental, Health, Environment and QualitySafety Management System (EHSMSSHEQ MS) Program encompasses licensing, compliance, environmental monitoring, industrial hygiene, and health physics programs under one umbrella, and it includes involvement for all employees from the individual worker to senior management. This EHSMSSHEQ programMS. will allow CBR to operate efficiently and maintain an effective environment, health and safety program.

Figure 5.1-1 is a partial organization chart for CBR with respect to the operation of the Crow Butte Uranium Project and associated operations and represents the management levels that play a key part in the EHSMSSHEQ MS Program. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under Section 5.2.3.

Specific responsibilities in the organization are provided below:

Figure 5.1-1: Crow Butte Resources Organizational Chart

Add revised org chart

5.1.1 Board of Directors

The Board of Directors for Crow Butte Resources, Inc. has the ultimate responsibility and authority for radiation safety and environmental compliance for CBR. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors provides operational direction to the President of CBR.

5.1.2 President

The President of Crow Butte Resources, Inc. is responsible for interpreting and acting upon the Board of Directors policy and procedural decisions. The President directly supervises the Vice-President of Operations, the ~~and~~ Director of Safety, Health, Environment and Quality (SHEQ) and the Director of Radiation Safety and Licensing~~, Compliance and Licensing~~. The President is empowered by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance programs at the Crow Butte facility. The President is responsible for ensuring that CBR operations staff comply with all applicable regulations and permit/license conditions through direct supervision of the Vice President of Operations, ~~and~~ the SHEQ Director and the Director of Radiation Safety and Licensing~~, Compliance and Licensing~~. The President has overall responsibility for approving the North Trend facility design including radiological controls (e.g., ventilation systems), and the manner in which the RSO is integrated into this process.

5.1.3 Vice President of Operations

The Vice President of Operations reports to the President and is directly responsible for ensuring that CBR personnel comply with industrial safety, radiation safety, and environmental protection programs as established in the SHEQ ~~E~~MS ~~Management System Program~~. The Vice President of Operations is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The Vice President of Operations has the responsibility and authority to terminate immediately 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. ~~as indicated in reports from the Manager of Health, Safety, and Environmental Affairs or the RSO.~~ The Vice President of Operations directly supervises the General Manager of Operations.

5.1.4 General Manager

The General Manager is responsible for all uranium production activity at the project site. The General Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations. The General Manager is authorized to immediately implement any action to correct or prevent hazards. The General Manager 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 cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the Vice President of Operations, the ~~Director, Compliance and Licensing~~SHEQ Director, the SHEQ Manager ~~of Health, Safety and Environmental Affairs~~, or the RSO. The General Manager reports directly to the Vice President of Operations.

5.1.5 Director Safety, Health, Environment and Quality~~, Compliance and Licensing~~

The ~~Director, Compliance and Licensing~~SHEQ Director reports directly to the President and is responsible for ensuring the corporate personnel comply with industrial safety, radiation safety, and environmental protection programs as stated in the ~~EHS~~SHEQ MS ~~Management System~~. The ~~Director, Compliance and Licensing~~SHEQ Director is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The ~~Director, Compliance and Licensing~~SHEQ Director has the responsibility and authority to terminate immediately 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 as indicated in reports from the SHEQ Manager ~~of Health, Safety and Environmental Affairs~~ or the RSO. ~~The Director, Compliance and Licensing may also serve as Corporate Radiation Safety Officer (CRSO) and if doing so, shall meet the qualifications described in Regulatory Guide 8.31~~

5.1.5a Director of Radiation Safety and Licensing

The Director of Radiation Safety and Licensing reports directly to the President, is responsible for submitting quality permit and license applications to appropriate regulatory agencies and will manage the approval process. The position will also act as a resource to site SHEQ managers and ensure that permit conditions, agency responses, revisions, and, other Cameco SHEQ requirements are met. Additionally, this position will act as the corporate RSO and assists in the development and review of radiologic sampling and analysis and programs.
~~This reports directly to the President and is responsible for submitting quality permit and license applications to appropriate regulatory agencies and will manage the approval process. The position will also act as a resource to site SHEQ managers and ensure that permit conditions, agency responses,~~

....
~~The Director of Radiation Safety and Licensing may also serve as Corporate Radiation Safety Officer (CRSO) and if doing so, shall meet the qualifications described in Regulatory Guide 8.31.~~

5.1.6 Safety, Health, Environment and Quality Manager ~~of Health, Safety, and Environmental Affairs~~

The ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager is responsible for all radiation protection, health and safety, and environmental programs as stated in the ~~EHSMS~~SHEQ MS ~~Program~~ and for ensuring that CBR complies with all applicable regulatory requirements. This manger is responsible for the drafting, approving and updating ~~EHSMS~~SHEQ MS procedures on an annual basis. The ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager reports directly to the General Manager ~~and supervises the RSO~~ to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements and the SHEQ MS. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager also 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. As such the SHEQ Manager ~~of Health, Safety and Environmental Affairs~~ has a secondary reporting requirement to the ~~Director, Compliance and Licensing~~SHEQ Director. The ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager has no production-related responsibilities.

5.1.7 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs, having sufficient authority for the development and administration of the radiation protection and ALARA program. The RSO is directly responsible for supervising the Health Physics Technician, for overseeing the day-to-day operation of the health physics program, and for ensuring records required by the NRC are maintained. The RSO has responsibility to review and approve plans for new equipment, process changes, or changes in operating procedures to ensure that the plans do not adversely affect the protection program against uranium and its daughters. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance.

The RSO is responsible for the implementation of all on-site environmental programs, including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The RSO makes recommendations to improve any and all radiological safety related controls. The RSO reports directly to the General ~~Manager of Health, Safety, and Environmental Affairs~~Manager. The RSO, as a direct report to the General ~~Manager of Health, Safety and Environmental Affairs~~Manager, and through reporting lines shown in Figure 5.1.1, has both the responsibility and the authority to suspend, postpone, or modify any observed or planned work activity that is unsafe or potentially a violation of the NRC's regulations or license conditions, including the ALARA program. The RSO has no production-related responsibilities, maintaining independence from operations personnel. The RSO also has a secondary reporting requirement to the Director of Radiation Safety and Licensing.

Consistent with Regulatory Guide 8.31, the RSO may delegate radiation survey requirements to properly trained, experienced, plant personnel. Such personnel would be familiar with operations and received the necessary radiation safety training, including hands-on training (e.g., use of survey instruments for monitoring items removed from the restricted area) (see Section 5.8.6 for additional discussions).

5.1.8 Health Physics Technician

The Health Physics Technician (HPT) assists the RSO with the implementation of the radiological and industrial safety programs. The HPT is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The HPT reports directly to the RSO.
~~The HPT may delegate radiation survey requirements to properly trained plant personnel. Such personnel would be familiar with operations and received the necessary radiation safety training, including hands-on training (e.g., use of survey instruments for monitoring items removed from the restricted area) (see Section 5.8.6 for additional discussions).~~

5.1.9 Safety Supervisor

The Safety Supervisor is responsible for the non-radiation related health and safety programs. The Safety Supervisor is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate safety hazards and/or maintain regulatory compliance. Responsibilities include the development and implementation of health and safety programs in compliance with Occupational Safety and Health Administration (OSHA) regulations. Responsibilities of the Safety Supervisor include development of industrial safety and health programs and procedures, coordination with the RSO where industrial and radiological safety concerns are interrelated, safety and health training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor may also be a qualified HPT and may function in that capacity when needed. The Safety Supervisor reports directly to the ~~Manager of Health, Safety and Environmental Affairs~~SHEQ Manager.

5.1.10 ALARA Program Responsibilities

The purpose of the ALARA ~~(As Low As Reasonably Achievable) P~~program is to keep exposures to all radioactive materials and other hazardous material as low as possible and to as few personnel as possible, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

In order for an ALARA p~~P~~rogram to correctly function, all individuals including management, supervisors, health physics staff, and workers, must take part in and share responsibility for keeping all exposures as low as reasonably achievable. This policy addresses this need and describes the responsibilities of each level in the organization.

5.1.11 Management Responsibilities

Consistent with Regulatory Guide 8.31[1], CBR senior management is responsible for the development, implementation, and enforcement of applicable rules, policies, and procedures as directed by regulatory agencies and company policies. These responsibilities include the following:

1. The development of a strong commitment to and continuing support of the implementation and operations of the ALARA program;
2. An Annual Audit Program which reviews radiation monitoring results, procedural, and operational methods;
3. A continuing evaluation of the Health Physics Program including adequate staffing and support; and
4. Proper training and discussions that address the ALARA program and its function to all facility employees and, when appropriate, to contractors and visitors.

5.1.11.1 Radiation Safety Officer ALARA Responsibility

The RSO is responsible for ensuring the technical adequacy of the radiation protection program, implementation of proper radiation protection measures, and the overall surveillance and maintenance of the ALARA program. The RSO is assigned the following:

1. The responsibility for the development and administration of the ALARA program;
2. Enforcement of regulations and administrative policies that affect any radiological aspect of the ~~EHSMS~~SHEQ MS ~~Program~~;
3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the radiological aspects of the ~~EHSMS~~SHEQ MS ~~Program~~;
4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA program;
5. Assist with conducting an Annual ALARA Audit as discussed in Section 5.3.3, to determine the effectiveness of the program and make any appropriate recommendations or changes as may be dictated by the ALARA philosophy;
6. Review annually all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure the procedures are ALARA and do not violate any newly established or instituted radiation protection practices; and
7. Conduct (or designate a qualified individual to conduct) daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle.

5.1.11.2 Supervisor Responsibility

Supervisors shall be the front line for implementing the ALARA program. Each supervisor shall be trained and instructed in the general radiation safety practices and procedures. Their responsibilities include:

1. Adequate training to implement the general philosophy behind the ALARA program;
2. Provide direction and guidance to subordinates in ways to adhere to the ALARA program;
3. Enforcement of rules and policies as directed by the ~~EHSMS~~SHEQ MS ~~Program~~, which implement the requirements of regulatory agencies and company management; and
4. Seek additional help from management and the RSO should radiological problems be deemed by the supervisor to be outside their sphere of training.

5.1.11.3 Worker Responsibility

Because success of both the radiation protection and ALARA programs are contingent upon the cooperation and adherence to those policies by the workers themselves, the facility employees must be responsible for certain aspects of the program in order for the program to accomplish its goal of keeping exposures as low as possible. Worker responsibilities include:

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO through the ~~EHSMS~~SHEQ ~~Program~~MS.;
2. Making valid suggestions which might improve the radiation protection and ALARA programs;
3. Reporting promptly, to immediate supervisor, any malfunction of equipment or violation of procedures which could result in an unacceptable increased radiological hazard;
4. Proper use of protective equipment; and
5. Proper performance of required contamination surveys.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Environment, Health and Safety Management System

CBR's SHEQ MS ~~Environmental, Health, and Safety Management System (EHSMS~~SHEQ MS~~)~~ Program formalizes the Company's approach to environmental, health, and safety management to ensure a consistency across its operations. The ~~EHSMS~~SHEQ MS ~~Program~~ is a key element in assuring that all employees demonstrate "due diligence" in addressing environmental, health, and safety issues and describes how the operations of the facility will comply with the requirements of the CBR Safety, Health, Environment~~al, Health,~~ and Quality ~~Safety~~ (SHEQ~~EH&S~~) Policy and regulatory requirements. The ~~Manager of Health, Safety and Environmental Affairs~~SHEQ Manager, with assistance from the RSO and Safety Supervisor, is responsible for drafting, approving, and updating (as needed) the ~~EHSMS~~SHEQ MS procedures on an annual basis. More frequent updates may be made if site activities and/or conditions warrant such actions.

The CBR ~~EHS~~SHEQ MS ~~Management System~~:

- Assures that sound management practices and processes are in place to ensure that strong EHS performance is sustainable;
- Clearly sets out and formalizes the expectations of management;

- Provides a systematic approach to the identification of issues and ensures that a system of risk identification and management is in place;
- Provides a framework for personal, site and corporate responsibility and leadership;
- Provides a systematic approach for the attainment of CBR's objectives; and
- Ensures continued improvement of programs and performance.

The ~~EHSMS~~SHEQ MS ~~Program~~ has the following characteristics:

- The system is certified to meet the ISO 14001 Environmental Management System Standard;
- The system is straightforward in design and is intended as an effective management tool for all types of activities and operations, and is capable of implementation at all levels of the organization;
- The system is supported by standards that clearly spell out CBR's expectations, while leaving the means by which these are attained as a responsibility of line management;
- The system is readily auditable; and
- The system is designed to provide a practical tool to assist the operations in identifying and achieving their EHS objectives while satisfying CBR's governance requirements.

The ~~EHSMS~~SHEQ MS ~~Program~~ uses a series of standards that align with specific management processes and sets out the minimum expectations for performance. The standards consist of management processes that require assessment, planning, implementation (including training, corrective actions, safe work programs, and emergency response), checking (including auditing, incident investigation, compliance management, and reporting), and management review. These standards meet the recommendations contained in USNRC Regulatory Guide 8.2[2]

5.2.1.1 Operating Procedures

CBR has developed procedures consistent with the corporate policies and standards and regulatory requirements to implement these management controls. The ~~EHSMS~~SHEQ MS ~~Program~~ consists of the following standards and operating procedures contained in eight volumes:

Volume 1 – *Standards*
Volume 2 – *Management Procedures*
Volume 3 – *Operating Manual* (SOPs)
Volume 4 – *Health Physics Manual*

Volume 5 – *Industrial Safety Manual*
Volume 6 – *Environmental Manual*
Volume 7 – *Training Manual*
Volume 8 – *Emergency Manual*

Written operating procedures have been developed for all process activities including those activities involving radioactive materials for the Crow Butte Uranium Project. Where radioactive material handling is involved, pertinent radiation safety practices are incorporated into the operating procedure. Additionally, written operating procedures have been developed for non-process activities including environmental monitoring, health physics procedures, emergency procedures, and general safety.

The procedures enumerate pertinent radiation safety procedures to be followed. A copy of the written procedure will be kept in the area where it is used. All procedures involving radiation safety will be reviewed and approved in writing by the RSO or another individual with similar qualifications prior to being implemented. The RSO will also perform a documented review of the operating procedures annually.

5.2.1.2 Radiation Work Permits

In the case that employees are required to conduct activities of a nonroutine nature where there is the potential for significant exposure to radioactive materials and for which no operating procedure exists, a Radiation Work Permit (RWP) will be required. The RWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The RWP shall be reviewed and approved in writing by the RSO (or qualified designee in the absence of the RSO) prior to initiation of the work.

The RSO may also issue Standing Radiation Work Permits (SRWP's) for periodic tasks that require similar radiological protection measures (e.g., maintenance work on a specified plant system). The SRWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The SRWP shall be reviewed and approved in writing by the RSO (or qualified designee in the absence of the RSO) prior to initiation of the work.

5.2.1.3 Record Keeping and Retention

The ~~EHSMS~~SHEQ MS ~~Program~~ Volume II, *Management Procedures,* provides specific instructions for the proper maintenance, control, and retention of records associated with implementation of the program. The program is consistent with the requirements of 10 CFR 20 Subpart L and 10 CFR §40.61 (d) and (e). Records of surveys, calibrations, personnel monitoring, bioassays, transfers or disposal of source or byproduct material, and transportation accidents will be maintained on site until license termination. Records containing information pertinent to decommissioning and reclamation such as descriptions of spills, excursions, contamination events, etc., as well as information related to site and aquifer characterization and background radiation levels will be maintained on site until license termination. Duplicates of all significant records will be maintained in the corporate office or other offsite locations.

5.2.2 Performance Based License Condition

This license application is the basis of the Performance Based License (PBL) originally issued in 1998. Under that license CBR may, without prior NRC approval or the need to obtain a License Amendment:

1. Make changes to the facility or process, as presented in the license application (as updated);
2. Make changes in the procedures presented in the license application (as updated); and
3. Conduct tests or experiments not presented in the license application (as updated).

A License Amendment and/or NRC approval will be necessary prior to implementing a proposed change, test or experiment if the change, test or experiment would:

1. Result in any appreciable increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
2. Result in any appreciable increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the license application (as updated);
3. Result in any appreciable increase in the consequences of an accident previously evaluated in the license application (as updated);
4. Result in any appreciable increase in the consequences of a malfunction of an SSC previously evaluated in the license application (as updated);
5. Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);
6. Create a possibility for a malfunction of an SSC with a different result than previously evaluated in the license application (as updated);
7. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER) or the environmental assessment (EA) or technical evaluation reports (TERs) or other analysis and evaluations for license amendments.

8. For purposes of this paragraph as applied to this license, SSC means any SSC that has been referenced in a staff SER, TER, EA, or environmental impact statement (EIS) and supplements and amendments thereof.

Additionally CBR must obtain a license amendment unless the change, test, or experiment is consistent with the NRC conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TERs, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, and EISs issued with amendments to this license.

5.2.3 Safety and Environmental Review Panel ~~(SERP)~~

A Safety and Environmental Review Panel (SERP) will make the determination of compliance concerning the conditions discussed in Section 5.2.2. The SERP will consist of a minimum of three individuals. One member of the SERP will have expertise in management and will be responsible for managerial and financial approval for changes; one member will have expertise in operations and/or construction and will have expertise in implementation of any changes; and one member will be the ~~Radiation Safety Officer (~~RSO~~)~~, or equivalent. Other members of the SERP may be utilized as appropriate, to address technical aspects of the change, experiment or test, in several areas, such as health physics, groundwater hydrology, surface water hydrology, specific earth sciences, and others. Temporary members, or permanent members other than the three identified above, may be consultants.

The SERP is responsible for monitoring any proposed change in the facility or process, making changes in procedures, and conducting tests or experiments not contained in the current NRC license. As such, they are responsible for insuring that any such change results in no degradation in the essential safety or environmental commitments of CBR.

5.2.3.1 Safety and Environmental Review Panel Review Procedures

The CBR SERP will implement the following review procedures for the evaluation of all appropriate changes to the facility operations as outlined in ~~EHSMS~~SHEQ ~~Program~~MS. Volume II, *Management Procedures*. The SERP may delegate any portion of these responsibilities to a committee of two or more members of the SERP. Any committees so constituted will report their findings to the full SERP for a determination of compliance with Section 5.2.2 of this chapter. In their documented review of whether a potential change, test, or experiment (hereinafter called the change) is allowed under the PBL (or Performance Based License Condition (PBLC)) without a license amendment, the SERP shall consider the following:

- Current NRC License Requirements

The SERP will conduct a review of the most current NRC license conditions to assess which, if any, conditions will have an impact on or be impacted by the potential SERP action. If the SERP action will conflict with a specific license requirement, then a license amendment is necessary before initiating the change. This review includes information included in the approved license application.

- Ability to Meet NRC Regulations

The SERP will determine if the change, test, or experiment conflicts with applicable NRC regulations (example: 10 CFR Parts 20 and 40 requirements). If the SERP action conflicts with NRC regulations, a license amendment is necessary.

- Licensing Basis

The SERP will review whether the change, test, or experiment is consistent with NRC's conclusions regarding actions analyzed and selected in the licensing basis. Documents that the SERP must review in conducting this evaluation include the SER and EA prepared in support of the license renewal application (February 1998) and any SERs, TERs, EAs, or EISs prepared to support amendments to the license. The RSO will maintain a current copy of all pertinent documents for review by the SERP during these evaluations.

- Financial Surety

The SERP will review the proposed action to determine if any adjustment to financial surety arrangement or approved amount is required. If the proposed action will require an increase to the existing surety amount, the financial surety instrument must be increased accordingly before the change can be approved. The surety estimate must be updated either through a license amendment or through the course of the annual surety update to the NRC. The NRC incorporates the annual surety update by license amendment.

- Essential Safety and Environmental Commitments

The SERP will assure that there is no degradation in the essential safety or environmental commitment in the license application, or as provided by the approved reclamation plan.

5.2.3.2 Documentation of SERP Review Process

After the SERP conducts the review process for a proposed action, it will document its findings, recommendations, and conclusions in a written report format. All members of the SERP shall sign concurrence on the final report. If the report concludes that the action meets the appropriate PBL or PBLC requirements and does not require a license amendment, the proposed action may then be implemented. If the report concludes that a license amendment is necessary before implementing the action, the report will document the reasons why, and what course CBR plans to pursue. The SERP report shall include the following:

- A description of the proposed change, test, or experiment (proposed action);
- A listing of all SERP members conducting the review and their qualifications (if a consultant or other member not previously qualified);
- The technical evaluation of the proposed action, including all aspects of the SERP review procedures listed above;
- Conclusions and recommendations;
- Signatory approvals of the SERP members; and
- Any attachments such as all applicable technical, environmental, or safety evaluations, reports, or other relevant information including consultant reports.

All SERP reports and associated records of any changes made pursuant to the PBL or PBLC shall be maintained through termination of the NRC license.

On an annual basis, CBR will submit a report to the NRC that describes all changes, tests, or experiments made pursuant to the PBL or PBLC. The report will include a summary of the SERP evaluation of each change. In addition, CBR will annually submit any pages of the license renewal application to reflect changes to the License Renewal Application or supplementary information. Each replacement page shall include both a change indicator for the area of change (e.g., bold marking vertically in the margin adjacent to the portion actually changed), and a page change identification (date of change or change number, or both).

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

The following internal inspections, audits and reports are performed for the Crow Butte Uranium Project operations. Similar activities will be performed for the North Trend Expansion Area.

5.3.1 Radiation Safety Inspections

5.3.1.1 Daily Inspections

The RSO, HPT or Lead Operator conducts a daily walkthrough inspection of the plant. In addition to the Lead Operator having been trained and having experience with the operating facilities, this position also has been trained and instructed in the general radiation safety practices and procedures described in Section 5.2.3. Daily inspections consist of a daily walk-through (visual) inspection of all work and storage areas of the facility to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that would minimize unnecessary contamination. The inspection entails a visual examination of compliance or other problems, which are reviewed with the Operations Manager.

5.3.1.2 Weekly RSO Inspections

On a weekly basis, the RSO and Operations Manager (or designee in their absence, such as the HPT, General Manager or Lead Operator) will conduct an inspection of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The results of the daily inspections are reviewed, and as needed, schedules are developed for addressing any identified corrective actions. Daily work-orders and shift logs are reviewed in order to determine that all jobs and operations with a potential for exposing personnel to uranium, especially those RWP jobs that would require a radiation survey and monitoring, were approved in writing by the RSO, the RSO's staff or the RSO's designee (e.g., HPT) prior to initiation of work.

5.3.1.3 Monthly RSO Reports

The RSO provides a written summary of the month's radiological activities at the Crow Butte Uranium Project facilities. The report includes a review of all monitoring and exposure data for the month, a summary of worker protection activities, a summary of all pertinent radiation survey records, a discussion of any trends in the ALARA program, and a review of adequacy of the implementation of NRC license conditions. Recommendations are made for any corrective actions or improvements in the process or safety programs.

5.3.2 Evaporation Pond Inspections

The inspection program developed by CBR for use on the ponds in the current production area are contained in ~~EHSMS~~SHEQ MS ~~Program~~ Volume VI, *Environmental Manual,* and is based on the guidance in USNRC Regulatory Guide 3.11.1[3]. The existing pond inspection program will be used as applicable as the basis for inspections on the NTEA~~orth Trend Expansion Area~~ evaporation pond. The inspection program is summarized below.

5.3.2.1 Daily Inspections

- Pond Depth - The depth of water in each pond is measured and recorded.
- Pond Embankments - The pond embankments are visually inspected for signs of cracking, slumping, movement or a concentration of seepage.

5.3.2.2 Weekly Inspections

- Perimeter Fence - The game-proof perimeter fence is inspected for holes that would allow animals to enter the pond area.
- Inlet Pipes – The pond inlet piping is inspected to verify that it is not clogged with ice, dirt, etc.
- Underdrain Measurements - The underdrains are measured and the vertical depth of fluid in the standpipe is recorded.
- Pond Sprays - When in use, the enhanced evaporation systems should be checked at regular intervals.
- Pond Liner - The liner is visually inspected weekly for holes or other signs of distress.
- Leak Detection System - The leak detection pipes for all ponds are measured for fluid in the standpipes and the vertical depth of the fluid shall be recorded on the Pond Inspection Forms.

5.3.2.3 Quarterly Inspections

- Embankment Settlement - The top of the embankments and downstream toe area are examined for settlement or depressions.
- Embankment Slopes - Embankment slopes are examined for irregularities in alignment and variances from originally constructed slopes (i.e., sloughing, toe movement, surface cracking or erosion).
- Seepage - Evidence of seepage in any areas surrounding the ponds (especially the downstream toes) is investigated and documented.

- Slope Protection - Vegetation on the out slopes of the pond is examined. Any evidence of rills or gullies forming is noted.
- Post-Construction Changes - Any changes to the upstream watershed areas that could affect runoff to the ponds is noted.
- Emergency lines are inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

5.3.2.4 Annual Inspection

A technical evaluation of the pond system will be done annually which addresses the hydraulic and hydrologic capacities of the ponds and ditches and the structural stability of the embankments. A survey of the pond embankments will be done on an annual basis and the survey results documented and incorporated into the annual inspection report. The survey is reviewed for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes.

The technical evaluation will be the result of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in ~~the State of~~ Nebraska. Examination of the pond monitor well sampling data will also be reviewed for signs of seepage in the embankments.

The inspection report will present the results of the technical evaluation and the inspection data collected since the last report. The report will be kept on file at the site for review by regulatory agencies. A copy is also submitted to the NRC within one month of the annual inspection.

5.3.3 Annual ALARA Audits

CBR will conduct annual audits of the radiation safety and ALARA programs. The ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager may conduct these audits. Alternatively, CBR may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits is to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Crow Butte Uranium Project facility. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an audit service, the auditor will meet the minimum qualifications for education and experience as for the RSO as described in Section 5.4.

The audit of the radiation protection and ALARA program is conducted in accordance with the recommendations contained in Regulatory Guide 8.31. A written report of the results is submitted to corporate management. The RSO may accompany the auditor but

may not participate in the conclusions.

The annual ALARA audit report summarizes the following data:

1. Employee exposure records;
2. Bioassay results;
3. Inspection log entries and summary reports of mine and process inspections;
4. Documented training program activities;
5. Applicable safety meeting reports;
6. Radiological survey and sampling data;
7. Reports on any overexposure of workers; and
8. Operating procedures that were reviewed during this time period

The ALARA audit report specifically discusses the following:

1. Trends in personnel exposures;
2. Proper use, maintenance and inspection of equipment used for exposure control; and
3. Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report is submitted to and reviewed by the President and General Manager. Implementations of the recommendations to further reduce employee exposures, or improvements to the ALARA program, are discussed with the ALARA auditor.

An audit of the Quality Assurance/Quality Control (QA/QC) program is also conducted on an annual basis. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited performs the audit. The results of the QA/QC audit are documented with the ALARA Audit. The RSO has the primary responsibility for the implementation of the radiological QA/QC programs at the Crow Butte Uranium Project facilities.

The RSO has the ultimate responsibility for ensuring that the NRC's radiological standards are being met at the North Trend site. The Lead Operator at the Satellite Facility or Wellfield operations would have the responsibility for responding to any spill requiring cleanup. Plant operators and wellfield operators, who have received spill response training, would conduct the cleanup operations.

The proposed management audit and inspection programs for the North Trend operations would be sufficient for the type of operations and number and type of employees. CBR has projected that the staffing level for the North Trend operations would be twelve full-time CBR staff members in order to staff 3 employees per 12-hour shifts (One lead Operator and two plant operators). These new employees will be needed for the satellite plant, wellfield operations and maintenance positions. Other staff members working out of the current CBR processing facility that would occasionally visit the North Trend Satellite Facility and associated wellfields would include the RSO, HPT, Safety Supervisor, ~~Manager of Health, Safety and Environmental Affairs~~SHEQ Manager, as well as various technical and managerial staff members.

5.4 HEALTH PHYSICS STAFF QUALIFICATIONS

CBR project staff is highly experienced in the management of uranium development, mining and operations. The following minimum personnel specifications and qualifications are strictly adhered to.

5.4.1 Radiation Safety Officer Qualifications

The minimum qualifications for the Radiation Safety Officer (RSO) are as follows:

- Education - A Bachelor's Degree in the physical sciences, industrial hygiene, environmental technology or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. As per Regulatory Guide 8.31, two years of relevant experience are generally considered equivalent to 1 year of academic study.

- Health Physics Experience - A minimum of 1 year of work experience relevant to uranium mill/solution mining operations in applied health physics, radiation protection, industrial hygiene or similar work.
- Specialized Training - A formalized, specialized course(s) in health physics specifically applicable to uranium milling/solution mining operations, of at least 4 weeks duration. The RSO attends refresher training on uranium mill health physics every two years.
- Specialized Knowledge - The RSO, through classroom training and on-the-job experience, possesses a thorough knowledge of the proper application and use of all health physics equipment used in the operation, the procedures used for radiological sampling and monitoring, methods used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the solution mining process and equipment used and how hazards are generated and controlled during the process.

5.4.2 Health Physics Technician Qualifications

The Health Physics Technician (HPT) will have one of the following combinations of education, training and experience:

1. Education (Option #1) – An associate degree or 2 years or more of study in the physical sciences, engineering or a health-related field,

   Training - At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to uranium mills/solution mining operations.

   Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill/solution mining operation; or

2. Education (Option #2) - A high school diploma.

   Training - A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to uranium mills.

   Experience - Two years of relevant work experience in applied radiation protection.

5.5 RADIATION SAFETY TRAINING

All site employees and contractor personnel at the Crow Butte Uranium Project are administered a training program based upon the ~~EHS~~SHEQ MS ~~Management System~~ covering radiation safety, radioactive material handling, and radiological emergency procedures. The CBR Training Program in ~~EHSMS~~SHEQ MS ~~Program~~ Volume VII, *Training Manual,* provides requirements for radiation safety training. The training program is administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29[4], USNRC Regulatory Guide 8.31, and USNRC Regulatory Guide 8.13[5]. The technical content of the training program is under the direction of the RSO. The RSO or a qualified designee conducts all radiation safety training. CBR will implement this training program for activities at the North Trend Expansion Area.

5.5.1 Training Program Content

5.5.1.1 Visitors

Visitors to the Crow Butte Uranium Project facilities who have not received training are escorted by on site personnel properly trained and knowledgeable about the hazards of the facility. At a minimum, visitors are instructed specifically on what they should do to avoid possible hazards in the area of the facilities that they are visiting.

5.5.1.2 Contractors

Any contractors having work assignments at the facilities are given appropriate radiological safety training. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of Crow Butte workers as discussed in Section 5.5.1.3.

5.5.1.3 Crow Butte Resources Employees

All CBR employees (and some contractors as noted in Section 5.5.1.2) receive training as radiation workers. The program incorporates the following topics recommended in USNRC Regulatory Guide 8.31:

<u>Fundamentals of health protection</u>

- Using respirators when appropriate.

- Eating, drinking and smoking only in designated areas.
- Using proper methods for decontamination.

Facility-provided protection

- Cleanliness of working space.
- Safety designed features for process equipment.
- Ventilation systems and effluent controls.
- Standard operating procedures.
- Security and access control to designated areas.

Health protection measurements

- Measurements of airborne radioactive material.
- Bioassay to detect uranium (urinalysis and in vivo counting).
- Surveys to detect contamination of personnel and equipment.
- Personnel dosimetry.

Radiation protection regulations

- Regulatory authority of NRC, OSHA and state.
- Employee rights in 10 CFR Part 19.
- Radiation protection requirements in 10 CFR Part 20.

Emergency procedures

All new workers, including supervisors, are given specialized instruction on the health and safety aspects of the specific jobs they will perform. This instruction is done in the form of individualized on-the-job training. Retraining is performed annually and documented.

5.5.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course is given to each worker. The instructor reviews the test results with each worker and discusses incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam are retested and test results remain on file.

5.5.3 On-The-Job Training

5.5.3.1 Health Physics Technician

On-the-job training is provided to HPT's in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs and Health Physics Procedures contained in ~~EHSMS~~SHEQ MS ~~Program~~ Volume IV, *Health Physics Manual.*

5.5.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors receive ongoing radiation safety training as part of the annual refresher training and, if determined necessary by the RSO, during monthly safety meetings. This ongoing training is used to discuss problems and questions that have arisen, any relevant information or regulations that have changed, exposure trends and other pertinent topics.

5.5.5 Training Records

Records of training are kept until license termination for all employees trained as radiation workers (i.e., occupationally-exposed employees).

5.6 SECURITY

CBR security measures for the current operation are specified in the Security Plan and Security Threat chapter in Volume VIII, *Emergency Manual.* Crow Butte Resources, Inc. ~~(~~CBR~~)~~ is committed to:

- Providing employees with a safe, healthful, and secure working environment;
- Maintaining control and security of NRC licensed material;
- Ensuring the safe and secure handling and transporting of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The NRC requires licensees to maintain control over licensed material (i.e., natural uranium ("source material") and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material
The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material Not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored licensed material at the Crow Butte Central Processing Plant would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

At the North Trend Expansion Area, licensed stored material would typically include loaded ion exchange resin and byproduct waste awaiting disposal. Lixiviant would be found in production piping in the well field and well field house, production trunkline to the Satellite Facility, and within piping located in the satellite building. Loaded ion exchange resin would be placed in a transport truck and temporarily stored in the vehicle until the truck is filled and ready for delivery to the Crow Butte Central Processing Plant.

5.6.1 License Area and Plant Facility Security

5.6.1.1 Current Central Processing Facility Area

The active mining areas are controlled with fences and appropriate signs. All central processing facility areas where source or byproduct material is handled are fenced. The main access road is equipped with a locking gate. Strategically placed surveillance

cameras monitor the access road and areas around the central processing facility. A 24-hour per day 7-day per week staff is on duty in the central processing facility.
Central plant operators perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection determines whether all licensed material is properly stored in a restricted area Figure 2.1-2) or, if in controlled or unrestricted areas, is properly secured. In particular, operators ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material is properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel or surveillance cameras. The results of this inspection will be properly documented.

5.6.1.2 Office Building

There is a reception area located at the main entrance into the office building. All other entrances are locked during off-shift hours. There are a limited number of traceable keys to the office and they are given out to select employees. The main door and the door to the central plant facility entrance are also equipped with an access keypad.

Visitors entering the office are greeted by the receptionist and announced to the receiving person. All visitors are required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited is responsible to supervise the visitors at all times when they are on site. Visitors are only allowed at the facility during regular working hours unless prior approval is obtained from the Mine Manager or the ~~Manager of Health, Safety, and Environmental Affairs~~SHEQ Manager.

5.6.2 North Trend Security

The entrance to the North Trend Expansion Area site will be from a gravel road to the south of the facility. The entrance to the site will be posted indicating that permission is required prior to entry. A gate on the access route will be capable of being locked. The satellite plant site within the license area will be properly posted in accordance with 10 CFR § 20.1902 (e). Evaporation ponds will be fenced and posted.

The security fence surrounding the North Trend Satellite Facility serves as a control for industrial/property protection purposes, with the restricted areas as required by 10 CFR 20 noted in red in Figures 2.3-1 and 3.2-1. The area within the security fencing surrounding the evaporation ponds will be a designated restricted area as per 10 CFR 20 (Figure 3.2-1). Access to wellfields will have area fencing that will serve as a control for industrial/property protection purposes. Appropriate signage will be placed on all fencing advising of access restrictions.

Restricted area at the North Trend Satellite Facility refers to "*...an area where access to is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials*" (10 CFR 20.1003). Proposed restricted areas for the North Trend Satellite Facility are shown in Figures 2.1-3 and 3.2-1. Each radiation area will be posted with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA" (10 CFR 20.1902). Radiological warnings are posted based upon actual or likely conditions. Actual conditions are determined through area monitoring. Likely conditions are identified based on professional judgment or experience regarding the probability that a radiological condition will exist. When evaluating the likelihood of specific conditions, normal situations as well as unique situations that can reasonably be expected to occur will be considered.

All visitors, contractors, inspectors, and new employees entering the North Trend Expansion Area site will be required to register at the plant office and will not be permitted inside the plant or wellfield areas without proper authorization. All visitors needing safety equipment, such as hardhat and safety glasses, will be issued the items by company personnel. Inexperienced visitors will be escorted within the controlled area of the facility unless they are frequent visitors who have been instructed regarding the potential hazards in various site areas. All appropriate and necessary safety or radiological training will be provided and documented by the Radiation Safety Officer or designee. Training requirements associated with visitors and contractors are discussed in Section 5.5.

The satellite plant will routinely operate 24 hours per day and 7 days per week, so CBR employees will normally be on-site except for occasional shutdowns. The Satellite Plant structure will be equipped with locks to prevent unauthorized access. All plant personnel are instructed to immediately report any unauthorized persons to their supervisors. The supervisor will contact the reported unauthorized person and make sure that they have been authorized for entry. If the person is unauthorized, and has no business on the property, they will be escorted to the main entrance for departure.

Access by unauthorized personnel to the stored and non-stored licensed materials (pregnant lixiviant solution, loaded ion exchange resin and By-product material awaiting disposal) would be controlled by perimeter access gates with locks and site personnel. This would include piping, process vessels, tankage, and any truck vehicle containing loaded ion exchange resin and parked within or near the Satellite Facility building.

Wellfield houses where pregnant lixiviant solutions would be present in the production piping would be kept locked. Only authorized personnel would have keys to the wellfield houses. The production trunk line conveying pregnant lixivant from the wellfield houses to the satellite building would be located within an area within perimeter fencing that only authorized personnel would be allowed to enter. Gates associated with perimeter fencing enclosing any well field that is in operation would be kept locked when operators and workers are not present (e.g., remote from the satellite facility). Security may further be increased by installing continuous video surveillance of outside areas.

CBR maintains and enforces requirements of the SHEQ MS Volume *IV*, *Health Physics Manual*~~, *Environmental, Health, and Safety Management Plan*~~, that specifies access controls and security issues applicable to visitors, contractors and employees, radiological posting, and radiological survey and monitoring requirements associated with activities at the site.

Even without consideration of reduced exposures due to the security measures discussed above, the highest estimated total effective dose equivalent (TEDE), as determined using methods described in Section 7.3.3, for a downwind receptor near the North Trend Expansion Area is 5.8 mrem/year. This is based on an occupancy factor of 100% or 8760 hours per year. If the frequent visitor were onsite for 2000 hours per year (a full work year) and exposed to the same sources of radiation as the highest downwind receptor, the visitor would receive an annual dose of 1.2 mrem per year. It is unlikely that even frequent visitors to the North Trend Expansion area could receive annual doses near the 100 mrem public dose limit.

5.6.3 Transportation Security

CBR routinely receives, stores, uses, and ships hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans*, requires that persons that offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

> §172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;
>
> §172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required for that class under the provisions of subpart F of this part;

§172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F of this part.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by CBR employees will generally be restricted to moving ion exchange resin from a satellite facility to the central processing facility or transferring contaminated equipment between company facilities. This transport generally occurs over short distances through remote areas. Therefore, the potential for a security threat during transport by CBR vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following will be adhered to:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators;
- Off site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle;
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel are expected to be knowledgeable of, and adhere to, these guidelines and procedures when performing any load-related activity.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

CBR has a strong corporate commitment to and support for the implementation of the radiological control program at the Crow Butte Uranium Project facilities. This corporate commitment to maintaining personnel exposures as low as reasonably achievable (ALARA) has been incorporated into the radiation safety controls and monitoring programs described in the following sections.

5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Effluents

Under routine operations, the only radioactive effluent at the North Trend satellite plant facility will be the release of radon-222 gas from the production solutions. Elution and processing of uranium product will be performed at the central plant, where a vacuum dryer is used for drying the yellowcake product. Therefore, there will be no airborne particulate effluent from the North Trend Satellite Plant.

The radon-222 is found in the pregnant lixiviant that comes from the wellfield into the North Trend Satellite Plant. The production flow will be directed to the satellite plant process building for separation of the uranium. The uranium will be separated by passing the recovery solution through pressurized downflow ion exchange units. The vents from the individual vessels will be connected to a manifold that will be exhausted outside the plant building through the plant stack.

Venting to the atmosphere outside of the plant building minimizes personnel exposure. Small amounts of radon-222 may be released in the satellite plant building during solution spills, filter changes, ion exchange resin transfer operations and maintenance activities. The satellite plant building will be equipped with exhaust fans to remove any radon that may be released in the building. No significant personnel exposure to radon gas is expected based on operating experience from similar facilities. Ventilation and effluent control equipment will be inspected for proper operation as recommended in USNRC Regulatory Guide 3.56[6]. Ventilation and effluent control equipment inspections will be conducted during radiation safety inspections as discussed in Section 5.3.1.

5.7.1.2 Liquid Effluents

The liquid effluents from the North Trend Satellite Plant can be classified as follows:

- Water generated during well development - This water is recovered groundwater and has not been exposed to any mining process or chemicals. The water will be discharged directly to a solar evaporation pond and silt, fines and other natural suspended matter collected during well development will settle out.

- Liquid process waste - The operation of the satellite facility results in one primary source of liquid waste, a production bleed stream. The production bleed will be disposed of in the solar evaporation pond or in a deep disposal well permitted under the Nebraska Department of Environmental Quality (NDEQ) Class I Underground Injection Control (UIC) Program.

- Aquifer restoration - Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities: 1) Groundwater Transfer; 2) Groundwater Sweep; 3) Groundwater Treatment; and, 4) Wellfield Recirculation. Only the groundwater sweep and groundwater treatment activities will generate wastewater.

  During groundwater sweep, water would be extracted from the mining zone without injection causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity, such as deep well disposal and/or onsite evaporation ponds. Historically Crow Butte has not used groundwater sweep, but this option could be used in the future if warranted. As has been the case with past operations at Crow Butte, it is anticipated that during restoration groundwater at the NTEA will be treated using ion exchange (IX) and reverse osmosis (RO). Using this method, there would be no water consumption activities and only the bleed has to be dealt with for disposal, with the rest of the treated water being reinjected.

  Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit is typically used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is normally injected into the formation but, under certain circumstances, may be disposed of in the wastewater disposal system. The brine is sent to the wastewater disposal system. There are no plans for land application as an alternate groundwater disposal option.

The existing NRC Source Materials License allows CBR to dispose of wastewater from the central plant by three methods:

- Evaporation from the evaporation ponds;

- Deep well injection; and

- Land application.

CBR proposes to handle liquid effluents from the North Trend Expansion Area using evaporation from evaporation ponds and deep well injection.

The design, installation and operation criteria for solar evaporation ponds are those found to be applicable in USNRC Regulatory Guide 3.11[7]. The pond will be membrane-lined with a leak detection system under the membrane. The pond will have the capability of being pumped for deep disposal well injection. The pond may also be pumped for water treatment prior to discharge under an NPDES land application permit. A variety of treatment options exist depending upon the specific chemical contaminants identified in the wastewater. In general, a combination of chemical precipitation and reverse osmosis is adequate to restore the water to a quality that falls within the NPDES parameters.

5.7.1.3 Spill Contingency Plans

The RSO is charged with the responsibility to develop and implement appropriate procedures to handle potential spills of radioactive materials. Personnel representing the engineering and operations functions of the Crow Butte Uranium Project facility will assist the RSO in this effort. Basic responsibilities include:

- Assignment of resources and manpower.
- Responsibility for materials inventory.
- Responsibility for identifying potential spill sources.
- Establishment of spill reporting procedures and visual inspection programs.
- Review of past incidents of spills.
- Coordination of all departments in carrying out goals of containing potential spills.
- Establishment of employee emergency response training programs.
- Responsibility for program implementation and subsequent review and updating.
- Review of new construction and process changes relative to spill prevention and control.

Spills can take two forms within an in-situ uranium mining facility: 1) surface spills such as tank failures, piping ruptures, transportation accidents, etc.; and 2) subsurface releases such as a well excursion, in which process chemicals migrate beyond the wellfield, or a pond liner leak resulting in a subsurface release of waste solutions.

Engineering and administrative controls are currently in place to prevent both surface and subsurface releases to the environment and to mitigate the effects should a release occur. Where appropriate, similar controls will be instituted for the North Trend Satellite Plant.

Supervisory personnel, as well as satellite facility and wellfield operators, receive spill response training for release of radiological and non-radiological materials. In the event of a spill, a designated supervisor (dependent upon location of spill) would take the lead, providing guidance and direction to the facility operators responding to the spill. Supervisory personnel take guidance and direction from the RSO, Safety Supervisor and ~~Manager of Health, Safety and Environmental Affairs~~SHEQ Manager, as applicable.

- Surface Releases

  Failure of process tanks - Potential failures of process tanks will be contained within the satellite building. The entire building will drain to a sump that will allow transfer of the spilled solutions to appropriate tankage or the evaporation pond.

  Surface Releases - The most common form of surface releases from in-situ mining operations occurs from breaks, leaks, or separations within the piping system that transfers mining fluids between the central plant and the wellfield. These are generally small releases due to engineering controls that detect pressure changes in the piping systems and alert the plant operators through system alarms.

  In general, piping from the satellite plant to and within the wellfield will be constructed of PVC or high-density polyethylene (HDPE) pipe with butt welded joints or an equivalent. All pipelines will be pressure tested at operating pressures prior to operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines will be protected from vehicles driving over the lines, which could cause breaks. The only exposed pipes will be at the satellite process plant, the wellheads and in the wellhouses. Trunkline flows and wellhead pressures will be monitored for process control. Spill response is specifically addressed in the Radiological Emergencies and Emergency Reporting chapters of ~~EHSMS~~SHEQ ~~Program~~MS. Volume VIII, *Emergency Manual.*

CBR's spill control programs have been very effective at limiting surface releases from mining operations. CBR has never had a spill that was reportable under 10 CFR 20 reporting requirements. All spills are analyzed for root causes and contributing factors. Periodically, the CBR SERP meets to analyze recent spill events and to determine whether engineering or administrative improvements are indicated to reduce the frequency and magnitude of spills.

- Releases Associated With Transportation

The Transportation Emergencies chapter of ~~EHSMS~~SHEQ ~~Program~~MS. Volume VIII, *Emergency Manual,* provides the CBR emergency action plan for responding to a transportation accident involving a radioactive materials shipment. The chapter provides instructions for proper packaging, documentation, driver emergency and accident response procedures and cleanup and recovery actions. This chapter currently includes instructions that specifically address the CBR emergency action plan for responding to a transportation accident involving a shipment of eluent or ion exchange resin enroute to or from the Central Plant. Tanker trailers used for transportation of ion exchange resin between the North Trend satellite plant and the central plant will meet or exceed DOT and NRC requirements.

The worst-case transportation accident would involve a failure of the tanker, spilling the entire contents of uranium-loaded resin enroute to the central plant. The wet resin with the chemically bonded uranium would be confined to the immediate vicinity of the accident and would not become an airborne hazard. The close proximity of any accident to the central plant would ensure the rapid response of cleanup crews to contain and retrieve any spilled material.

- Sub-surface releases

Well Excursions - Mining fluids are normally maintained in the production aquifer within the immediate vicinity of the wellfield. The function of the encircling monitor well ring is to detect any mining solutions that may migrate away from the production area due to fluid pressure imbalance. This system has been proven to function satisfactorily over many years of operating experience with in-situ mining.

At the North Trend Expansion Area site, an undetected excursion will be highly unlikely. A ring of perimeter monitor wells located no further than 300 feet from the wellfield and screened in the ore-bearing Chadron Aquifer will surround all wellfields. Additionally, shallow monitor wells will be placed in the first overlying aquifer above each wellfield segment. Sampling of these wells will be done on a biweekly basis. Past experience at the Crow Butte central plant and other in-situ leach mining facilities has shown that this monitoring system is effective in detecting lixiviant migration. The total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and over-production of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

Migration of fluids to overlying aquifers has also been considered. Several controls are in place to prevent this. CBR will plug all exploration holes to prevent commingling of the Brule and Chadron aquifers and to isolate the mineralized zone. In addition, prior to placing a well in service, a well mechanical integrity test (MIT) will be performed. This requirement of the NDEQ UIC Program ensures that all wells are constructed properly and capable of maintaining pressure without leakage. Finally, monitor wells completed in the overlying aquifer will be sampled on a regular basis for the presence of leach solution.

Pond Liner Leak - Seepage of solutions from the evaporation ponds into ground or surface water is a potential release source. This has not been a problem at the Crow Butte central plant and should not be a problem at the North Trend Expansion Area ponds. Construction and operational safeguards will be implemented to insure maximum competency of the synthetic liner and earthen embankments. An underdrain leak detection system will allow sampling that would detect a leak. The pond soil foundation will have low ambient moisture due to its elevation, soil type and preparation. In the unlikely event of pond fluids seeping into the compacted subsoil, the liquid would be quickly absorbed and would not migrate. Pond monitor wells will be located downgradient in the uppermost aquifer to detect leaks.

In addition to the spills described above, the accumulation of sediment or erosion of existing soils can lead to potential releases of pollutants. The likelihood of significant sediment or erosion problems is greatest during construction activities. If rain, producing runoff, occurs during construction a small amount of the fill may be carried away from the construction area. Significant precipitation during pond and plant facility construction may also produce the same effect. Plant cover for erosion control will be established as soon as possible on exposed areas. Little additional suspendable material should be produced during mining operations and restoration activities. Site reclamation in the future with backfilling of ponds, grading the plant site, and replacing the topsoil will also expose unsecured soil for suspension in runoff waters. The sediment load as a result of precipitation during future construction or reclamation activities should not significantly affect the quality of any watercourses since the projected satellite plant location is not crossed by any streams.

Runoff from precipitation events should be controlled to minimize any exposure to pollutants on the site. At the North Trend Expansion Area, runoff should not be a major issue, given the engineering design of the facilities, as well as engineering and administrative controls. Rainwater entering a pond leading to a pond overflow would be the greatest item of concern. The design and operation of the ponds will preclude a runoff-induced overflow as a realistic possibility. Should there be high runoff concurrent with a pipeline failure, some contamination could be spread depending upon the relative saturation of the soils beneath the leaking area. In any event, only minimal releases of solutions would occur in the event of a pipeline failure, and migration of pollutants due to runoff would be minimal.

As an adjunct to this approach, CBR will survey, remove and dispose field spill soils at levels greater than the 10 CFR Part 40, Appendix A, Criterion 6(6), with the unity rule applied where appropriate. This approach will reduce CBR decommissioning obligations and further mitigate the already limited contribution from field spills to offsite soil, vegetation and surface water contamination.

5.7.2 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM

5.7.2.1. Gamma Surveys

External gamma radiation surveys have been performed routinely at the Crow Butte Uranium Project and will be performed at the North Trend Satellite Plant. The required frequency is quarterly in designated Radiation Areas and semiannually in all other areas of the plant. Surveys will be performed at worker-occupied stations and areas of potential gamma sources such as tanks and filters. CBR establishes a Radiation Area if the gamma survey exceeds the action level of 5.0 mRem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. An investigation is performed to determine the probable source and survey frequency for areas exceeding 5.0 mRem per hour is increased to quarterly. Records are maintained of each investigation and the corrective action taken. If the results of a gamma survey identified areas where gamma radiation is in excess of levels that delineate a "Radiation Area", access to the area is restricted and the area is posted as required in 10 CFR §20.1902 (a). Designated Radiation Areas will be as defined in 10 CFR 20.1003: *Radiation area* means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

External gamma surveys are performed with survey equipment that meets the following minimum specifications:

1. Range - Lowest range not to exceed 100 microRoentgens per hour (μR/hr) full-scale with the highest range to read at least 5 milliRoentgens per hour (mR per hour) full scale; and

2. Battery operated and portable.

Examples of satisfactory instrumentation that meets these requirements are the Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent. Gamma survey instruments are calibrated at the manufacturer's suggested interval or at least annually and are operated in accordance with the manufacturer's recommendations. Instrument checks are performed each day that an instrument is used.

Gamma exposure rate surveys will be performed in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.* Proposed survey locations for the North Trend Satellite Plant are shown on Figure 5.7-~~2~~1. Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions. Surveys are performed in accordance with the guidance contained in USNRC Regulatory Guide 8.30[8].

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake are recommended in USNRC Regulatory Guide 8.30, Section 1.4 and are performed in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.* Beta evaluations may be substituted for surveys using radiation survey instruments. Since elution, precipitation, and drying operations will be performed in the existing central plant, beta surveys should not be necessary at the North Trend Satellite Plant.

5.7.2.2 Personnel Dosimetry

10 CFR §20.1502 (a)(1) requires exposure monitoring for "Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.500 Rem. Maximum individual annual exposures at the Crow Butte Uranium Project facilities since 1987 have been well below the limit, with a maximum individual external exposure of 495 mRem in 1995.

CBR determines monitoring requirements in accordance with the guidance contained in USNRC Regulatory Guide 8.34[9]. CBR believes that it is not likely that any employee working at the North Trend satellite plant will exceed 10 percent of the regulatory limit (i.e., 500 mrem/yr). Although monitoring of external exposure may not be required in accordance with §20.1201(a), CBR currently issues dosimetry to all process employees and exchanges them on a quarterly basis. The North Trend process plant and wellfield operators would be included in this program.

Dosimeters are provided by a vendor that is accredited by National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology as required in 10 CFR § 20.1501. The dosimeters have a range of 1 mR to 1000 R. Dosimeters are exchanged and read on a quarterly basis.

Results from personnel dosimetry will be used to determine individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE) in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume IV, *Health Physics Manual.*

CBR has data for other external dose parameters such as Shallow Dose Equivalent (SDE) and Lens Dose Equivalent (LDE) for the existing site. As with the Deep Dose Equivalent (DDE) it can be shown that the external doses are all less than 10% of the applicable limits. Extremity monitoring is required when the dose to the extremity is higher than the dose to rest of the body. This would be applicable to beta doses associated with aged yellowcake sources as discussed in 5.7.2.1. The North Trend Expansion area will not have aged sources of yellowcake since it is frequently transferring the ion exchange resin to the central plant facility for further processing. There may be cases such as wellfield piping where Radium-226 has built up in pipe scale but in these cases the whole body DDE should be similar to the extremity dose.

Cumulative Exposures

Based on the proposed type of operations at the North Trend site (i.e., wet process) and historical exposures at the current operations, no significant increase in risks associated with exposure levels are expected for employees that work at the North Trend site and the current main operating plant. The North Trend operations would have a full-time staff that would be dedicated to working at that site. However, there may be some employees that would work at both locations for specified periods of time. Regardless of work locations, all CBR employees would be monitored for occupational external exposure if the exposure is likely to exceed 10% of the occupational dose limit appropriate for the individual (e.g., adult or declared pregnant woman), as specified in 10 CFR 20 1201 (a). As stated above, all wellfield and plant personnel at the North Trend operations would be included in the dosimetry program. The RSO would be responsible for determining the radiological monitoring requirements for all employees based on the facility radiation levels, worker job locations and tasks, and specific licensing requirements. The RSO would be responsible for reviewing the dosimetry results and comparing them with past data and regulatory exposure limits.

5.7.3 IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

The proposed airborne sampling location for the North Trend satellite facility is shown on Figure 5.7-~~2~~1. The location of the sampling points for radon, airborne uranium and gamma surveys are based on experience with similar equipment and operations at the current CBR operations. Factors that would be considered are the stage of the process (some areas more prone to exposure than others), potential known release points associated with the equipment and operations, and airflow patterns (based on current CBR operations). The sites selected are expected to have the highest potential for Figure 5.7-~~2~~1 Proposed North Trend Satellite Plant Survey and Sampling Locations releases of radiological contaminants (specific release points in the process and resin storage areas) and in areas where sampling would identify any elevated exposure levels due to inadvertent contamination (i.e., office, laboratory, change room and restroom). Sampling points of the process area are similar to other proposed satellite facilities. During the first year of operation, CBR will carry out a sampling program to assess the initial sampling locations and determine whether these locations provide measurements of the concentration representative of the concentration to which workers would be exposed.

Figure 5.7-21 North Trend Operation Proposed Monitoring Locations

The NTEA would be subject to requirements of CBR's SHEQ MS Volume III, Operating Manual, Environmental, Health and Safety Management System (EHSMSSHEQ MS), which has a section on the operation of the ventilation system.

Locations of sample points are based, in part, on a determination of airflow patterns in areas where monitoring is needed. Once the ventilation system is installed and operational, and prior to process operations, a portable anemometer would be used to assess the ventilation patterns (i.e., direction and velocity) in the work areas. Specific attention would be given to areas perceived as having a higher risk for releases. Assessments would be made of any different configurations that may be used for the ventilation system. The RSO would work with those designing the ventilation system in order to offer any suggestions to minimize worker exposure and to locate monitors at the most optimum locations, using experience from the current CBR operating facilities.

Once the final design has been completed, an assessment would be made by the RSO and operations staff as to the most optimum locations of radiological sampling points. Once the facility is constructed and operational, another assessment would be made of the sampling points and results, and a determination made as to the need for any changes to the monitoring points and frequency.

Monitoring locations and planned surveys would be consistent with USNRC Regulatory Guide 8.30. The airborne radiation monitoring program would allow for the determination of concentrations of airborne radioactive materials (including radon) during routine and non-routine operations, maintenance and cleanup. The controls and monitoring program will be sufficient to limit airborne radiation exposures and airborne radioactive releases to as low as reasonably achievable and is in conformance with regulatory requirement identified in 10 CFR Part 20.

5.7.3.1 Airborne Uranium Particulate Monitoring

Airborne particulate levels at solution mines that ship loaded ion exchange resin are normally very low since the product is wet. No precipitation, drying, or packaging of source material will be performed at the North Trend satellite facility. Yellowcake drying and packaging operations will be performed at the central facility. Therefore, the airborne uranium concentrations should be at or near local background levels. One location near the resin transfer station will be sampled monthly for airborne uranium particulates.

Area samples will be taken in accordance with the instructions currently contained in EHSMSSHEQ ProgramMS. Volume IV, *Health Physics Manual.* The Air Monitoring Chapter implements the guidance contained in USNRC Regulatory Guide 8.25[10]. Samples will be taken with a glass fiber filter and a regulated air sampler such as an

Eberline RAS-1 or equivalent. Sample volume will be adequate to achieve the lower limits of detection (LLD) for uranium in air. The LLD value for uranium in air would be $5e^{-11}$ uCi/ml, which is 10% of the DAC. Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard. Sampler calibration will be performed in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume IV, *Health Physics Manual.*

Breathing zone sampling is performed to determine individual exposure to airborne uranium during certain operations involving potential airborne exposure. Individual breathing zone monitoring may be required infrequently occur at times when engineering controls are impracticable or inoperable (non-routine operations). This would include maintenance activities (e.g., tank entry, disconnection of piping, repair of equipment such as pumps, etc.) that are required to maintain or regain control of normal production activities. A Radiation Work Permit (RWP) is required for such activities that involve the potential for significant exposure to radioactive materials and for which there are no SOPs. The RWPs dictate the proper type of breathing zone monitoring to be used and identifies procedures for protection against radiological hazards during the course of the work activity. There are certain SOPs that require individual monitoring, such as workers performing tasks such as transferring resin beads, changing the bicarbonate mix system filter media and changing deep disposal filter media.

Sampling is performed with lapel sampler or equivalent. The air filters are counted and compared to the DAC using the same method described for area sampling. Air samplers are calibrated at the manufacturer's recommended frequency or daily before each use using a primary calibration standard.

Measurement of airborne uranium will be performed by gross alpha counting of the air filters using an alpha scaler such as a Ludlum Model 2000 or equivalent. The Derived Air Concentration (DAC) for soluble (D classification) natural uranium of $5x10^{-10}$ μCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 will be used. The expected mix of long-lived radionuclides would be predominantly natural uranium with a lesser amount of Ra-226. The DAC for Ra-226 is $3x10^{-10}$ uCi/ml. The DAC for the mixture would be between the natural uranium DAC and the Radium-226 DAC. CBR believes the use of natural uranium DAC for comparison to administrative action levels to be appropriate since most of the expected mixture of airborne radionuclides is natural uranium and the DAC for natural uranium and Radium-226 are similar. An action level of 25% of the DAC for soluble natural uranium will be established at the North Trend Satellite Plant. If an airborne uranium sample exceeds the action level of 25% of the DAC, an investigation of the cause will be performed. If a monthly airborne uranium sample exceeds 25% of the action level, the sampling frequency would be increased from monthly to weekly until the airborne uranium levels do not exceed the action level for four consecutive weeks. The RSO may initiate corrective actions that may reduce future exposures.

No dose is calculated when comparing the measured airborne uranium concentrations to the natural uranium DAC. The purpose for this comparison is to see if the airborne uranium concentration is greater than the administrative action level of 25% DAC which triggers an investigation. If internal doses are required to be estimated pursuant to 10 CFR 20.1202, methods described in Section 5.7.4 of the application will be used.

As per 10 CFR 20.1201 (e), in addition to the annual dose limits, the intake of soluble uranium by an individual is limited to 10 mg in a week in consideration of chemical toxicity. If exposure to soluble uranium exceeds 25% of the weekly allowable intake of 10 mg, which would be 2.5 mg/week, then the RSO would initiate an investigation into the cause of the occurrence and initiate corrective actions that may reduce future exposures. As with any hazardous material handled on the site, the ALARA program would be applied to such potential chemical exposures as described in Section 2.5 of CBR's Health Physics Manual of the ~~EHSMS~~SHEQ MS.

Any worker likely to receive, in one year, an occupational dose in excess of 10% of the limits in 10 CFR 20 1201(a) will be monitored. The RSO will use historical and current monitoring and survey data to ensure worker external radiation exposures. The external and internal dose that an individual may be allowed to receive in the current year may be reduced by the amount of occupational dose received or amount of intake while employed by any other person. The record of prior occupational dose that the individual received while performing work involving radiation exposure would be obtained, as per 10 CFR 20.2104. All new employees would be asked to provide their past radiological exposure history and asked to sign an Exposure Release Form so previously radiological exposure history may be obtained. If a complete record of the individual's current and previously accumulated occupation dose is not available, it shall be assumed that in establishing administrative controls under 10 CFR 1201(f) for the current year, that the allowable dose limit for the individual would be reduced by 1.25 rems (12.5 mSv) for each quarter for which records were unavailable and the individual worker engaged in activities that could have resulted in occupational radiation exposure. It would also be assumed that the individual would not be available for planned special exposures. As per 10 CFR 20.2104, CBR would not be required to partition historical data between external dose equivalent(s) and internal committed dose equivalent(s).

5.7.3.2 Radon Daughter Concentration Monitoring

Surveys for radon daughter concentrations will be conducted in the operating areas of the North Trend Satellite Plant on a monthly basis. Sampling locations will be determined in accordance with the guidance contained in USNRC Regulatory Guide 8.25. Section 3.1 of NRC Regulatory Guide 8.25 states "lapel samplers or samplers located within about 1 foot of the workers head may be accepted as representative without further demonstration that the results are representative." Working Level measurements will be made using the Modified Kusnetz method (ANSI-N13.8-1973) which involves taking a grab sample, typically 5 minutes, and analyzing the filter for alpha activity. This grab sample will be taken at locations depicted on Figure 5.7-2 of the amendment application at a height typical of where a worker's breathing zone would exist and within the breathing zone of the worker collecting the sample.

Routine radon daughter monitoring will be performed in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.* Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard. Air sampler calibration will be performed in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.*

Results of radon daughter sampling are expressed in Working Levels (WL) where one WL is defined as any combination of short-lived radon-222 daughters in one liter of air without regard to equilibrium that emit 1.3×10^5 MeV of alpha energy. The DAC limit from Appendix B to 10 CFR §§ 20.1001 - 20.2402 for radon-222 with daughters present is 0.33 WL. CBR has established an action level of 25% of the DAC or 0.08 WL. The LLD for radon measures would be 0.033 WL, which is 10% of the DAC limit. Radon daughter results in areas with an average concentration in excess of the action level will result in an investigation of the cause and an increase in the sampling frequency to weekly until the radon daughter concentration levels do not exceed the action level for four consecutive weeks.

5.7.3.3 Respiratory Protection Program

Respiratory protective equipment has been supplied by CBR for activities where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. Use of respiratory equipment at Crow Butte Uranium Project is in accordance with the procedures currently set forth in the ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.* The respirator program is designed to implement the guidance contained in USNRC Regulatory Guide 8.15[11] and USNRC Regulatory Guide 8.31. The respirator program is administered by the RSO as the Respiratory Protection Program Administrator (RPPA).

Since airborne uranium concentrations at the North Trend Satellite Facility during typical operations are not expected to exceed action levels, it is not expected that respirator use will be required for such "normal" operation of the satellite facility. However, anytime the potential exists for elevated exposures to employees, respirators could be required. For example, certain maintenance activities (e.g., tank entry, disassembly of potentially contaminated piping and equipment, and welding/grinding on contaminated piping/equipment), and failure of the process building ventilation system, could require the use of respirators. The use of respirators at North Trend would be determined by CBR Standard Operations Procedures (SOPs) and Radiation Work Permits for specific tasks. CBR's respirator policy and requirements of respirator use are discussed in detail in CBR's above referenced ~~EHSMS~~SHEQ MS

5.7.4 EXPOSURE CALCULATIONS

Employee internal exposure to airborne radioactive materials at the North Trend satellite plant will be determined based upon the requirements of 10 CFR § 20.1204 and the guidance contained in USNRC Regulatory Guides 8.30 and 8.7[12]. Following is a discussion of the exposure calculation methods and results.

5.7.4.1 Natural Uranium Exposure

Exposure calculations for airborne natural uranium are carried out using the intake method from USNRC Regulatory Guide 8.30, Section 3. The intake is calculated using the following equation:

$$I_u = b\sum_{i=1}^{n}\frac{X_i \times t_i}{PF}$$

where:

I_u	=	uranium intake, μg or μCi
t_i	=	time that the worker is exposed to concentrations X_i (hr)
X_i	=	average concentration of uranium in breathing zone, $\mu g/m^3$, $\mu Ci/m^3$

b	=	breathing rate, 1.2 m^3/hr
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the week or quarter

The intake for uranium is calculated and recorded. The intakes are totaled and entered onto each employee's Occupational Exposure Record.

The data required to calculate internal exposure to airborne natural uranium is determined as follows:

Time of Exposure Determination

100% occupancy time is used to determine routine worker exposures. Exposures during non-routine work are always based upon actual time.

When calculating radiological exposures for North Trend, the occupancy time for "routine" operations would be an exposure period based on actual hours worked (12-hours shift period for plant personnel). This would be considered a 100% occupancy time that is used to determine routine worker exposures. For such routine exposures (i.e., 12-hr shift period), it is assumed that the worker was exposed to the measured "work area" average concentration of uranium for the entire work period (exposure 100% of the time). During part of that exposure period, the worker would be expected to spend some time in non-work areas such as the lunch room, office, restroom, hallways, etc. The 100% occupancy time approach generally results in a conservative (i.e., higher than actual) estimate of internal exposure to airborne natural uranium because it does not account for time the employee may have spent outside the work area, such as described above.

The measured average airborne uranium concentration is multiplied by the time of worker exposure (12 hours) to obtain the estimated average worker exposure for that time period. Routine operations refer to the facilities operating in a normal fashion with no upsets, maintenance activities, or other activities that may result in non-routine and elevated exposures. If a worker works more than the normal 12-hour shifts, the measured average airborne uranium concentration and the total hours actually worked are used to establish exposure levels.

For exposures during non-routine work tasks (e.g., maintenance or cleanup), measured exposures are based on actual time. The results of breathing zone samples collected during maintenance activities or Radiation Work Permits (RWP's) are taken over a specific time period and are added to the calculations of routine employee exposures for a given work period. For example, a worker working under a Radiation Work Permit for 2 hours would have exposures based on measurements taken for that time period (actual time), with the exposures for the remaining 10 hours of routine work based on the measured average concentration of airborne uranium.

Airborne Uranium Activity Determination

Airborne uranium activity is determined from surveys performed as described in Section 5.7.3.1.

CBR proposes to institute the same internal airborne uranium exposure calculation methods at the North Trend satellite plant that have been used to date at the Central Processing Plant and which are currently contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume IV, *Health Physics Manual.* Exposures to airborne uranium will be compared to the DAC for the "D" solubility class for natural uranium from Appendix B of 10 CFR §§20.1001 - 20.2401 ($5x10^{-10}$ µCi/ml). Footnote 3 in Table 1 of Appendix B to 10 CFR 20 states "the specific activity for natural uranium is 6.77 E-7 curies per gram U". This is equivalent to 6.77 E-7 µCi per microgram of natural uranium. This is the specific activity CBR will use to calculate the mass of uranium from an activity measurement and vice versa.

When required by 10 CFR 20.1202, CBR will use methods in NRC Regulatory Guide 8.30 to estimate internal doses. As an example, the Committed Effective Dose Equivalent (CEDE) can be calculated using Equation 2 in NRC Regulatory Guide 8.30 where:

H_{iE} =	Committed effective dose equivalent (CEDE) from radionuclide (rem)
I_i=	is the intake in µCi of Class D natural uranium as determined by the equation in Section 5.7.4.1 of the application
ALI_{iE} =	Value of the stochastic inhalation ALI for natural uranium from Column 2 of Table 1 in appendix B to 10 CFR Part 20 (2 µCi)
5 =	CEDE from intake of 1 ALI (rem)

If an intake (I_i) of 0.5 µCi was determined using the stated equation, the estimate CEDE from this intake would be:

$$H_{iE} = 5*0.5/2 = 1.25 \text{ rem}$$

If an intake (I_i) of 0.5 µg of natural uranium was determined using the stated equation, the estimated CEDE from this intake would be:

$$H_{iE} = 5*0.5*6.77 \text{ E-7}/2 = 8.5 \text{ E-7 rem}$$

It should be noted that the weekly limit for soluble uranium in 10 CFR 20.1202 (e) due to chemical toxicity is 10 milligram (10,000 µg) which would be equivalent to a CEDE of 17 mrem per week or 844 mrem per year. The occupational weekly toxicity limit for Class D natural uranium is more restrictive than the radiological limit.

5.7.4.2 Radon Daughter Exposure

Exposure calculations for airborne radon daughters are carried out using the intake method from USNRC Regulatory Guide 8.30, Section 3. The radon daughter intake is calculated using the following equation:

$$I_r = \frac{1}{170} \sum_{i=1}^{n} \frac{W_i \times t_i}{PF}$$

where:

I_r	=	radon daughter intake, working-level months
t_i	=	time that the worker is exposed to concentrations W_i (hr)
W_i	=	average number of working levels in the air near the worker's breathing zone during the time (t_i)
170	=	number of hours in a working month
PF	=	the respirator protection factor, if applicable

n = the number of exposure periods during the year

The data required to calculate exposure to radon daughters is determined as follows:

Time of Exposure Determination

100% occupancy time is used to determine routine worker exposure times. Exposures during non-routine work are always based upon actual time. A clarification of the 100% occupancy time is presented in Section 5.7.4.1 for natural uranium exposure. This explanation would also apply to radon daughter exposure.

Radon Daughter Concentration Determination

Radon-222 daughter concentrations are determined from surveys performed as described in Section 5.7.3.2. The working-level months for radon daughter exposure are calculated and recorded. The working-level months are totaled and entered onto each employee's Occupational Exposure Record.

CBR proposes to institute the same internal radon daughter exposure calculation methods at the North Trend satellite plant that have been used to date and which are currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual.* Exposures to radon daughters will be compared to the DAC for radon daughters from Appendix B of 10 CFR §§20.1001 - 20.2401 (0.33 WL).

The equation above calculates Working Level Months (WLM). If required by 10 CFR 20.1202, CBR can calculate a CEDE from the WLM estimate using Equation 2 in NRC Regulatory Guide 8.30 where:

H_{iE} = Committed effective dose equivalent (CEDE) from radionuclide (rem)

I_i = is the intake in WLM of radon-222 and its associated progeny as determined by the equation in Section 5.7.4.2 of the application

ALI_{iE} = Value of the stochastic inhalation ALI for radon-222 with progeny present from Column 2 of Table 1 in appendix B to Part 20 (4 WLM)

5 = CEDE from intake of 1 ALI (rem)

If an intake (I_i) of 1 WLM was determined using the stated equation, the estimate CEDE from this intake would be:

$$H_{iE} = 5*1/4 = 1.25 \text{ rem}$$

5.7.4.3 Prenatal and Fetal Exposure

- Dose Equivalent to an Embryo/Fetus

10 CFR §20.1208 requires that licensees ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman does not exceed 0.5 Rem (5 mSv). Licensees are also required to make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 0.5 Rem limit. The dose equivalent to the embryo/fetus is calculated as the sum of (1) the deep-dose equivalent to the declared pregnant woman; and, (2) the dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman. If the dose equivalent to the embryo is determined to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licenses shall be deemed to be in compliance with 10 CFR 20.1208 if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

- Individual Monitoring of External and Internal Occupational Exposure

The dose equivalent to the embryo/fetus is determined by the monitoring of the declared pregnant woman. 10 CFR §20.1502(a)(3) requires monitoring the exposure of a declared pregnant woman when the external dose to the embryo/fetus is likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv). All of the occupational doses in 10 CFR 20.1201 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded. 10 CFR 20.1502(b)(3) requires the monitoring of occupational intake of radioactive material by and assess the committed effective dose equivalent to a declared pregnant woman likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 0.1 rem (1 mSv). Based on this 0.1 rem threshold, the dose to the embryo/fetus must be determined if the intake is likely to exceed 1% of Annual Limit on Intake (ALI) during the entire period of gestation.

Prior to declaration of pregnancy, the woman may not have been subject to monitoring based on the conditions specified in 10 CFR 20.1502. In this case, CBR will estimate the exposure during the period monitoring was not provided, using any combination of surveys or other available data (for example, air monitoring, area monitoring, and bioassay). Exposure calculations will be performed as recommended in USNRC Regulatory Guide 8.36[13].

- External Dose to the Embryo/Fetus

The deep-dose equivalent to the declared pregnant woman during the gestation period will be taken as the external dose for the embryo/fetus. The determination of external dose will consider all occupational exposures of the declared pregnant woman since the estimated date of conception and will be based on the methods discussed in Section 5.7.2. External dose to the declared pregnant woman after declaration for the duration of the pregnancy shall be accomplished by personnel dosimetry with exchanges on a monthly basis.

- Internal Dose to the Embryo/Fetus

The internal dose to the embryo/fetus will consider the exposure to the embryo/fetus from radionuclides in the declared pregnant woman and in the embryo/fetus. The dose to the embryo/fetus will include the contribution from any radionuclides in the declared pregnant woman (body burden) from occupational intakes occurring prior to conception.

The intake for the declared pregnant woman will be determined as discussed in Sections 5.7.3.1 and 5.7.3.2.

5.7.5 BIOASSAY PROGRAM

CBR has implemented a urinalysis bioassay program at the Crow Butte Uranium Project facilities that meets the guidelines contained in USNRC Regulatory Guide 8.22[14]. The primary purpose of the program is to detect uranium intake in employees who are regularly exposed to uranium. The bioassay program consists of the following elements:

1. Prior to assignment to the facility, all new employees are required to submit a baseline urinalysis sample. Upon termination, an exit bioassay is required from all employees.

2. During operations, urine samples are collected from workers on a quarterly basis. Employees who have the potential for exposure to dried yellowcake submit bioassay samples on a monthly basis or more frequently as determined by the RSO. Samples are analyzed for uranium content by a contract analytical laboratory. Blank and spiked samples are also submitted to the laboratory with employee samples as part of the Quality Assurance program. The measurement sensitivity for the analytical laboratory is 5 μg/l.

3. Action levels for urinalysis are established based upon Table 1 in USNRC Regulatory Guide 8.22.

Elements of the quality assurance requirements for the Bioassay Program are based upon the guidelines contained in USNRC Regulatory Guide 8.22. These elements included the following:

1. Each batch of samples submitted to the analytical laboratory is accompanied by two blind control samples. The control samples are from persons that have not been occupationally exposed and are spiked to a uranium concentration of 10 to 20 μg/l and 40 to 60 μg/l. The results of analysis for these samples are required to be within ± 30% of the spiked value

2. The analytical laboratory spikes 10 to 30% of all samples received with known concentrations of uranium and the recovery fraction determined. Results are reported to CBR.

CBR proposes to continue to implement the Bioassay Program described in this section for operations at the North Trend Satellite Plant. The plant and wellfield operators will be included in a personnel dosimetry (exchanged on quarterly basis) and bioassay program, with urine samples collected on a quarterly basis. The program will be implemented in accordance with the guidance contained in USNRC Regulatory Guide 8.22 and with the instructions currently contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume IV, *Health Physics Manual.*

5.7.6 CONTAMINATION CONTROL PROGRAM

CBR will perform surveys for surface contamination in operating and clean areas of the North Trend Satellite Plant in accordance with the guidelines contained in USNRC

Regulatory Guide 8.30. Surveys for total alpha contamination in clean areas will be conducted weekly. In designated clean areas, such as lunchrooms, offices, change rooms, and respirator cabinets, the target level of contamination is nothing detectable above background. If the total alpha survey indicates contamination that exceeds 250 dpm/100 cm^2 (25% of the removable limit) a smear survey must be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area will be promptly cleaned and resurveyed.

All personnel leaving the restricted area will be required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields will be required to monitor themselves prior to leaving the area. All personnel receive training in the performance of surveys for skin and personal contamination. All contamination on skin and clothing is considered removable, so the limit of 1,000 dpm/100 cm^2 is applied to personnel monitoring. Personnel will also be allowed to conduct contamination monitoring of small, hand-carried items for use in wellfield and controlled areas as long as all surfaces can be reached with the instrument probe and the item does not originate in yellowcake areas. All other items are surveyed as described below.

Consistent with Regulatory Guide 8.31, t~~T~~he RSO, the radiation safety staff, or qualified ~~properly trained~~ employees will perform surveys of all items removed from the restricted areas with the exception of small, hand-carried items described above. Due to the remoteness of the North Trend operations site from the current CBR processing facility where the RSO and radiation staff has offices~~is officed~~, it is necessary~~would be more efficient~~ to have properly trained full-time personnel at the North Trend site available to perform surveys for releasing items from the restricted area.

~~Such a person would be the~~ Lead Operators and~~or a~~ plant/wellfield operators with a minimum of six months experience, will be trained by the RSO or radiation staff in the use of applicable radiation survey instruments and procedures including hands-on use of the instrumentation. These operators~~staff members~~ will~~ould~~ have also received job-specific training as operators as well as the ~~nd received~~ radiation safety training described in Section 5.6.1.3. ~~that all employees are required to take.~~ In addition, they would also be subject to additional hands-on training as to the survey instruments and procedures.

The release limits for beta gamma contamination are 0.2 mrad average and 1.0 mrad maximum at 10 cm as required by the~~are set by~~ *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials"*, USNRC, May 1987.

Surveys are performed with the following equipment:

1. Total surface activity will be measured with an appropriate alpha survey meter. A Ludlum Model 2241 scaler.or a Ludlum Model 177 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe, or equivalent, will be used for the surveys.

2. Portable GM survey meter with a beta/gamma probe with an end window thickness of not more than 7 mg/cm^2, a Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent.

3. Swipes for removable contamination surveys as required.

Survey equipment is calibrated annually or at the manufacturer's recommended frequency, whichever is more frequent. Surface contamination instruments are checked daily when in use. Alpha survey meters for personnel surveys are response checked before each use with other checks performed weekly.

As recommended in USNRC Regulatory Guide 8.30, CBR conducts quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. A spot check of the employees assigned to the North Trend satellite plant site will be conducted, concentrating on plant operators and maintenance personnel. The purpose of the surveys is to ensure that employees are adequately surveying and decontaminating themselves prior to exiting the restricted areas.

The contamination control program for the North Trend satellite plant will be implemented in accordance with the instructions currently contained in ~~EHSMS~~SHEQ ~~Program~~MS. Volume IV, *Health Physics Manual*.

5.7.7 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Radon

The radon gas effluent released to the environment from North Trend operations will be monitored at the same air monitoring locations (AM-9 through AM-14) that were used for baseline determination of radon concentrations as described in Section 2.9.2. Sampling locations are shown on Figure 5.7-3. Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged on a semiannual basis in order to achieve the required lower limit of detection (LLD) of $2x10^{-10}$. SHEQ~~EHSMS~~ Program Volume IV, *Health Physics Manual* currently provides the instructions for environmental radon gas monitoring. In addition to the manufacturer's Quality Assurance program, CBR will expose one duplicate radon Track Etch cup per monitoring period.

Monitoring of radon gas releases from the satellite facility building and ventilation discharge points is not deemed to be practicable. Section 3.3 of Regulatory Guide 8.37 indicates that where monitoring effluent points is not practicable, an estimate can be made of the magnitude of these releases, with such estimated releases used in demonstrating compliance with the annual dose limit. In 10 CFR 20.1302, allowance is made for demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from licensed operations does not exceed the annual dose limit of 100 mrem.

The North Trend Satellite Facility would use pressurized downflow ion exchange columns, which do not routinely release radon gas except during resin transfer and column backwashing. The design and operation of these systems result in the majority of the radon in the production fluid to stay in solution and is not released from the columns. Radon may be released from occasional venting of process vessels and tanks, small leaks in ion exchange equipment, and maintenance of equipment. Therefore, releases via the vent stacks would not have a consistent concentration of radon or flow rate, making it impracticable to try to use such data for public exposure estimates.

CBR has used MILDOS-Area to model the dose from facility operations resulting from releases of radon gas. Discussions are presented in Section 7.3.3. In determining the source term for MILDOS-Area for North Trend, radon gas release was estimated at 25% of the radon-222 in the production fluid from the wellfields and an additional 10% in the ion exchange circuit in the satellite building. The release of radon-222 at this

Figure 5.7-3

Proposed North Trend Satellite Plant Operational Monitoring Locations

concentration did not result in significant public dose. The closest resident in the downwind direction for the satellite facility had the highest estimated TEDE of 5.8 mrem/yr, which is approximately 6% of the public dose limit of 100 mrem. This is based on an occupancy factor of 100% or 8760 hours per year. The effect of the satellite facility operations on nearby residents of the existing Crow Butte facility is less than 1 mrem/yr.

Environmental monitoring and estimated release of radon from process operations will be reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1534 License Condition Number 12.1.

Air Particulate Monitoring

In-plant operational air particulate monitoring is discussed in Section 5.7.3.1. As a "wet facility" negligible particulate emissions are expected at the NTEA. Based upon experience the CPF, and the MILDOS Area simulation, air particulate monitoring is not contemplated as part of the airborne effluent and environmental monitoring program. This conclusion is further supported by the current license which only requires particulate monitoring when the yellowcake dryer is in operation

Surface Soil

Surface soil has been sampled as described in Section 2.9. Surface soil samples will be taken at the monitoring locations (AM-9 through AM-14) following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Surface soil will also be sampled at the plant location as described in Section 2.9. Post operational surface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Subsurface Soil

Subsurface soil will be sampled at the plant location as described in Section 2.9. Post operational subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Vegetation

Preoperational vegetation samples from the North Trend Expansion Area were collected in 1996-1997 at the air monitoring locations as described in Section 2.9. Vegetation sampling was discontinued at the CPF when the NRC approved the 1998 license renewal. It is reasonable to expect that the NTEA, without yellowcake drying and packaging, would also satisfy the criteria considered by the NRC when approving discontinuance of vegetation monitoring at the CPF.

CBR does not perform operational vegetation sampling at the environmental monitoring stations for the current production area and does not propose to perform operational vegetation sampling for the North Trend Expansion Area. In accordance with the provisions of USNRC Regulatory Guide 4.14[13], Footnote (o) to Table 2 requires that "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-Area and is discussed further in Section 7.3.

Based upon the prior NRC determination to cease vegetation sampling at the Crow Butte CPF, application of the above noted exclusion to the NTEA is appropriate. As a result, ~~In the absence of a fate and transport mechanism sufficient to warrant vegetation sampling,~~ crop and livestock sampling is not contemplated.

Fish

If the results of sediment and surface water sampling indicate upward trends in contaminant concentrations, CBR will develop and implement a fish sampling program.

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Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (AM-9 through AM-14). Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. Dosimeters will be exchanged on a quarterly basis.

Sediment

Reg. Guide 4.14 recommends that sediment samples be collected from sediments of surface water passing through the project site or offsite surface waters that may be subject to drainage from potentially contaminated areas or that could be affected by a tailings impoundment failure. Samples are to be collected once following spring runoff and late summer following a period of extended low flow. Samples are to be analyzed for natural uranium, radium-226, thorium-230, and lead-210.

Sediment samples will be collected at the sample locations that have been established for surface water sampling (**Figure 2.9-5**). Samples shall be collected and analyzed annually for natural uranium, ra-226, ~~th-230,~~ and pb-210. Sediment sampling procedures shall be the same as described in the preoperational monitoring plan (Section 2.9.9.2).

~~The proposed operational radiological monitoring program for sediment is summarized in **Table 5.7-1.**~~ Sediment monitoring results will be submitted in the semi-annual environmental and effluent reports submitted to the USNRC.

~~Upstream and downstream sediment samples from the White River will be collected annually. Samples will be analyzed for natural uranium, radium-226, and lead-210.~~

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5.7.8. GROUNDWATER/SURFACE WATER MONITORING PROGRAM

5.7.8.1 Program Description

During operations at the North Trend satellite plant, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. CBR's operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis.

5.7.8.2 Groundwater Monitoring

The groundwater excursion monitoring program is designed to detect excursions of lixiviant into the ore zone aquifer outside of the wellfield being leached and into the overlying water bearing strata. The Pierre Shale below the ore zone is over 1200 feet thick and contains no water bearing strata. Therefore, it is not necessary to monitor any water bearing strata below the ore zone.

- Private Well Monitoring

All private wells within one kilometer of the wellfield area boundary are sampled on a quarterly basis with the landowner's consent. CBR will perform similar private well monitoring around the North Trend Expansion Area. Groundwater samples are taken in accordance with the instructions contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume VI, *Environmental Manual.* Samples are analyzed for natural uranium and radium-226.

- Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed no further than 300 feet from the wellfield boundary and no further than 400 feet apart. After completion, wells are washed out and developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears stable and consistent with the anticipated quality of the area. After development, wells are sampled to obtain baseline water quality. For baseline sampling, wells are purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying monitor wells are sampled three times at least fourteen (14) days apart. Samples are analyzed for chloride, conductivity, and total alkalinity as specified in License Condition 10.4. Results from the samples are averaged arithmetically to obtain an average baseline value as well as a maximum value for determination of upper control limits for excursion detection. Well development and sampling activities are performed in accordance with the instructions contained in ~~EHSMS~~SHEQ ~~-Program~~MS. Volume VI, *Environmental Manual.*

- Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCL's) are set for chemical constituents which would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration and for which UCLs are set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits are set at 20% above the maximum baseline concentration for the excursion indicator. For excursion indicators with a baseline average below 50 mg/l, the UCL may be determined by adding 5 standard deviations or 15 mg/l to the baseline average for the indicator.

Operational monitoring consists of sampling the monitor wells on a biweekly basis and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. License SUA-1534 Condition 11.2 currently requires that monitor wells be sampled no more than 14 days apart except in the event of certain situations. These situations include inclement weather, mechanical failure, holiday scheduling, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment. In these situations, CBR documents the cause and the duration of any delays. In no event is sampling delayed for more than five days.

- Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, or if one UCL value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the USNRC Project Manager is notified by telephone or email within 48 hours and notified in writing within ~~thirty~~ seven (~~30~~7) days.

If an excursion is verified, the following methods of corrective action are instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation is completed to determine the probable cause;

- Production and/or injection rates in the vicinity of the monitor well are adjusted as necessary to increase the net over recovery, thus forming a hydraulic gradient toward the production zone; and

- Individual wells are pumped to enhance recovery of mining solutions.

Injection into the well field area adjacent to the monitor well may be suspended. Recovery operations continue, thus increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status is increased to weekly. An excursion is considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive one-week samples.

5.7.8.3 Surface Water Monitoring

~~Pre-operational surface water quality monitoring was performed as discussed in Section 2.9. The proposed license area does not contain surface water features. However, the proximity of the White River to the southern boundary of the license area required CBR to collect upstream and downstream samples. Surface water samples are taken in accordance with the instructions contained in EHSMS Program Volume VI, *Environmental Manual.* Upstream and downstream samples from all locations will be obtained quarterly. Surface water samples are analyzed for the parameters given in Section 2.9, Table 2.9-2. Surface monitoring results are submitted in the semi-annual environmental and effluent reports submitted to NRC.~~
Reg. Guide 4.14 recommends that surface water samples (drainages, streams and rivers) be collected the same as in the surface water preoperational monitoring program discussed in Section 2.9.4.2. Grab samples should be analyzed quarterly for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210 and polonium-210.

Reg. Guide 4.14 recommends an operational monitoring program for surface impoundments. However, there are no surface impoundments within, or in close proximity of the NTEA that could be impacted by discharges from NTEA operations. Therefore, there will be no such operational monitoring program.

Surface water samples will be collected from the surface sampling points identified in **Figure 2.9-5**, providing sufficient flow is available. Samples shall be collected quarterly and analyzed for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210 and polonium-210. If thorium-230 is not detected above background in the first year of operational monitoring, thorium-230 will be eliminated as an operational surface water analyte.

~~The radiological monitoring program for surface water is summarized in **Table 5.7-1.**~~
Surface water monitoring results will be submitted in the semi-annual environmental and effluent reports submitted to the USNRC.

5.7.8.4 Evaporation Pond Leak Detection Monitoring

The evaporation pond will be lined and equipped with a leak detection system. During operations, the leak detection standpipes will be checked for evidence of leakage. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard will also be performed during normal operations. The current CBR Pond Inspection Program will be adapted for the North Trend Satellite Plant and will meet the guidance contained in USNRC Regulatory Guide 3.11 and USNRC Regulatory Guide 3.11.1.

A minimum freeboard of 5 feet is allowed for the current commercial ponds during normal operations. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, it will be analyzed for specific conductivity. Should the analyses indicate that the liner is leaking (by comparison to chemical analyses of pond water), the following actions will be taken:

- The USNRC will be notified by telephone or email within 48 hours of leak verification;
- The level of the leaking pond will be lowered by transferring its contents into an adjacent pond. While lowering the water level in the pond, inspections of the liner will be made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid;
- Once the source of the leakage is found, the liner will be repaired and water will be reintroduced to the pond; and
- A written report will be submitted to the USNRC within 30 days of leak verification. The report will include analytical data and describe the cause of the leakage, corrective actions taken and the results of those actions.

5.7.9 QUALITY ASSURANCE PROGRAM

A quality assurance program is in place at Crow Butte Uranium Project for all relevant operational monitoring and analytical procedures. The objective of the program is to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program provides assurance to both regulatory agencies and the public that the monitoring results are valid.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports is provided;
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program;
- Written procedures for QA activities. These procedures include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting;
- Quality control (QC) in the laboratory. Procedures cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included; and
- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

The ~~EHSMS~~SHEQ ~~-Program~~MS. developed by CBR is a critical step to ensuring that quality assurance objectives are met. Current procedures exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures;
2. Testing procedures;
3. Exposure procedures;

4. Equipment operation and maintenance procedures;

5. Employee health and safety procedures; and,

6. Incident response procedures.

5.8 REFERENCES

[1] USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

[2] USNRC Regulatory Guide 8.2, *Guide For Administrative Practices In Radiation Monitoring* (February 1973).

[3] USNRC Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

[4] USNRC Regulatory Guide 8.29, *Instructions Concerning Risks from Occupational Radiation Exposure* (Revision 1, February 1996).

[5] USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999).

[6] USNRC Regulatory Guide 3.56, *General Guidance For Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills* (May 1986).

[7] USNRC Regulatory Guide 3.11, *Design, Construction and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

[8] USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities* (Revision 1, May 2002).

[9] USNRC Regulatory Guide 8.34, *Monitoring Criteria and Methods To Calculate Occupational Radiation Doses* (July 1992).

[10] USNRC Regulatory Guide 8.25, *Air Sampling in the Workplace* (Revision 1, June 1992).

[11] USNRC Regulatory Guide 8.15, *Acceptable Programs for Respiratory Protection* (Revision 1, October 1999).

[12] USNRC Regulatory Guide 8.7, *Instructions for Recording and Reporting Occupational Radiation Exposure Data* (Revision 1, June 1992).

[13] USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (Revision 1, April 1980).

Replacement Pages for Section 6
Groundwater Quality Restoration, Surface Reclamation, and Facility Decommissioning

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Replace pages 6-1 through 6-16

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6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 PLANS AND SCHEDULES FOR GROUNDWATER RESTORATION

The objective of the Restoration and Reclamation Plan is to return the affected ground water and land surface to conditions suitable for the uses for which they were suitable before mining. The methods to achieve this objective for both the affected ground water and the surface are described in the following sections. Before discussing restoration methodologies, a discussion of the ore body genesis and chemical and physical interactions between the ore body and the lixiviant is provided.

6.1.1 Ore Body Genesis

The uranium deposit in the North Trend Expansion Area (NTEA) is similar to that found in the current license area. It is a roll front deposit in fluvial sandstone and is similar to those in the Wyoming basins such as the Gas Hills, Shirley Basin and the Powder River Basin. The origin of the uranium in the deposit could lie within the host rock itself either from the feldspar or volcanic ash content of the Chadron Sandstone. The source of the uranium could also be volcanic ash of the Chadron Formation which overlays the Chadron Sandstone. Regardless of the source of the uranium, it has precipitated in several long sinuous roll fronts. The individual roll fronts are developed within subunits of the Chadron Sandstone. The Chadron Sandstone is divided into local subunits by thin clay beds that confined the uranium bearing waters to several distinct hydrological subunits of the sandstone. These clay beds are laterally continuous for hundreds of feet but control the deposition of the uranium over greater distances as other clay beds exert vertical control when the locally controlling beds pinch out. Precipitation of the uranium resulted when the oxidizing water containing the uranium entered reducing conditions. These reducing agents are likely hydrogen sulfide (H_2S) and, to a lesser degree, organic matter and pyrite. More detailed discussions of the geochemical description of the mineralized zone are presented in Section 2.6.2.3.1.

Solution mining of the deposit is accomplished by reversing the natural processes that deposited the uranium. Oxidizing solution is injected into the mineralized portion of the Chadron Sandstone to oxidize the reduced uranium and to complex it with bicarbonates. Pumping from recovery wells draws the uranium bearing solution through the mineralized portion of the sandstone. The presence of reducing agents will increase oxidant requirements over that necessary to only oxidize the uranium.

Since the deposition of the uranium was controlled between clay beds within the Chadron Sandstone, the mining solutions will be largely confined to this portion of the sandstone

by selectively screening these intervals. This will limit the contamination and thus the required restoration of unmineralized portions of the sandstone.

6.1.2 Chemical and Physical Interactions of Lixiviant with the Ore Body

The following discussion is based on a range of lixiviant conditions from 0.5 to 3.0 grams per liter total carbonate and a pH from 6.5 to 9.0 standard units (S.U.). This represents the normal range of operating conditions for the NTEA in-situ mining operations.

6.1.2.1 Ion Exchange

The principal ion exchange reaction is the exchange of sodium from the lixiviant onto exchangeable sites on ore minerals with the release into solution of calcium, magnesium and potassium. This reaction can be shown as follows:

$$Ca_{clay} + 2\,Na^{+}_{solution} = 2\,Na_{clay} + Ca^{++}_{solution}$$

Similar reactions can be written for magnesium and potassium. Due to higher solubility of their sulfate and carbonate compounds and their low concentrations in Chadron Sandstone and the ore, magnesium and potassium in solution have no impact. The limited solubility of calcium carbonate ($CaCO_3$), and to a lesser degree, calcium sulfate, may lead to the potential for calcium precipitation.

Laboratory tests have indicated that the maximum calcium ion exchange capacity of the ore in a sodium lixiviant with 3.0 g/L total carbonate strength is 1.21 milliequivalents of calcium per 100 grams of ore. This equates roughly to ½ pound of calcium or about 1.2 pounds of calcium carbonate per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized since laboratory testing is run in such a way as to indicate the maximum amount of calcium that can be exchanged. Somewhat less than this amount will be released and only a portion of that precipitated. There is no way to directly control the buildup of calcium in the lixiviant circuit. In practice, the lixiviant carbonate concentration and the lixiviant pH is controlled. The formation characteristics dictate an equilibrium calcium concentration in the lixiviant system and ion exchange and/or precipitation will occur until the equilibrium is satisfied. The production bleed represents a departure from this equilibrium and as such has some effect on the amount of calcium exchanged. If the bleed is kept generally small, on the order of 0.5 percent, the effect of the bleed on the ion exchange is small.

6.1.2.2 Precipitation

In the presence of carbonate ions and bicarbonate ions in the lixiviant system, calcium ions will precipitate provided the limit of saturation has been reached. Calcium precipitation is a function of total carbonate, pH and temperature. For example, at 15° C, a pH of 7.5 S.U., and 1 g/L carbonate in lixiviant, the equilibrium solubility of calcium is approximately 40 to 100 ppm. Some uncertainty is seen in these numbers due to the effect of ionic strength and supersaturation considerations. However, these figures illustrate the effect of carbonate concentration and pH on the equilibrium solubility of calcium.

The amount of calcium produced depends on the ion exchange that is taking place, while the precipitation of calcium is a function of the lixiviant chemistry, and the degree of supersaturation that is observed in the system. As a first approximation, the proportion of calcium precipitation occurring above ground and underground will occur in the ratio of the residence times. In other words, if the residence time is much longer underground than it is above ground, as is the case for most in-situ leach operations including those projected for the NTEA, then more of the calcium will precipitate underground than above ground. The calcium precipitation is a function of turbulence in the solution, changes in dissolved carbon dioxide (CO_2) partial pressure or pH, and the presence of surface area. The most likely places for calcium to precipitate are underground where the ore provides abundant surface area for precipitation, at or near the injection or production wellbore where changes in pressure, turbulence and CO_2 partial pressure are all observed, and on the surface in the filters, in pipes, and in tanks. If all the calcium were to precipitate (based on 1.2 pounds of $CaCO_3$ per ton of ore) the precipitate would occupy about 0.15% of the void space in that ton of ore.

Calcium may be removed from the system in two ways:

- Filters will be routinely backwashed to the evaporation ponds and periodically acid cleaned, if necessary, to remove precipitated calcium carbonate from the filter housing or filter media; and
- The solution bleed (approximately 0.5 to 1.0 percent) taken to create overproduction and a hydrologic sink in the mining area serves to eliminate some calcium from the system.

Should precipitation of calcium carbonate at or near the wellbore of the wellfield wells become a problem, these wells may be air lifted, surged, water jetted, or acidified to remove the precipitated calcium. Any water recovered from these wells containing dissolved calcium carbonate or particulate calcium carbonate is collected and placed into the waste disposal system. A liquid seal is maintained on any calcium carbonate in the evaporation ponds. Upon decommissioning, calcium carbonate from the plant equipment and pond residues will be disposed of in either a licensed tailings pond or a commercial disposal site.

The other possible precipitating species that has been identified is iron, which could precipitate as either the hydroxide or the carbonate, causing some fouling. Such fouling is usually evidenced by a reduction in the ion exchange capacity of the resin in the extraction circuit. Should this fouling become a serious problem, the resin can be washed and the wash solution disposed of in the waste disposal system. Due to the small amount of iron present in the Chadron Sandstone, iron precipitation has not been a problem in mining operations to date.

6.1.2.3 Hydrolysis

Hydrolysis reactions, which involve minerals and hydrogen or hydroxide ions, do not play an important role in the ore/lixiviant interaction. In the pH range of 6.5 to 9.0 S.U., the concentration of hydrogen and hydroxide ions is so small that these types of reactions do not occur to any great degree. The only potential impact would be a small increase in the dissolved silica content of the lixiviant system and a possible small increase in the cations associated with the siliceous minerals. The hydrolysis reaction does not have a significant effect on operations.

6.1.2.4 Oxidation

The oxidant consumers in the Chadron Sandstone are hydrogen sulfide in the groundwater, uranium, vanadium, iron pyrite, and other trace and heavy metals. The impact of these oxidant consumers on the operation of the plant is a general increase in the oxidant consumption over that which would be required for uranium alone. The second effect is a release of iron and sulfate into solution from the oxidation of pyrite. A third effect is an increase in the levels of some trace metals such as arsenic, vanadium and selenium into solution. As mentioned previously, the iron solubilized will most likely be precipitated as the hydroxide or carbonate, depending on its oxidation state. Any vanadium that is oxidized along with the uranium will be solubilized by the lixiviant, recovered with the uranium and could potentially contaminate the precipitated yellowcake product. Hydrogen peroxide precipitation of uranium is used to reduce the amount of vanadium precipitated in the product. Oxidation will also solubilize arsenic and selenium. The restoration program will return these substances to acceptable levels. A final potential oxidation reaction is the partial oxidation of sulfur species, increasing the concentrations of compounds such as polythionates, which can foul ion exchange resins. In in-situ operations with chemistries similar to the North Trend Expansion Area, these sulfur species are completely oxidized to sulfate, which poses no problems.

6.1.2.5 Organics

Organic materials are generally not present in the North Trend Expansion Area ore body at levels greater than 0.1 to 0.2 percent. Where present organic materials effectively increase the oxidant consumption and reduce uranium leaching. On longer flow paths, organic material could potentially re-precipitate uranium should all of the oxidant be consumed and conditions become reducing. Another potential impact of mobilized organics could be the coloring and fouling of leach solutions. As the aquifer is maintained in the pH range of 6.5 to 9.0 S.U., mobilization of the organics and coloring of the leach solution is avoided.

6.1.3 Basis of Restoration Goals

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to pre-injection baseline values on a mine unit average as determined by the baseline water quality sampling program. This sampling program is performed for each mine unit before mining operations commence. Should restoration efforts be unable to achieve baseline conditions after diligent application of the best practicable technology (BPT) available, CBR commits, in accordance with the Nebraska Environmental Quality Act and NDEQ regulations, to return the groundwater to the restoration values set by the NDEQ in the Class III UIC Permit. These secondary restoration values ensure that the groundwater is returned to a quality consistent with the use, or uses, for which the water was suitable prior to ISL mining. These secondary restoration values are approved by the NDEQ in the individual Notice of Intent (NOI) for each mine unit based on the permit requirements and the results of the baseline monitoring program.

EPA groundwater protection standards issued under the authority of the Uranium Mill Tailings Radiation Control Act (UMTRCA) are required to be followed by ISL licenses of the NRC and its Agreement States. The EPA regulations issued under UMTRCA authority provide the principal standards for uranium ISL operations and groundwater protection, while the UIC regulations are considered additional requirements for ISL operations. CBR is required to restore groundwater quality to the standards listed in Criterion 5B(5) of 10 CFR Part 40, Appendix A as required by the UMTRCA, as amended. Under EPA requirements, groundwater restoration at ISL facilities must meet the UMTRCA standards and not those associated with the Safe Drinking Water Act or analogous state regulations.

Under Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA, at the point of compliance (mining zone after restoration), the concentration of hazardous constituent must not exceed:

a. The Commission approved background concentration of that constituent in the groundwater;

b. The respective value given in Table 6.1-1 for the UMTRCA values if the constituent is listed in the table and of the background level of the constituent is below the value listed; or

c. Alternate concentration limit established by the Commission.

CBR will comply with these provisions as to groundwater restoration limits. The NRC is currently developing rulemaking on groundwater protection standards in an effort to eliminate dual jurisdiction and interactions with the EPA. Such new rulemaking could affect the groundwater restoration limits, but the new language will emphasize that UMTRCA would govern.

During restoration, sampling and analysis will be conduction in accordance with the program described in Section 5.7.8 and 5.7.9.

6.1.3.1 Establishment of Baseline Water Quality

Before mining in each mine unit, the baseline groundwater quality is determined. The data are established in each mine unit by assigning and evaluating groundwater quality in "baseline restoration wells". A minimum of one baseline restoration well for each four acres, but no less than six wells total for each mine unit are sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. The samples are collected at least 14 days apart. The samples are analyzed for the parameters listed in Table 6.1-1.

Attachment 6.1(A) contains the restoration tables for Mine Units 1 through 9 in the current commercial license area. These tables provide the baseline average and the range for all restoration parameters as well as the NDEQ restoration standard approved for that mine unit in the NOI.

6.1.3.2 Establishment of Restoration Goals

The baseline data are used to establish the restoration standards for each mine unit. As previously noted, the primary goal of restoration is to return the mine unit to preoperational water quality condition on a mine unit average. Since ISL operations alter the groundwater geochemistry, it is unlikely that restoration efforts will return the groundwater to the precise water quality that existed before operations.

Restoration goals are established by NDEQ to ensure that, if baseline water quality is not achievable after diligent application of best practicable technology (BPT), the groundwater is suitable for any use for which it was suitable before mining. USNRC considers these NDEQ restoration goals as the secondary goals. The NDEQ restoration values are established for each mine unit and are approved with the Notice of Intent to Operate submittals according to the following analysis:

- For parameters that have numerical groundwater standards established in Title 118[1], the restoration goal is based on the Title 118 maximum contaminant level (MCL).
- If the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.
- If there is no MCL for an element (e.g., vanadium), the restoration value is based a wellfield average of the preoperational sampling data. Normal statistical procedures will be used to obtain the average.
- The restoration values for the major cations (Ca, Mg, K, Na) allow the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criterion allows for the total carbonate to be less than 50 percent of the TDS. The TDS restoration value is set at the baseline mine unit average plus one standard deviation.

The current NDEQ restoration standards are listed in Table 6.1-1.

Table 6.1-1: NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]	NRC UMTRCA Groundwater Protection Standards
Ammonium (mg/l)	Not Listed	10.0	--
Arsenic (mg/l)	0.010	0.010	0.05
Barium (mg/l)	2.0	2.0	1.0
Cadmium (mg/l)	0.005	0.005	0.01
Chloride (mg/l)	250	250	--
Chromium (mg/l)	--	--	0.05
Copper (mg/l)	1.3	1.3	--
Fluoride (mg/l)	4.0	4.0	--
Iron (mg/l)	0.3	0.3	--
Mercury (mg/l)	0.002	0.002	0.002
Manganese (mg/l)	0.05	0.05	==

Table 6.1-1: NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]	NRC UMTRCA Groundwater Protection Standards
Molybdenum (mg/l)	(Reserved)	1.0	--
Nickel (mg/l)	(Reserved)	0.15	--
Nitrate (mg/l)	10.0	10.0	--
Lead (mg/l)	0.015	0.015	0.05
Radium (pCi/L)	5.0	5.0	--
Selenium (mg/l)	0.05	0.05	0.01
Sodium (mg/l)	N/A	Note 2	--
Sulfate (mg/l)	250	250	--
Uranium (mg/l)	0.030	0.030	
Ra-226 & Ra-228 (pCi/l)	--	--	5
Vanadium (mg/l)	(Reserved)	0.2	--
Zinc (mg/l)	5.0	5.0	--
pH (Std. Units)	6.5 - 8.5	6.5 – 8.5	--
Calcium (mg/l)	N/A	Note 2	--
Total Carbonate (mg/l)	N/A	Note 3	--
Potassium (mg/l)	N/A	Note 2	--
Magnesium (mg/l)	N/A	Note 2	--
TDS (mg/l)	N/A	Note 4	--

Notes:

1 NDEQ Restoration Standard based on groundwater standard (MCL) from Title 118. For parameters where the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.

2 One order of magnitude above baseline is used as the restoration value for some parameters due to the ability of some major ions to vary one order of magnitude depending on pH.

3 Total carbonate shall not exceed 50% of the total dissolved solids value.

4 The restoration value for Total Dissolved Solids (TDS) shall be the baseline mean plus one standard deviation.

Source: NDEQ Class III UIC Permit Number NE0122611 (except for NRC UMTRCA Groundwater Protection Standards)

Source: NRC UMTRCA Groundwater Protection Standards (Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA

It is anticipated that the Class III UIC Permit issued for the NTEA will have similar requirements. Under the provisions of the performance-based license, the CBR Safety and Environmental Review Panel (SERP) reviews and approves the establishment of restoration standards using the review procedures discussed in Section 5. Table 6.1-1 lists the 27 parameters used at the Crow Butte Project to determine groundwater quality. The current MCLs from Title 118 are listed as well as the restoration standards from the Class III UIC Permit. The restoration value for each mine unit is based on the current Title 118 standard at the time the Notice of Intent is approved by the NDEQ.

Proposals for Alternate Concentration Limits will include consideration of factors listed under Criterion 5B(6) of 10 CFR Part 40, Appendix A and approval by NRC pursuant to Criterion 5B(5)(c).

6.1.4 Groundwater Restoration Methods

6.1.4.1 Introduction

Restoration activities in the current license area have proven that the groundwater can be restored to the appropriate standards following commercial mining activities. As shown in Table 1.7-1, Mine Units 2 through 4 are currently undergoing restoration, with Mine Unit 2 undergoing extended stability monitoring following active restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the USNRC. On February 12, 2003, the NRC issued the final approval of groundwater restoration in Mine Unit 1 at Crow Butte. This approval was the culmination of three years of agency reviews including a license amendment to accept the NDEQ restoration standards as the approved secondary goals. Mine Unit 1 consisted of 40 patterns installed in 9.3 acres immediately adjacent to the Central Plant. Included within the boundaries of Mine Unit 1 were five wells that were originally mined beginning in 1986 as part of the research and development (R & D) pilot plant operation. Commercial mining activities began in 1991 and were completed in 1994. Mine Unit 1 was successfully restored to the approved primary or secondary restoration standards for all parameters.

CBR's approved restoration plan consists of four steps:

- Groundwater transfer
- Groundwater sweep
- Groundwater treatment
- Wellfield Recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species. Safety and handling issues associated with the use of sodium sulfide are discussed in Section 3.2.2.2 (Process Related Chemicals). Instructions and safety precautions on the use of sodium sulfide are included in Crow Butte's SHEQ MS, *Volume III Operating Manual* (Restoration Reductant [Sodium Sulfide]).

Crow Butte Resources' Class III UIC Permit requires a minimum of a six month period for stability monitoring of a Mine Unit to demonstrate the success of restoration activities (stabilization). As shown by historical Mine Unit 1 restoration data, six months may not be sufficient to assure stability for all monitored constituents. Stability monitoring may continue beyond the six month period as necessary. Stability monitoring will conclude, instead, when stabilization samples show that restoration goals on a mine unit average for monitored constituents are met and there is an absence of significant increasing trends. At the end of the stabilization period, when restoration parameters have been achieved and there is absence of significant increasing trends for any of the restoration parameters, a request would be made to the NDEQ for acceptance of restoration completion for the mine unit. The NDEQ would either accept the restoration of the mine unit, or extend the stabilization period or require further restoration.

During mining or standby periods and until restoration is complete, a hydrologic bleed will be maintained in each Mine Unit to prevent lateral migration of mining lixiviant. If a proper hydrologic bleed is not maintained, it is possible for water with chemistry similar to that in Table 2.7-15 column "Typical Water Quality During Mining at CSA" to begin migrating toward the monitor well ring. The mobile ions such as chloride and carbonate would be detected at the monitor well ring and adjustments would be made to reverse the trend. The maintenance of a hydrologic bleed and the close proximity of the monitor well ring, less than 300 feet from the mining patterns, will ensure there is negligible migration of mining fluid. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. The ubiquitous Chadron Formation clays, which cap the Lower Chadron Formation ore body, have hydraulic conductivities on the order of 10-11 cm/sec as outlined in section 2.7.2.2 of this application. Likewise, the underlying Pierre Shale is over 1,200 feet thick and acts as a significant aquitard. The vastly different piezometric heads between the Lower and Middle Chadron as well as the results of the pumping test support the conclusion that the Lower Chadron is vertically isolated.

Crow Butte is currently starting a pilot study using bioremediation to complete restoration of Mine Unit 4 at the existing production facility. This bioremediation test was initiated on December 17, 2008. Based on the results of a one-year study, bioremediation may or may not be used at the NTEA. If the tests are successful, and use at the NTEA appears to be a viable restoration alternative, a request for a license amendment will be submitted to the NRC.

6.1.4.2 Restoration Process

Restoration activities include four steps that are designed to optimize restoration equipment used in treating groundwater and to minimize the number of pore volumes circulated during the restoration stage. The number of pore volumes that would be displaced during groundwater restoration would be as follows: 3 pore volumes through IX treatment; 6 pore volumes through the Reverse Osmosis (RO); and 2 pore volumes of recirculation. There were 9 pore volumes used for Mine Unit 1 at the current CBR operations. CBR will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary.

The calculated pore volume for the entire North Trend Wellfield would be 997,000,000 gallons. This is based on a calculated square footage (30,636,400 ft^2) of the potential wellfield area, an average under-ream interval of 15 feet and a 29% open pore space value.

- Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mine unit commencing restoration and a mine unit commencing mining operations. Baseline quality water from the mine unit starting mining may be pumped and injected into the mine unit in restoration. The higher TDS water from the mine unit in restoration is recovered and injected into the mine unit commencing mining. The direct transfer of water will act to lower the TDS in the mine unit being restored by displacing water affected by the mining with baseline quality water.

The goal of the groundwater transfer step is to blend the water in the two mine units until they become similar in conductivity. The recovered water may be passed through ion exchange columns and filtration during this step if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer step to occur, a newly constructed mine unit must be ready to commence mining. If a mine unit is not available to accept transferred water, groundwater sweep or other activity will be utilized as the first step of restoration. The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the wastewater disposal system during restoration activities.

- Groundwater Sweep

During groundwater sweep, water is pumped without injection from the wellfield, causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline quality water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The affected water near the edge patterns of the wellfield is also drawn into the boundaries of the mine unit. The number of pore volumes transferred during groundwater sweep, if any, is dependent upon the presence of other active mine units along the mine unit boundary, the capacity of the wastewater disposal system, and the success of the groundwater transfer step in lowering TDS.

- Groundwater Treatment

Following the groundwater sweep step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. Ion exchange (IX), reverse osmosis (RO), and/or Electro Dialysis Reversal (EDR) treatment equipment is generally used during this stage as shown on the generalized restoration flow sheet on Figure 6.1-1.

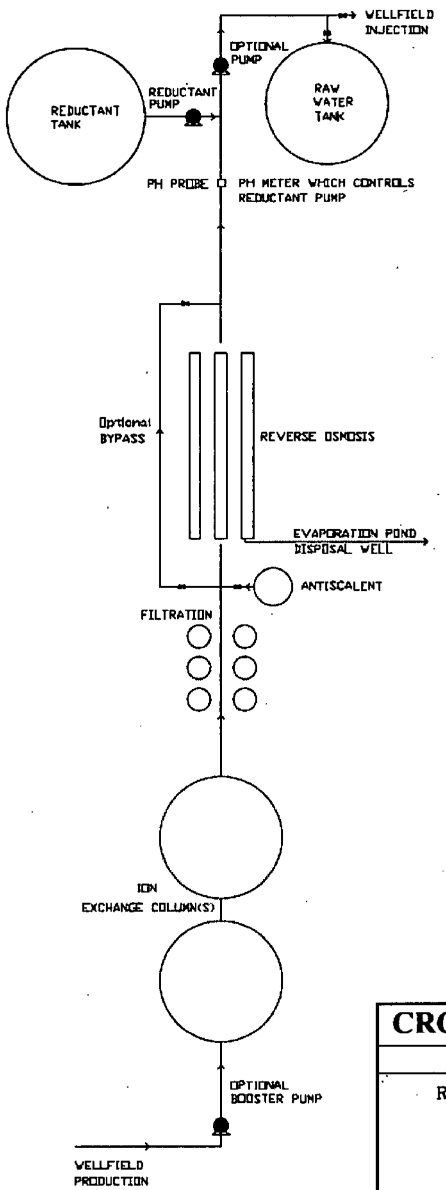
Water recovered from restoration that contains a significant amount of uranium is passed through the IX system. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Once the solubilized uranium is removed, a small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration of reductant injected into the formation is determined by the concentration and type of trace elements encountered. The goal of reductant addition is to reduce those minerals that are solubilized by carbonate complexes to prevent the buildup of dissolved solids, which would increase the time for restoration to be completed.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit 1) reduces the total dissolved solids in the contaminated groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration.

Before the water can be processed by the RO, soluble uranium can be removed by the IX system. The RO unit contains membranes that pass about 60 to 75 percent of the water through, leaving 60 to 90 percent of the dissolved salts in the water that will not pass the membranes. Table 6.1-2 shows typical RO manufacturers specification data for removal of ion constituents. The clean water, called “permeate”, will be re-injected, sent to storage for use in the mining process, or to the wastewater disposal system. The 25 to 40 percent of water that is rejected, called “brine”, contains the majority of dissolved salts that contaminate the groundwater and is sent for disposal in the waste system. Make-up

FIGURE 6.1-1

Restoration Process Flow Diagram



CROW BUTTE RESOURCES	
DAWES COUNTY, NEBRASKA	
Restoration Process Flow Diagram	
Prepared By : JD	
Drawn By: JD	Date: 3/30

water may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

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The reductant (either biological or chemical) added to the injection stream during the groundwater treatment stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding a reductant, the Eh of the aquifer is lowered, thereby decreasing the solubility of these elements. Hydrogen sulfide (H_2S), sodium sulfide (Na_2S), or a similar compound will be added as a reductant. CBR typically uses sodium sulfide due to the chemical safety issues associated with proper handling of hydrogen sulfide. A comprehensive safety plan regarding reductant use is implemented.

The number of pore volumes treated and re-injected during the groundwater treatment stage will depend on the efficiency of the RO in removing total dissolved solids (TDS) and the reductant in lowering the uranium and trace element concentrations.

- Wellfield Recirculation

At the completion of the Groundwater Treatment Stage, wellfield recirculation may be initiated. In order to homogenize the aquifer, pumping from the production wells and re-injecting the recovered solution into injection wells may be performed to recirculate solutions.

The sequence of the activities will be determined by CBR based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by CBR.

Once the restoration activities are completed, CBR will sample the restoration wells and determine if the mining unit has achieved the restoration values, on a mine unit average basis. If so, CBR will notify the regulatory agencies that it is initiating the Stabilization

Table 6.1-2: Typical Reverse Osmosis Membrane Rejection

NAME	SYMBOL	PERCENT REJECTION
	Cations	
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Cadmium	Cd^{+2}	96-98
Calcium	Ca^{+2}	96-98
Copper	Cu^{+2}	98-99
Hardness	Ca and Mg	96-98
Iron	Fe^{+2}	98-99
Magnesium	Mg^{+2}	96-98
Manganese	Mn^{+2}	98-99
Mercury	Hg^{+2}	96-98
Nickel	Ni^{+2}	98-99
Potassium	K^{+1}	94-96
Silver	Ag^{+1}	94-96
Sodium	Na^{+}	94-96
Strontium	Sr^{+2}	96-99
Zinc	Zn^{+2}	98-99
	Anions	
Bicarbonate	HCO_3^{-1}	95-96
Borate	$B_4O_7^{-2}$	35-70
Bromide	Br^{-1}	94-96
Chloride	Cl^{-1}	94-95
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Ferrocyanide	$Fe(CN)_6^{-3}$	99+
Fluoride	F^{-1}	94-96
Nitrate	NO_3^{-1}	95
Phosphate	PO_4^{-3}	99+
Silicate	SiO_2^{-1}	80-95
Sulfate	SO_4^{-2}	99+
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+

Source: Osmonics, Inc.

Stage and will submit supporting documentation that the restoration parameters are at or below the restoration standards. If at the end of restoration activities the parameters are not at or below the approved values, CBR will either re-initiate certain steps of the restoration plan or submit documentation to the agencies that the best practical technology has been used in restoration. The documentation will include a justification for alternate parameter value(s) including available water quality data and a narrative of the restoration techniques used.

6.1.5 Stabilization Phase

Upon completion of restoration, a groundwater stabilization monitoring program will begin in which the restoration wells and any monitor wells on excursion status during mining operations will be sampled and analyzed for the restoration parameters listed in Table 6.1-1. The sampling frequency will be one sample every other month for four quarters, and if the six samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, restoration shall be deemed complete.

6.1.6 Reporting

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be summarized and discussed in the Semiannual Radiological Effluent and Environmental Monitoring Report submitted to USNRC. This information will also be included in the final report on restoration. In the unlikely event that a well goes on excursion during restoration, the process described in Section 5.7.8.2 will be used.

Upon completion of restoration activities and before stabilization, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 6.1-1. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the USNRC and the NDEQ, CBR will proceed with the stabilization phase of restoration.

During stabilization, all designated restoration wells will be sampled monthly for the constituents listed in Table 6.1-1. At the end of a six-month stabilization period, CBR will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. If the analytical results continue to meet the appropriate standards for the mine unit and do not exhibit significant increasing trends, CBR would request the mine unit be declared restored. Following agency approval, wellfield reclamation and plugging and abandonment of wells will be performed as described in Section 6.2.

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6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 PLANS AND SCHEDULES FOR GROUNDWATER RESTORATION

The objective of the Restoration and Reclamation Plan is to return the affected ground water and land surface to conditions suitable for the uses for which they were suitable before mining. The methods to achieve this objective for both the affected ground water and the surface are described in the following sections. Before discussing restoration methodologies, a discussion of the ore body genesis and chemical and physical interactions between the ore body and the lixiviant is provided.

6.1.1 Ore Body Genesis

The uranium deposit in the North Trend Expansion Area (NTEA) is similar to that found in the current license area. It is a roll front deposit in fluvial sandstone and is similar to those in the Wyoming basins such as the Gas Hills, Shirley Basin and the Powder River Basin. The origin of the uranium in the deposit could lie within the host rock itself either from the feldspar or volcanic ash content of the Chadron Sandstone. The source of the uranium could also be volcanic ash of the Chadron Formation which overlays the Chadron Sandstone. Regardless of the source of the uranium, it has precipitated in several long sinuous roll fronts. The individual roll fronts are developed within subunits of the Chadron Sandstone. The Chadron Sandstone is divided into local subunits by thin clay beds that confined the uranium bearing waters to several distinct hydrological subunits of the sandstone. These clay beds are laterally continuous for hundreds of feet but control the deposition of the uranium over greater distances as other clay beds exert vertical control when the locally controlling beds pinch out. Precipitation of the uranium resulted when the oxidizing water containing the uranium entered reducing conditions. These reducing agents are likely hydrogen sulfide (H_2S) and, to a lesser degree, organic matter and pyrite. More detailed discussions of the geochemical description of the mineralized zone are presented in Section 2.6.2.3.1.

Solution mining of the deposit is accomplished by reversing the natural processes that deposited the uranium. Oxidizing solution is injected into the mineralized portion of the Chadron Sandstone to oxidize the reduced uranium and to complex it with bicarbonates. Pumping from recovery wells draws the uranium bearing solution through the mineralized portion of the sandstone. The presence of reducing agents will increase oxidant requirements over that necessary to only oxidize the uranium.

Since the deposition of the uranium was controlled between clay beds within the Chadron Sandstone, the mining solutions will be largely confined to this portion of the sandstone

by selectively screening these intervals. This will limit the contamination and thus the required restoration of unmineralized portions of the sandstone.

6.1.2 Chemical and Physical Interactions of Lixiviant with the Ore Body

The following discussion is based on a range of lixiviant conditions from 0.5 to 3.0 grams per liter total carbonate and a pH from 6.5 to 9.0 standard units (S.U.). This represents the normal range of operating conditions for the NTEA in-situ mining operations.

6.1.2.1 Ion Exchange

The principal ion exchange reaction is the exchange of sodium from the lixiviant onto exchangeable sites on ore minerals with the release into solution of calcium, magnesium and potassium. This reaction can be shown as follows:

$$Ca_{clay} + 2\ Na^{+}_{solution} = 2\ Na_{clay} + Ca^{++}_{solution}$$

Similar reactions can be written for magnesium and potassium. Due to higher solubility of their sulfate and carbonate compounds and their low concentrations in Chadron Sandstone and the ore, magnesium and potassium in solution have no impact. The limited solubility of calcium carbonate ($CaCO_3$), and to a lesser degree, calcium sulfate, may lead to the potential for calcium precipitation.

Laboratory tests have indicated that the maximum calcium ion exchange capacity of the ore in a sodium lixiviant with 3.0 g/L total carbonate strength is 1.21 milliequivalents of calcium per 100 grams of ore. This equates roughly to ½ pound of calcium or about 1.2 pounds of calcium carbonate per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized since laboratory testing is run in such a way as to indicate the maximum amount of calcium that can be exchanged. Somewhat less than this amount will be released and only a portion of that precipitated. There is no way to directly control the buildup of calcium in the lixiviant circuit. In practice, the lixiviant carbonate concentration and the lixiviant pH is controlled. The formation characteristics dictate an equilibrium calcium concentration in the lixiviant system and ion exchange and/or precipitation will occur until the equilibrium is satisfied. The production bleed represents a departure from this equilibrium and as such has some effect on the amount of calcium exchanged. If the bleed is kept generally small, on the order of 0.5 percent, the effect of the bleed on the ion exchange is small.

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$$Ca_{clay} + 2\ Na^{+}_{solution} = 2\ Na_{clay} + Ca^{++}_{solution}$$

Similar reactions can be written for magnesium and potassium. Due to higher solubility of their sulfate and carbonate compounds and their low concentrations in Chadron Sandstone and the ore, magnesium and potassium in solution have no impact. The limited solubility of calcium carbonate ($CaCO_3$), and to a lesser degree, calcium sulfate, may lead to the potential for calcium precipitation.

Laboratory tests have indicated that the maximum calcium ion exchange capacity of the ore in a sodium lixiviant with 3.0 g/L total carbonate strength is 1.21 milliequivalents of calcium per 100 grams of ore. This equates roughly to ½ pound of calcium or about 1.2 pounds of calcium carbonate per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized since laboratory testing is run in such a way as to indicate the maximum amount of calcium that can be exchanged. Somewhat less than this amount will be released and only a portion of that precipitated. There is no way to directly control the buildup of calcium in the lixiviant circuit. In practice, the lixiviant carbonate concentration and the lixiviant pH is controlled. The formation characteristics dictate an equilibrium calcium concentration in the lixiviant system and ion exchange and/or precipitation will occur until the equilibrium is satisfied. The production bleed represents a departure from this equilibrium and as such has some effect on the amount of calcium exchanged. If the bleed is kept generally small, on the order of 0.5 percent, the effect of the bleed on the ion exchange is small.

6.1.2.2 Precipitation

In the presence of carbonate ions and bicarbonate ions in the lixiviant system, calcium ions will precipitate provided the limit of saturation has been reached. Calcium precipitation is a function of total carbonate, pH and temperature. For example, at 15° C, a pH of 7.5 S.U., and 1 g/L carbonate in lixiviant, the equilibrium solubility of calcium is approximately 40 to 100 ppm. Some uncertainty is seen in these numbers due to the effect of ionic strength and supersaturation considerations. However, these figures illustrate the effect of carbonate concentration and pH on the equilibrium solubility of calcium.

The amount of calcium produced depends on the ion exchange that is taking place, while the precipitation of calcium is a function of the lixiviant chemistry, and the degree of supersaturation that is observed in the system. As a first approximation, the proportion of calcium precipitation occurring above ground and underground will occur in the ratio of the residence times. In other words, if the residence time is much longer underground than it is above ground, as is the case for most in-situ leach operations including those projected for the NTEA, then more of the calcium will precipitate underground than above ground. The calcium precipitation is a function of turbulence in the solution, changes in dissolved carbon dioxide (CO_2) partial pressure or pH, and the presence of surface area. The most likely places for calcium to precipitate are underground where the ore provides abundant surface area for precipitation, at or near the injection or production wellbore where changes in pressure, turbulence and CO_2 partial pressure are all observed, and on the surface in the filters, in pipes, and in tanks. If all the calcium were to precipitate (based on 1.2 pounds of $CaCO_3$ per ton of ore) the precipitate would occupy about 0.15% of the void space in that ton of ore.

Calcium may be removed from the system in two ways:

- Filters will be routinely backwashed to the evaporation ponds and periodically acid cleaned, if necessary, to remove precipitated calcium carbonate from the filter housing or filter media; and

- The solution bleed (approximately 0.5 to 1.0 percent) taken to create overproduction and a hydrologic sink in the mining area serves to eliminate some calcium from the system.

Should precipitation of calcium carbonate at or near the wellbore of the wellfield wells become a problem, these wells may be air lifted, surged, water jetted, or acidified to remove the precipitated calcium. Any water recovered from these wells containing dissolved calcium carbonate or particulate calcium carbonate is collected and placed into the waste disposal system. A liquid seal is maintained on any calcium carbonate in the evaporation ponds. Upon decommissioning, calcium carbonate from the plant equipment and pond residues will be disposed of in either a licensed tailings pond or a commercial disposal site.

The other possible precipitating species that has been identified is iron, which could precipitate as either the hydroxide or the carbonate, causing some fouling. Such fouling is usually evidenced by a reduction in the ion exchange capacity of the resin in the extraction circuit. Should this fouling become a serious problem, the resin can be washed and the wash solution disposed of in the waste disposal system. Due to the small amount of iron present in the Chadron Sandstone, iron precipitation has not been a problem in mining operations to date.

6.1.2.3 Hydrolysis

Hydrolysis reactions, which involve minerals and hydrogen or hydroxide ions, do not play an important role in the ore/lixiviant interaction. In the pH range of 6.5 to 9.0 S.U., the concentration of hydrogen and hydroxide ions is so small that these types of reactions do not occur to any great degree. The only potential impact would be a small increase in the dissolved silica content of the lixiviant system and a possible small increase in the cations associated with the siliceous minerals. The hydrolysis reaction does not have a significant effect on operations.

6.1.2.4 Oxidation

The oxidant consumers in the Chadron Sandstone are hydrogen sulfide in the groundwater, uranium, vanadium, iron pyrite, and other trace and heavy metals. The impact of these oxidant consumers on the operation of the plant is a general increase in the oxidant consumption over that which would be required for uranium alone. The second effect is a release of iron and sulfate into solution from the oxidation of pyrite. A third effect is an increase in the levels of some trace metals such as arsenic, vanadium and selenium into solution. As mentioned previously, the iron solubilized will most likely be precipitated as the hydroxide or carbonate, depending on its oxidation state. Any vanadium that is oxidized along with the uranium will be solubilized by the lixiviant, recovered with the uranium and could potentially contaminate the precipitated yellowcake product. Hydrogen peroxide precipitation of uranium is used to reduce the amount of vanadium precipitated in the product. Oxidation will also solubilize arsenic and selenium. The restoration program will return these substances to acceptable levels. A final potential oxidation reaction is the partial oxidation of sulfur species, increasing the concentrations of compounds such as polythionates, which can foul ion exchange resins. In in-situ operations with chemistries similar to the North Trend Expansion Area, these sulfur species are completely oxidized to sulfate, which poses no problems.

6.1.2.5 Organics

Organic materials are generally not present in the North Trend Expansion Area ore body at levels greater than 0.1 to 0.2 percent. Where present organic materials effectively increase the oxidant consumption and reduce uranium leaching. On longer flow paths, organic material could potentially re-precipitate uranium should all of the oxidant be consumed and conditions become reducing. Another potential impact of mobilized organics could be the coloring and fouling of leach solutions. As the aquifer is maintained in the pH range of 6.5 to 9.0 S.U., mobilization of the organics and coloring of the leach solution is avoided.

6.1.3 Basis of Restoration Goals

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to pre-injection baseline values on a mine unit average as determined by the baseline water quality sampling program. This sampling program is performed for each mine unit before mining operations commence. Should restoration efforts be unable to achieve baseline conditions after diligent application of the best practicable technology (BPT) available, CBR commits, in accordance with the Nebraska Environmental Quality Act and NDEQ regulations, to return the groundwater to the restoration values set by the NDEQ in the Class III UIC Permit. These secondary restoration values ensure that the groundwater is returned to a quality consistent with the use, or uses, for which the water was suitable prior to ISL mining. These secondary restoration values are approved by the NDEQ in the individual Notice of Intent (NOI) for each mine unit based on the permit requirements and the results of the baseline monitoring program.

EPA groundwater protection standards issued under the authority of the Uranium Mill Tailings Radiation Control Act (UMTRCA) are required to be followed by ISL licenses of the NRC and its Agreement States. The EPA regulations issued under UMTRCA authority provide the principal standards for uranium ISL operations and groundwater protection, while the UIC regulations are considered additional requirements for ISL operations. CBR is required to restore groundwater quality to the standards listed in Criterion 5B(5) of 10 CFR Part 40, Appendix A as required by the UMTRCA, as amended. Under EPA requirements, groundwater restoration at ISL facilities must meet the UMTRCA standards and not those associated with the Safe Drinking Water Act or analogous state regulations.

Under Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA, at the point of compliance (mining zone after restoration), the concentration of hazardous constituent must not exceed:

a. The Commission approved background concentration of that constituent in the groundwater;

b. The respective value given in Table 6.1-1 -for the UMTRCA values if the constituent is listed in the table and of the background level of the constituent is below the value listed; or

c. Alternate concentration limit established by the Commission.

CBR will comply with these provisions as to groundwater restoration limits. The NRC is currently developing rulemaking on groundwater protection standards in an effort to eliminate dual jurisdiction and interactions with the EPA. Such new rulemaking could affect the groundwater restoration limits, but the new language will emphasize that UMTRCA would govern.

During restoration, sampling and analysis will be conduction in accordance with the program described in Section 5.7.8 and 5.7.9.

6.1.3.1 Establishment of Baseline Water Quality

Before mining in each mine unit, the baseline groundwater quality is determined. The data are established in each mine unit by assigning and evaluating groundwater quality in "baseline restoration wells". A minimum of one baseline restoration well for each four acres, but no less than six wells total for each mine unit areis sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. The samples are collected at least 14 days apart. The samples are analyzed for the parameters listed in Table 6.1-1.

Attachment 6.1(A) contains the restoration tables for Mine Units 1 through 9 in the current commercial license area. These tables provide the baseline average and the range for all restoration parameters as well as the NDEQ restoration standard approved for that mine unit in the NOI.

6.1.3.2 Establishment of Restoration Goals

The baseline data are used to establish the restoration standards for each mine unit. As previously noted, the primary goal of restoration is to return the mine unit to preoperational water quality condition on a mine unit average. Since ISL operations alter the groundwater geochemistry, it is unlikely that restoration efforts will return the groundwater to the precise water quality that existed before operations.

Restoration goals are established by NDEQ to ensure that, if baseline water quality is not achievable after diligent application of best practicable technology (BPT), the groundwater is suitable for any use for which it was suitable before mining. USNRC considers these NDEQ restoration goals as the secondary goals. The NDEQ restoration values are established for each mine unit and are approved with the Notice of Intent to Operate submittals according to the following analysis:

- For parameters that have numerical groundwater standards established in Title 118[1], the restoration goal is based on the Title 118 maximum contaminant level (MCL).
- If the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.
- If there is no MCL for an element (e.g., vanadium), the restoration value is based a wellfield average of the preoperational sampling data. Normal statistical procedures will be used to obtain the average.
- The restoration values for the major cations (Ca, Mg, K, Na) allow the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criterion allows for the total carbonate to be less than 50 percent of the TDS. The TDS restoration value is set at the baseline mine unit average plus one standard deviation.

The current NDEQ restoration standards are listed in Table 6.1-1.

Table 6.1-1: NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]	NRC UMTRCA Groundwater Protection Standards
Ammonium (mg/l)	Not Listed	10.0	--
Arsenic (mg/l)	0.010	0.010	0.05
Barium (mg/l)	2.0	2.0	1.0
Cadmium (mg/l)	0.005	0.005	0.01
Chloride (mg/l)	250	250	--
Chromium (mg/l)	--	--	0.05
Copper (mg/l)	1.3	1.3	--
Fluoride (mg/l)	4.0	4.0	--
Iron (mg/l)	0.3	0.3	--
Mercury (mg/l)	0.002	0.002	0.002
Manganese (mg/l)	0.05	0.05	--

Table 6.1-1: NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]	NRC UMTRCA Groundwater Protection Standards
Molybdenum (mg/l)	(Reserved)	1.0	--
Nickel (mg/l)	(Reserved)	0.15	--
Nitrate (mg/l)	10.0	10.0	--
Lead (mg/l)	0.015	0.015	0.05
Radium (pCi/L)	5.0	5.0	--
Selenium (mg/l)	0.05	0.05	0.01
Sodium (mg/l)	N/A	Note 2	--
Sulfate (mg/l)	250	250	--
Uranium (mg/l)	0.030	0.030	
Ra-226 & Ra-228 (pCi/l)	--	--	5
Vanadium (mg/l)	(Reserved)	0.2	--
Zinc (mg/l)	5.0	5.0	--
pH (Std. Units)	6.5 - 8.5	6.5 – 8.5	--
Calcium (mg/l)	N/A	Note 2	--
Total Carbonate (mg/l)	N/A	Note 3	--
Potassium (mg/l)	N/A	Note 2	--
Magnesium (mg/l)	N/A	Note 2	--
TDS (mg/l)	N/A	Note 4	--

Notes:

1. NDEQ Restoration Standard based on groundwater standard (MCL) from Title 118. For parameters where the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.

2. One order of magnitude above baseline is used as the restoration value for some parameters due to the ability of some major ions to vary one order of magnitude depending on pH.

3. Total carbonate shall not exceed 50% of the total dissolved solids value.

4. The restoration value for Total Dissolved Solids (TDS) shall be the baseline mean plus one standard deviation.

Source: NDEQ Class III UIC Permit Number NE0122611 (except for NRC UMTRCA Groundwater Protection Standards)

Source: NRC UMTRCA Groundwater Protection Standards (Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA

It is anticipated that the Class III UIC Permit issued for the NTEA will have similar requirements. Under the provisions of the performance-based license, the CBR Safety and Environmental Review Panel (SERP) reviews and approves the establishment of restoration standards using the review procedures discussed in Section 5. Table 6.1-1 lists the 27 parameters used at the Crow Butte Project to determine groundwater quality. The current MCLs from Title 118 are listed as well as the restoration standards from the Class III UIC Permit. The restoration value for each mine unit is based on the current Title 118 standard at the time the Notice of Intent is approved by the NDEQ.

Proposals for Alternate Concentration Limits will include consideration of factors listed under Criterion 5B(6) of 10 CFR Part 40, Appendix A and approval by NRC pursuant to Criterion 5B(5)(c).

6.1.4 Groundwater Restoration Methods

6.1.4.1 Introduction

Restoration activities in the current license area have proven that the groundwater can be restored to the appropriate standards following commercial mining activities. As shown in Table 1.7-1, Mine Units 2 through 4 are currently undergoing restoration, with Mine Unit 2 undergoing extended stability monitoring following active restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the USNRC. On February 12, 2003, the NRC issued the final approval of groundwater restoration in Mine Unit 1 at Crow Butte. This approval was the culmination of three years of agency reviews including a license amendment to accept the NDEQ restoration standards as the approved secondary goals. Mine Unit 1 consisted of 40 patterns installed in 9.3 acres immediately adjacent to the Central Plant. Included within the boundaries of Mine Unit 1 were five wells that were originally mined beginning in 1986 as part of the research and development (R & D) pilot plant operation. Commercial mining activities began in 1991 and were completed in 1994. Mine Unit 1 was successfully restored to the approved primary or secondary restoration standards for all parameters.

CBR's approved restoration plan consists of four steps:

- Groundwater transfer
- Groundwater sweep
- Groundwater treatment
- Wellfield Recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species. Safety and handling issues associated with the use of sodium sulfide are discussed in Section 3.2.2.2 (Process Related Chemicals). Instructions and safety precautions on the use of sodium sulfide are included in Crow Butte's SHEQ MS~~*Environmental, Health, and Safety Management System*~~, *Volume III Operating Manual* (Restoration Reductant [Sodium Sulfide]).

Crow Butte Resources' Class III UIC Permit requires a minimum of a six month period for stability monitoring of a Mine Unit to demonstrate the success of restoration activities (stabilization). As shown by historical Mine Unit 1 restoration data, six months may not be sufficient to assure stability for all monitored constituents. Stability monitoring may continue beyond the six month period as necessary. Stability monitoring will conclude, instead, when stabilization samples show that restoration goals on a mine unit average for monitored constituents are met and there is an absence of significant increasing trends. At the end of the stabilization period, when restoration parameters have been achieved and there is absence of significant increasing trends for any of the restoration parameters, a request would be made to the NDEQ for acceptance of restoration completion for the mine unit. The NDEQ would either accept the restoration of the mine unit, or extend the stabilization period or require further restoration.

During mining or standby periods and until restoration is complete, a hydrologic bleed will be maintained in each Mine Unit to prevent lateral migration of mining lixiviant. If a proper hydrologic bleed is not maintained, it is possible for water with chemistry similar to that in Table 2.7-15 column "Typical Water Quality During Mining at CSA" to begin migrating toward the monitor well ring. The mobile ions such as chloride and carbonate would be detected at the monitor well ring and adjustments would be made to reverse the trend. The maintenance of a hydrologic bleed and the close proximity of the monitor well ring, less than 300 feet from the mining patterns, will ensure there is negligible migration of mining fluid. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. The ubiquitous Chadron Formation clays, which cap the Lower Chadron Formation ore body, have hydraulic conductivities on the order of 10-11 cm/sec as outlined in section 2.7.2.2 of this application. Likewise, the underlying Pierre Shale is over 1,200 feet thick and acts as a significant aquitard. The vastly different piezometric heads between the Lower and Middle Chadron as well as the results of the pumping test support the conclusion that the Lower Chadron is vertically isolated.

Crow Butte is currently starting a pilot study using bioremediation to complete restoration of Mine Unit 4 at the existing production facility. This bioremediation test was initiated on December 17, 2008. Based on the results of a one-year study, bioremediation may or may not be used at the NTEA. If the tests are successful, and use at the NTEA appears to be a viable restoration alternative, a request for a license amendment will be submitted to the NRC.

6.1.4.2 Restoration Process

Restoration activities include four steps that are designed to optimize restoration equipment used in treating groundwater and to minimize the number of pore volumes circulated during the restoration stage. The number of pore volumes that would be displaced during groundwater restoration would be as follows: 3 pore volumes through IX treatment; 6 pore volumes through the Reverse Osmosis (RO); and 2 pore volumes of recirculation. There were 9 pore volumes used for Mine Unit 1 at the current CBR operations. CBR will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary.

The calculated pore volume for the entire North Trend Wellfield would be 997~~133~~,000~~268~~,000 gallons. This is based on a calculated square footage (30,636,400 ft^2) of the potential wellfield area, an average under-ream interval of 15 feet and a 29% open pore space value.

- Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mine unit commencing restoration and a mine unit commencing mining operations. Baseline quality water from the mine unit starting mining may be pumped and injected into the mine unit in restoration. The higher TDS water from the mine unit in restoration is recovered and injected into the mine unit commencing mining. The direct transfer of water will act to lower the TDS in the mine unit being restored by displacing water affected by the mining with baseline quality water.

The goal of the groundwater transfer step is to blend the water in the two mine units until they become similar in conductivity. The recovered water may be passed through ion exchange columns and filtration during this step if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer step to occur, a newly constructed mine unit must be ready to commence mining. If a mine unit is not available to accept transferred water, groundwater sweep or other activity will be utilized as the first step of restoration. The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the wastewater disposal system during restoration activities.

- Groundwater Sweep

During groundwater sweep, water is pumped without injection from the wellfield, causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline quality water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The affected water near the edge patterns of the wellfield is also drawn into the boundaries of the mine unit. The number of pore volumes transferred during groundwater sweep, if any, is dependent upon the presence of other active mine units along the mine unit boundary, the capacity of the wastewater disposal system, and the success of the groundwater transfer step in lowering TDS.

- Groundwater Treatment

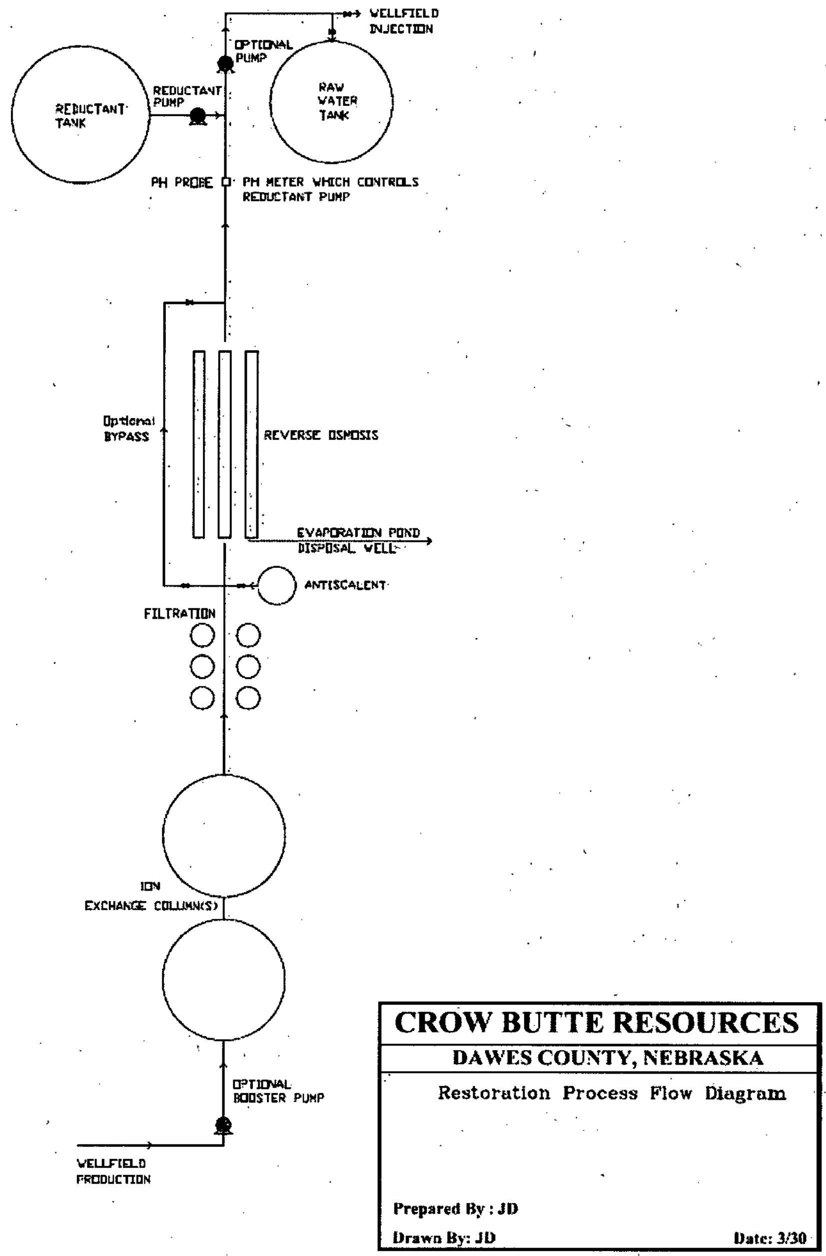
Following the groundwater sweep step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. Ion exchange (IX), reverse osmosis (RO), and/or Electro Dialysis Reversal (EDR) treatment equipment is generally used during this stage as shown on the generalized restoration flow sheet on Figure 6.1-1.

Water recovered from restoration that contains a significant amount of uranium is passed through the IX system. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Once the solubilized uranium is removed, a small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration of reductant injected into the formation is determined by the concentration and type of trace elements encountered. The goal of reductant addition is to reduce those minerals that are solubilized by carbonate complexes to prevent the buildup of dissolved solids, which would increase the time for restoration to be completed.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit 1) reduces the total dissolved solids in the contaminated groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration.

Before the water can be processed by the RO, soluble uranium can be removed by the IX system. The RO unit contains membranes that pass about 60 to 75 percent of the water through, leaving 60 to 90 percent of the dissolved salts in the water that will not pass the membranes. Table 6.1-2 shows typical RO manufacturers specification data for removal of ion constituents. The clean water, called "permeate", will be re-injected, sent to storage for use in the mining process, or to the wastewater disposal system. The 25 to 40 percent of water that is rejected, called "brine", contains the majority of dissolved salts that contaminate the groundwater and is sent for disposal in the waste system. Make-up

FIGURE 6.1-1
Restoration Process Flow Diagram



water may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

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The reductant (either biological or chemical) added to the injection stream during the groundwater treatment stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding a reductant, the Eh of the aquifer is lowered, thereby decreasing the solubility of these elements. Hydrogen sulfide (H_2S), sodium sulfide (Na_2S), or a similar compound will be added as a reductant. CBR typically uses sodium sulfide due to the chemical safety issues associated with proper handling of hydrogen sulfide. A comprehensive safety plan regarding reductant use is implemented.

The number of pore volumes treated and re-injected during the groundwater treatment stage will depend on the efficiency of the RO in removing total dissolved solids (TDS) and the reductant in lowering the uranium and trace element concentrations.

- Wellfield Recirculation

At the completion of the Groundwater Treatment Stage, wellfield recirculation may be initiated. In order to homogenize the aquifer, pumping from the production wells and re-injecting the recovered solution into injection wells may be performed to recirculate solutions.

The sequence of the activities will be determined by CBR based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by CBR.

Once the restoration activities are completed, CBR will sample the restoration wells and determine if the mining unit has achieved the restoration values, on a mine unit average basis. If so, CBR will notify the regulatory agencies that it is initiating the Stabilization

Table 6.1-2: Typical Reverse Osmosis Membrane Rejection

NAME	SYMBOL	PERCENT REJECTION
	Cations	
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Cadmium	Cd^{+2}	96-98
Calcium	Ca^{+2}	96-98
Copper	Cu^{+2}	98-99
Hardness	Ca and Mg	96-98
Iron	Fe^{+2}	98-99
Magnesium	Mg^{+2}	96-98
Manganese	Mn^{+2}	98-99
Mercury	Hg^{+2}	96-98
Nickel	Ni^{+2}	98-99
Potassium	K^{+1}	94-96
Silver	Ag^{+1}	94-96
Sodium	Na^{+}	94-96
Strontium	Sr^{+2}	96-99
Zinc	Zn^{+2}	98-99
	Anions	
Bicarbonate	HCO_3^{-1}	95-96
Borate	$B_4O_7^{-2}$	35-70
Bromide	Br^{-1}	94-96
Chloride	Cl^{-1}	94-95
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Ferrocyanide	$Fe(CN)_6^{-3}$	99+
Fluoride	F^{-1}	94-96
Nitrate	NO_3^{-1}	95
Phosphate	PO_4^{-3}	99+
Silicate	SiO_2^{-1}	80-95
Sulfate	SO_4^{-2}	99+
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+

Source: Osmonics, Inc.

Stage and will submit supporting documentation that the restoration parameters are at or below the restoration standards. If at the end of restoration activities the parameters are not at or below the approved values, CBR will either re-initiate certain steps of the restoration plan or submit documentation to the agencies that the best practical technology has been used in restoration. The documentation will include a justification for alternate parameter value(s) including available water quality data and a narrative of the restoration techniques used.

6.1.5 Stabilization Phase

Upon completion of restoration, a groundwater stabilization monitoring program will begin in which the restoration wells and any monitor wells on excursion status during mining operations will be sampled and analyzed for the restoration parameters listed in Table 6.1-1. The sampling frequency will be one sample every other month for four quartersper month for a period of 6 months, and if the six samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, restoration shall be deemed complete.

6.1.6 Reporting

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be summarized and discussed in the Semiannual Radiological Effluent and Environmental Monitoring Report submitted to USNRC. This information will also be included in the final report on restoration. In the unlikely event that a well goes on excursion during restoration, the process described in Section 5.7.8.2 will be used.

Upon completion of restoration activities and before stabilization, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 6.1-1. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the USNRC and the NDEQ, CBR will proceed with the stabilization phase of restoration.

During stabilization, all designated restoration wells will be sampled monthly for the constituents listed in Table 6.1-1. At the end of a six-month stabilization period, CBR will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. If the analytical results continue to meet the appropriate standards for the mine unit and do not exhibit significant increasing trends, CBR would request the mine unit be declared restored. Following agency approval, wellfield reclamation and plugging and abandonment of wells will be performed as described in Section 6.2.

Replacement Pages for Section 7
Environmental Effects

Replace All of Section 7, pages 7-1 through 7-53

Note: Red-line version located behind blue cover page after replacement pages

7 ENVIRONMENTAL EFFECTS

The objective of the mining and environmental monitoring program is to conduct an operation that is economically viable and environmentally responsible. The environmental monitoring programs, which are used to ensure that the potential sources of land, water and air pollution are controlled and monitored, are presented in Section 5.7, Radiation Safety Control and Monitoring.

This section discusses and describes the degree of unavoidable environmental impacts, the short and long term impacts associated with operations and the consequences of possible accidents at the current Crow Butte project and the North Trend Expansion Area.

7.1 ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND CONSTRUCTION

The initial site preparation and construction associated with the North Trend Expansion Area will include the following:

- Construction of a satellite process facility located approximately 3 miles west and 5 miles north of the current process plant. This satellite facility will be housed in a building approximately 130 feet long by 100 feet wide and will contain ion exchange and associated equipment capable of processing 4,500 gpm of production flow and 500 gpm of restoration flow.

- Construction of solar evaporation ponds located in conjunction with the satellite facility to be used as a feed pond for the deep injection well.

- Expansion of the main process facility in response to the increase in the ion exchange resin handling, elution, precipitation, thickening, and drying circuits to handle the additional production from the North Trend. Initial estimates are that this expansion may require an additional process area of 2,500 square feet.

- A deep well injection building(s).

- Access roads, as required.

Site preparation and construction activities will include topsoil salvaging, pond excavation, building erection, and access road construction. Note that wellfield construction activities and completion of injection, production and monitor wells are discussed in section 7.2 since these are ongoing activities at an ISL facility. This section strictly discusses the short-term impacts of initial site preparation and construction where they differ from the impacts of operations.

Environmental impacts of construction projected for the North Trend Expansion Area are based on the studies conducted by CBR and discussed in Section 2. The impacts are also projected based on experience with the current operation and the impacts that have been associated with this type of construction at the Crow Butte project over the past fifteen years of commercial operation.

The total area impacted by initial construction activities is approximately 30 acres. All areas disturbed will be reclaimed during final decommissioning activities. The planned schedule for construction, production, restoration, and decommissioning was presented in Section 1.

7.1.1 Air Quality Effects of Construction

Construction activities at the North Trend Expansion Area site would cause minimal effects on local air quality. Effects to air quality would be increased suspended particulates from vehicular traffic on unpaved roads, in addition to existing fugitive dust caused by wind erosion, and diesel emissions from construction equipment. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

7.1.2 Land Use Impacts of Construction

The principal land uses for the 30-acre site associated with the proposed North Trend Satellite Plant is as cropland, primarily for raising alfalfa for livestock feed. As a result of site preparation and construction, crop production will be excluded from the area that is under development. In 2001 Dawes County had 77,000 acres harvested for 123,800 tons of hay. This harvest resulted in yields of 1.6 tons of hay per acre harvested. Based on this average yield, construction activities in a 30-acre area would result in the lost production of up to 48 tons of hay per year. Considering the relatively small size of the area impacted by construction, the exclusion of agricultural activities from this area over the course of the North Trend project should not have a significant impact on local agricultural production.

7.1.3 Surface Water Impacts of Construction

When stormwater drains off a construction site, it carries sediment and other pollutants that can harm lakes, streams and wetlands. The U.S. Environmental Protection Agency

(EPA) estimates that 20 to 150 tons of soil per acre is lost every year to stormwater runoff from construction sites. For this reason, stormwater runoff is controlled by National Pollutant Discharge Elimination System (NPDES) regulations.

Construction activities at the Crow Butte project to date have had a minimal impact on the local hydrological system. CBR conducts construction activities under NDEQ permitting regulations for control of construction stormwater discharges contained in Title 119[1]. CBR is required by NDEQ General Construction Stormwater NPDES Permit NER 100000 to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in SHEQ MS Volume VI, *Environmental Manual* and require active engineering measures, such as berms, and administrative measures, such as work activity sequencing to control runoff and sedimentation of surface water features. CBR must annually submit a construction plan for the coming year and obtain authorization from the NDEQ under the general permit.

In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from initial site preparation and construction of the North Trend Satellite Plant and related facilities will be minimal since there are no nearby surface water features.

7.1.4 Population Impacts of Construction

The effects of construction of the proposed North Trend Satellite Facility on the immediate population will be an unavoidable impact, although a temporary one. Construction activities will require additional temporary construction workers. Many of these positions will likely be filled by local labor. Any additional workers that may not be from the immediate area will cause a short-term increase in housing demand. The population impacts of construction are discussed in more detail in section 7.6.

7.1.5 Social and Economic Impacts of Construction

The social and economic impacts to the town of Crawford and surrounding areas during the construction of the original facility were slight given the relatively small scale of activities. The future construction activities for the North Trend Satellite Facility will be even smaller in scope. CBR estimates that ten to fifteen temporary construction workers will be involved in constructing the North Trend Satellite facilities. The social and economic impacts of construction are discussed in more detail in section 7.6.

7.1.6 Noise Impacts of Construction

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. This varying sensitivity is accommodated by applying "A-Weighted" correction factors. This correction de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. The primary assumption is that the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise. In general, a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a rural area during the day is 40 dBA and a typical construction site is 80 dBA (EPA 1974[2]). As a comparison, a normal conversation at 5 feet is 60 dBA (EPA 1974).

The nearest noise receptor (residence) to the Crow Butte North Trend Project (Project) is on State Highway (SH) 2/71 along the eastern project boundary. This residence is located approximately ½ mile from the proposed satellite plant. The next closest residence is located along the southern project boundary at a distance of approximately 1.5 miles south of the satellite plant. The town of Crawford is located approximately 2.5 miles south of the satellite plant.

According to Sandy Seidel, Crawford City Clerk, the City of Crawford does not have a noise ordinance. A review of the City of Crawford Municipal Code revealed a noise ordinance related to industrial equipment. Section 2-103, Excessive Noise Control (Crawford 2007[3]) reports that it is "unlawful to operate industrial equipment, heavy machinery, jack hammer and other industrial equipment emitting loud noise or to race automobile engines within the City between the hours of 8:00 P.M. and 7:00 A.M., in such a manner so as to disturb the ... peace ... unless such activity has been approved in advance by the City Council." Construction activities associated with the project would be conducted outside of the City of Crawford limits. The Dawes County Clerk's office did not know of a noise ordinance for Dawes County.

The project area is bounded on the west by the Burlington Northern Santa Fe (BNSF) rail line and on the east by Nebraska SH 2/71. Therefore, the existing ambient noise in the vicinity of the Project area is dominated by the traffic noise from SH 2/71 and trains on the BNSF rail line.

The State of Nebraska, Department of Roads, reports that the annual 24-hour average number of total vehicles to travel SH 2/71 along the eastern project boundary in 2004 was 265 (Nebraska 2007[4]). Thirty-five of these vehicles were reported to be heavy commercial vehicles. Table 7.1-1 (USDOT 1995[5]) presents typical noise levels for automobiles at a distance of 15 meters (45 feet) at speeds ranging from 50 miles per hour (mph) to 70 mph.

Table 7.1-1
Typical Automobile Noise Levels

Speed (mph)	Noise Level at 45 ft (dBA)
50	62
55	64
60	65
65	66.5
70	68

Traffic noise is a combination of traffic density and vehicle speed. The speed limit along SH 2/71 near the project area is 60 miles per hour (Nebraska 2007[6]). The closest noise receptor (residence) to SH 2/71 is located adjacent to the road. Therefore, the existing noise level at that receptor due to existing traffic noise alone would be expected to be 65 dBA.

The precise noise levels from trains is a complex calculation that considers the train speed, the train length, the conditions of the wheels, and the condition of the track (Harris 1991[7]). Noise from trains has been measured (Harris 1991) to range from 87 to 96 dBA at 100 feet from a track. The BSNF rail line runs through the town of Crawford. Assuming that a resident may live as close as 100 feet from the track, the existing noise for that receptor would be expected to be at least 87 dBA due to train noise alone.

The propagation of noise depends on many factors including atmospheric conditions, ground cover, and the presence of any natural or man-made barriers. As a general rule, noise decreases by approximately 6 dBA with every doubling of the distance from the source (Bell 1982[8]). Therefore, noise levels at various distances can be predicted. The closest noise receptor, residence along SH 2/71, is located approximately 1.2 mile east of the BNSF. Using the doubling rule, the train noise at the residence would be 51 dBA, assuming a distance of 6400 feet. Because the effect of multiple noise sources is not a simple addition, but rather is a logarithmic addition, the existing noise levels at the closest receptor, based on noise from highway traffic and the BNSF, is likely to be 65 dBA or greater.

Noise sources during construction are expected to increase due to increased vehicle travel on SH 2/71. It is estimated that as many as 20 additional vehicles would travel along SH 2/71 each day as employees travel to and from Crawford for work. Additionally, heavy equipment used during construction may include bull dozers, scrapers, graders, front-end loaders, and cranes. Train usage would not increase as a result of construction.

Noise generated during the construction phase would result from vehicle travel and the operation of construction equipment. Table 7.1-2 presents typical noise levels for construction equipment at a distance of 15 meters (45 feet) (Crocker 1982[9]). These values assume the equipment is operating at full power.

Table 7.1-2
Typical Construction Noise Levels

Equipment Category	Noise Level at 45 ft (dBA)
Grader	85
Front-End Loader	84
Mobile Crane	83
Excavator	82
Backhoe	81
Bull Dozer	78

Using the doubling rule, noise impacts at a distance of 2880 feet, the approximate location of the closest receptor from construction equipment located at the satellite site, is calculated to be 49 dBA.

Increased vehicle travel during the construction phase of the project may result in a slight increase in noise impacts to residents. However, noise from construction would not be generated during nighttime hours and increases in noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction traffic, (including movement of heavy equipment, which would be much less dense and slower than highway traffic) would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad. Noise from construction would be temporary and would briefly add to existing highway noise. Construction would be completed in a timely manner.

7.2 ENVIRONMENTAL EFFECTS OF OPERATIONS

The major environmental concerns during the operation of the North Trend Satellite Facility will be air quality effects, land use and water quality impacts, ecological impacts, and radiological impacts.

7.2.1 Air Quality Impacts of Operations

The primary new emission source of non-radiological pollutants will be tailpipe emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), non-methane-ethane volatile organic compounds (VOC), and particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the North Trend Expansion Area. Approximately 6-8 vehicle trips per day (VTPD) are anticipated as part of regular operations. These vehicles are expected to be light duty pick-up style trucks. Heavy equipment in the form of drill rigs, equipment haulers, or water trucks will be used as necessary and are anticipated to average less than one VTPD. These emissions are expected to be minor and should not affect the local ambient air quality.

Although there are no ambient air quality monitoring data for these non-radiological pollutants in the license area, PM_{10} concentrations have been measured in Rapid City, South Dakota and Badlands National Park in South Dakota. Both locations are geographically similar to the license area.

The Rapid City data were collected at the National Guard Camp Armory site about 2 miles west of the city. This are is classified as suburban. The Badlands data were collected in an area classified as rural. Because of the degree of urbanization, the air quality at the license area would probably fall somewhere between the air quality at these two locations. These data were obtained from the United States Environmental Protection Agency (USEPA) air quality monitoring database (USEPA 2007[10]), and are presented in Table 7.2-1.

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (24-hour average), and 50 micrograms per cubic meter (annual average). All counties within the 80 km radius of the project are in attainment of NAAQS.

TABLE 7.2-1
PM_{10} MONITORING SUMMARY
(MICROGRAMS PER CUBIC METER)

Year	Maximum 24-hr Average		Annual Average	
	Black Hills, SD	Rapid City, SD	Black Hills, SD	Rapid City, SD
1998	-	87.4	-	30.7
1999	-	116.9	-	28.2
2000	38.5	97.4	12.0	31.3
2001	47.9	81.5	12.6	34.6
2002	26.0	104.7	9.9	34.9
2003	74.4	91.8	16.3	36.2
2004	24.0	72.0	10.0	30.0
2005	40.0	94.00	9.0	27.0
2006	30.0	124.0	10.0	29.0

There will be an increase in the total suspended particulates (TSP) in the region as a result of the North Trend Expansion Area. This increase in TSP will be greatest during the site preparation phase of the satellite facility. Revegetation will be performed where possible to mitigate the problems associated with the resuspension of dust and dirt from disturbed areas. All areas disturbed during construction are revegetated with the exception of plant pad areas, roads, and areas covered by the pond liners. Of these, the only significant source of TSP is dust emissions from unpaved roads. The amount of dust can be estimated from the following equation taken from "Supplement No. 8 For Compilation of Air Pollutant Emission Factors" (USEPA, 1978[11]).

$$E = (0.81s)\frac{S}{30}\frac{365-w}{w}$$

Where:

E	=	emission factor, lb per vehicle-mile
s	=	silt content of road surface material, 40%
S	=	average vehicle speed
w	=	mean number of days with 0.01 inches or more of rainfall, 85

Using the values stated above, the emission factor is equal to 0.27lb/vehicle-mile. The distance from the town of Crawford to the North Trend Satellite Plant is approximately 7.6 miles. Approximately 4 miles of this distance is on improved roads and 3.6 miles is on dirt or trail roads. CBR expects that most employees at the North Trend Satellite Plant will be from the town of Crawford. Assuming ten employees and a 7 day workweek, there would be 140 trips per week and the weekly mileage on dirt or trail roads would be 504 miles. Deliveries and other travel may require up to 50 trips per week which would be an additional 360 miles per week on dirt or trail roads.

The distance from the satellite plant to the Crow Butte Main Plant is 8.1 miles of which 7.1 miles are on dirt or trail roads. Assuming 2 trips per day for resin transfer and an additional 10 trips per day for plant personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1200 miles per week. This estimate is based on a 7 day work week.

The total travel on dirt and trail roads for personnel, resin transfer, deliveries and incidental travel will be approximately 2,060 miles per week. With an emission factor of 0.27 lb. TSP per vehicle-mile there will be a total dust emission of approximately 14.5 tons per year as a result of increased traffic on dirt and trail roads.

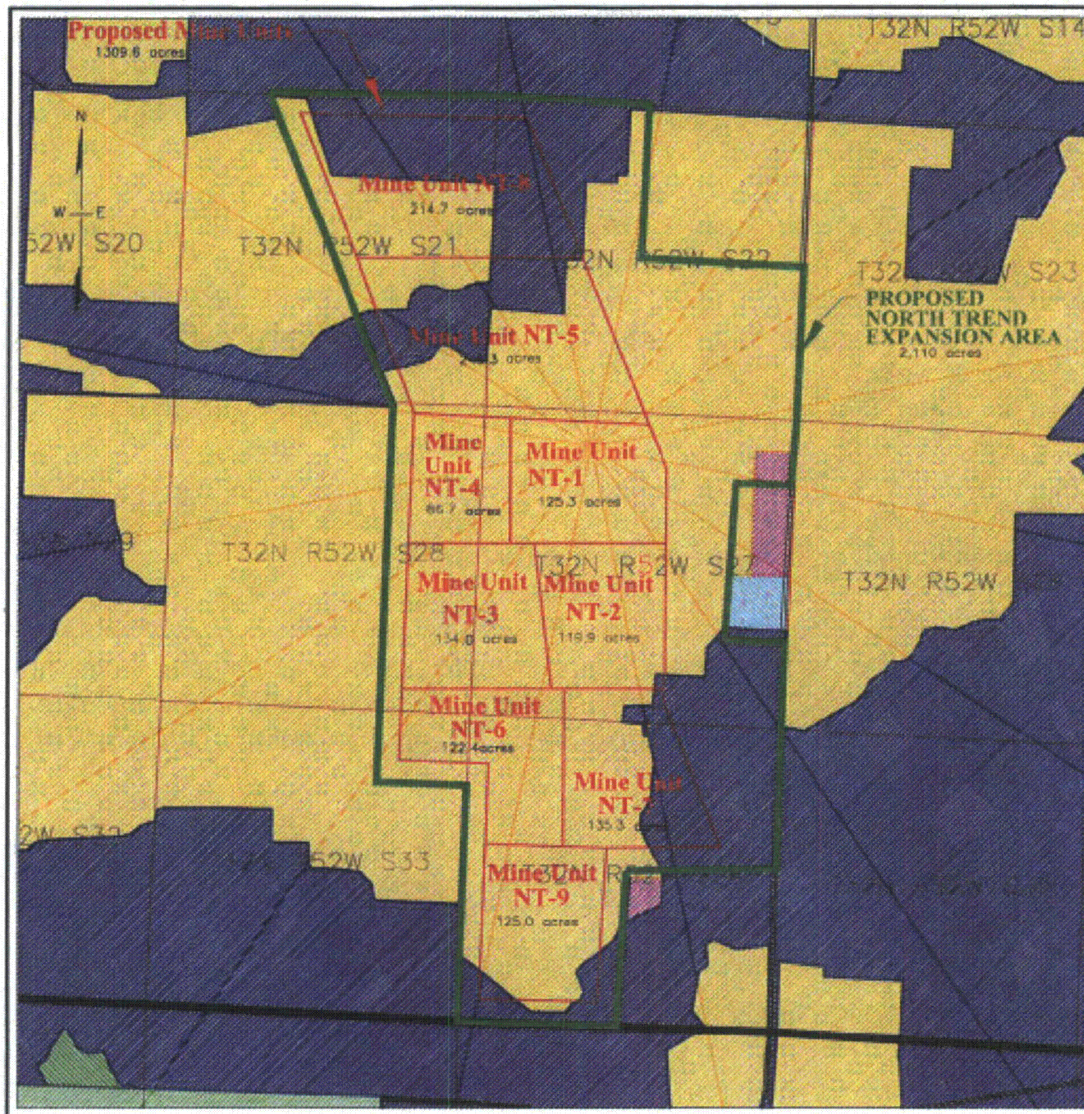
Any increase in fugitive dust emissions resulting from operational activities within the North Trend Expansion Area would be minimal. Implementation of mitigation measures such as the application of water or dust control chemicals to unpaved roads would ensure that the ambient air quality standards of the State of Nebraska would not be exceeded at any time during the life of the project.

Other operational activities may have impacts on surrounding air quality. The only atmospheric emission from the production and process facilities will be radon gas, which is discussed at length in Section 7.3.

7.2.2 Land Use Impacts of Operations

The principal land uses for the North Trend Expansion Area and the 2.25-mile review area is grazing livestock. Rangeland accounted for 55.7 percent of the land use in the North Trend Expansion Area and the review area as discussed in Section 2.2. The secondary land use within this area is cropland, primarily for wheat, although a small proportion is used for alfalfa. Cropland accounted for 29.9 percent of the land use in the North Trend Expansion Area and the review area. Land use was discussed in detail in Section 2.2.

For the 1,310 acre proposed wellfield areas, cropland accounts for 1,041.7 acres or 79.5 percent of the total area. Rangeland accounts for 267.9 acres or 20.5 percent of the total area. Figure 7.2-1 depicts the proposed wellfield areas and the current types of land use.



LEGEND

- RESIDENTIAL
- CROPLAND
- FOREST
- RANGELAND
- COMMERCIAL & SERVICES
- RECREATION

MU	ACRES RANGELAND	ACRES CROPLAND
1	0,0	125,3
2	1.0	118.9
3	0,0	134.0
4	0,0	86,7
5	80.8	165.5
6	0,0	122.4
7	47,2	88,1
8	130.2	84.5
9	8.7	116,3
TOTALS	267.9	1041.7

0 1250 2500 5000
SCALE IN FEET 1" = 2500'

CROW BUTTE RESOURCES, INC.

FIGURE 7.2-1
NORTH TREND WELLFIELD LAND USE

PROJECT: 223-30	DATE: MARCH 2007	
DWG: CBRNT3CBase.dwg	BY: KRS	CHECKED: HPD

Petrotek

As a result of site preparation and construction, cattle production will be excluded from the areas that are under development. The total estimated area that will be impacted during the course of the project is the 267.9 acres associated with the satellite plant and wellfields. As discussed in section 2.2, livestock and livestock products had a value of $28.81 per acre, indicating that livestock production on rangeland within the impacted wellfield area has a potential value of more than $7,770.

As a result of site preparation and construction, crop production will be excluded from the areas that are under development. The total estimated cropland area that will be impacted during the course of the project is the 1,041.7 acres associated with the satellite plant and wellfields. In 2001 Dawes County had 77,000 acres harvested for 123,800 tons of hay and 33,700 acres harvested for 1,198,700 bushels of winter wheat. These harvests resulted in yields of 1.6 tons of hay and 35.6 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the North Trend Expansion Area would be up to 1,666 ton of hay and up to 37,085 bushels of wheat.

Considering the relatively small size of the area impacted by operations, the exclusion of agricultural activities from this area over the course of the North Trend project should not have a significant impact on local agricultural production. These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation.

The current operations in the licensed area have shown that CBR can successfully restore the land surface following mining operations. Surface reclamation activities including contouring and revegetation have been performed routinely following initial mine unit construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of Mine Unit 1 following approval of groundwater restoration. These areas have been successfully recontoured and revegetation has been completed in accordance with NDEQ requirements.

7.2.3 Geologic and Soil Impacts of Operations

7.2.3.1 Geologic Impacts of Operations

Geologic impacts are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the Basal Chadron Sandstone will be on the order of 1% or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10% of the available head, or less. Further, once mining and restoration operations are completed and restoration approved, groundwater levels will return to near original conditions under a natural gradient.

If the White River structural feature is in fact a fault, changes in aquifer pressure potentially could impact activity related to the fault and the transmissive characteristics of the fault (e.g., resistance to flow). There are numerous documented cases where injection in the immediate vicinity of a fault has caused an increase in seismic activity. However, such response typically occurs when injection operations have increased the pressure in the aquifer by a significant amount (e.g., 40 to 200 percent pressure increase over initial conditions). The pressure in the Basal Chadron will be increased by localized scale by injection operations during mining and restoration operations, and will be more than offset by production within each wellfield pattern.

7.2.3.2 Soil Impacts of Operations

Construction of the facilities at the North Trend site will affect soils. Effects to soils would be significant on approximately 30 fenced acres of the 1,310 acres that will be disturbed by construction of the North Trend Satellite Plant and associated facilities. Much of the remaining 1,280 acres will be devoted to wellfield production where effects to soils would be much lower.

The severity of soil impacts would depend on the number of acres disturbed and the type of disturbance. Potential impacts include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Effects to soils at the North Trend site would result from the clearing of vegetation, excavating, leveling, stockpiling, compacting, and redistributing soils during construction and reclamation. Disturbance related to the construction and operation of the North Trend site would be long-term.

Wind erosion is a concern at the North Trend site. Various soils meet the criteria for severe wind erosion hazard (USDA 1977). These soils have one or more major constituents that are fine sand or sandy loam that can easily be picked up and spread by wind. Construction presents the greatest threat to soils with potential for wind erosion. Wind erosion will be controlled by removing vegetation only where it is necessary, avoiding clearing and grading on erosive areas, surfacing roads with gravel, and timely reclamation.

Water erosion is also a concern at the North Trend site. Various soils meet the criteria for severe water erosion hazard (USDA 1977). These soils have low permeability and high K-factors, making them susceptible to water erosion. The K-factor is used to describe a soil's erodibility; it represents both susceptibility of soil to erosion and the rate of runoff. It is calculated from soil texture, organic matter, and soil structure. Construction and operation would increase soil loss through water erosion. Removal of vegetation for any activity exposes soils to increased erosion. Excavation could break down soil aggregates, increasing runoff and gully formation. Soil loss will be reduced substantially by avoiding highly erosive areas such as badlands and steep drainages. Locating roads in areas where cuts and fills would not be required, surfacing roads, installing drainage controls, and reseeding and installing water bars across reclaimed areas will also aid in reducing soil loss.

Sedimentation in streams and rivers at the North Trend site could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of drainages in the area. Installation of appropriate erosion control measures as required by CBR's Construction Stormwater NPDES authorization (see section 7.1.3) and avoidance of erosive soils will aid in reducing sedimentation.

Activity on the site has the potential to compact soils. While soils sensitive to compaction, such as clay loams, do not exist on the site, the intense volume and degree of activity at the North Trend site could damage soil properties and cause compaction. Compaction of the soils could decrease infiltration, promoting high runoff. If compaction occurs, reduced infiltration capacity could persist for over 50 years in some soils. Construction and traffic will be minimized where possible, and soils will be loosened for reseeding during reclamation to control the effects of soil compaction.

Any soil on the site can be saline depending on site-specific soil conditions, such as permeability, clay content, quality of nearby surface waters, plant species, and drainage characteristics. Saline soils are extremely susceptible to soil loss caused by development. Soil erosion in areas with high salt content would contribute to salinity in the White River Basin. Reclamation of saline soils can be difficult, and no method that works in all situations has yet been found.

Facility development would displace topsoil, which would adversely affect the structure and microbial activity of the soil. Loss of vegetation would expose soils and could result in a loss of organic matter in the soil. Excavation could cause mixing of soil layers and breakdown of the soil structure. Removal and stockpiling of soils for reclamation could result in mixing of soil profiles and loss of soil structure. Compaction of the soil could decrease pore space and cause a loss of soil structure as well. This would result in a reduction of natural soil productivity.

A number of erosion and productivity problems resulting from the North Trend site may cause a long-term declining trend in soil resources. Long-term impacts to soil productivity and stability would occur as a result of large scale surface grading and leveling, until successful reclamation would be accomplished. Reduction in soil fertility levels and reduced productivity would affect diversity of reestablished vegetative communities. Moisture infiltration would be reduced, creating soil drought conditions. Vegetation would undergo physiological drought reactions.

Surface spillage of hazardous materials could occur at the North Trend site. If not remediated quickly, these materials have the potential to adversely impact soil resources. In order to minimize potential impacts from spills, a Spill Prevention, Control, and

Countermeasure (SPCC) Plan will be implemented. The SPCC plan will include accidental discharge reporting procedures, spill response, and cleanup measures.

7.2.3.2.1 Soil Impact Mitigation Measures

Best Management Practices (BMPs) have been included in the project description and will be followed for site preparation to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the North Trend site. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document.

Sediment Control

- Divert surface runoff from undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Surface drainage shall not be directed over the unprotected face of the fill.
- Operations and disturbance on slopes greater than 40 percent need special sediment controls and should be designed and implemented appropriately.
- Avoid continuous disturbance that provides continuous conduit for routing sediment to streams.
- Inspect and maintain all erosion control structures.
- Repair significant erosion features, clogged culverts, and other hydrological controls in a timely manner.
- If best management practices do not result in compliance with applicable standards, modify or improve such best management practices to meet the controlling standard of surface water quality.

Topsoil

- Topsoil to be removed should be removed prior to any development activity to prevent loss or contamination.
- When necessary to substitute for or supplement available topsoil, use overburden that is equally conducive to plant growth as topsoil.
- To the extent possible, directly haul (live handle) topsoil from site of salvage to concurrent reclamation sites.
- Avoid excessive compaction of topsoil and overburden used as plant growth medium by limiting the number of vehicle passes, and handling soil while saturated and scarifying compacted soils.
- Time topsoil redistribution so seeding, or other protective measures, can be readily applied to prevent compaction and erosion.

Roads

Construct and maintain roads to minimize soil erosion by:

- Restricting the length and grade of roadbeds;
- Surfacing roads with durable material;
- Creating cut and fill slopes that are stable;
- Revegetating the entire road prism including cut and fill slopes; and,
- Creating and maintaining vegetative buffer strips, and constructing sediment barriers (e.g. straw bales, wire-backed silt fences, check dams) during the useful life of roads.

Regraded Material

- Design regraded material to control erosion using activities that may include slope reduction, terracing, silt fences, chemical binders, seeding, mulching etc.
- Divert all surface water above regarded material away from the area and into protected channels.
- Shape and compact regraded material to allow surface drainage and ensure long-term stability.
- Concurrently reclaim regarded material to minimize surface runoff.

Potential long-term effects include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Potential short-term effects include reduced soil productivity, erosion, compaction and soil contamination. Implementation of BMPs, SPCCs, and SWPPPs will minimize effects to soils associated with the construction of the North Trend production facilities.

7.2.4 Archeological Resources Impacts of Operations

Field investigations were conducted in July 2004 on a 1,190-acre area of anticipated potential development. Three historic sites and three isolated prehistoric artifacts were located and identified. As noted in Section 2.4, these resources are not likely to yield information important in prehistory or history and are considered not eligible for the National Register of Historic Places. Because these resources are considered not eligible, they are not historic properties and the proposed North Trend Expansion Area will have no effect on historic properties.

7.2.5 Groundwater Impacts of Operations

Potential impacts to water resources from mining and restoration activities include the following:

7.2.5.1 Groundwater Consumption

Groundwater impacts and consumption related to the North Trend operation will be fully assessed in an Industrial Groundwater Permit application that is required by NDEQ. Information from the existing Groundwater Permit for the current license area indicates that the drawdown from mining operations in the basal Chadron Formation is minimal (e.g., less than 10 percent of the available head). Based on drawdown data from years of operation in the current license area, and on the formation characteristics from the North Trend Pump Test, the drawdown effect on the Chadron aquifer as a result of operations has been and is expected to remain minimal.

Groundwater consumption from the North Trend operation is expected to be on the order of 0.5% to 1.5% of the total mining flow (4,500 gpm). Additional consumptive volume will be used during aquifer restoration, especially the groundwater sweep phase. However, it is expected that the net consumption for the entire operation will be on the order of 50 to 100 gpm.

7.2.5.2 Potential Declines in Groundwater Quality

Excursions represent a potential effect on the adjacent groundwater as a result of operations. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, and hydrofracturing of the ore zone or surrounding units.

To date, there have been several confirmed horizontal excursions in the Chadron sandstone in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In all but one case, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent upper control limits (UCLs). In no case did the excursions threaten the water quality of an underground source of drinking water since the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. Table 7.2-2 provides a summary of excursions reported for the current license area.

Table 7.2-2: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 20, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	May 6, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)

Table 7.2-2: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 28, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 7, 2006	Excursion of mining solutions
PR-15	September 26, 2006		See IJ-13 and PR-8

7.2.5.3 Potential Groundwater Impacts from Accidents

Groundwater quality could potentially be impacted during operations due to an accident such as evaporation pond leakage or failure, or an uncontrolled release of process liquids due to a wellfield accident. If there should be an uncontrolled pond leak or wellfield accident, potential contamination of the shallow aquifer (Brule), as well as surrounding soil, could occur. This could occur as a result of a slow leak or a catastrophic failure, a shallow excursion, an overflow due to excess production or restoration flow, or due to the addition of excessive rainwater or runoff.

To mitigate the likelihood of pond failure, all ponds at North Trend will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all ponds will be inspected on a regular basis. In the event that a problem is detected, the contents of any given pond can be transferred to another pond while repairs are made. The proposed pond design and operation was discussed in greater detail in Section 4.

Over the course of the current licensed operation, CBR has experienced several leaks associated with the inner pond liner on the commercial evaporation ponds. These small leaks are virtually unavoidable since the liners are exposed to the elements. In each case these leaks were quickly discovered during routine inspections, primarily due to a response in the underdrain system. Corrective actions included lowering the pond level and locating the leak to allow repairs. In none of these situations was the shallow groundwater affected since the outer pond liner functioned as designed and prevented a release of the pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ.

With respect to potential overflow of a pond, current standard operating procedures require that pond levels be closely monitored as part of the daily inspection. Process flow to the ponds will be minimal in comparison to the pond capacity, thus it can easily be diverted to another pond if necessary. In addition, sufficient freeboard will be maintained on all ponds to allow for a significant addition of rainwater with no threat of overflow. Finally, the dikes and berms around the ponds will channel runoff away from the ponds.

Another potential cause of groundwater impacts from accidents could be releases as a result of a spill of injection or production solutions from a wellfield building or associated piping. In order to control these types of releases, all piping is either PVC, high density polyethylene with butt welded joints, or equivalent. All piping is leak tested prior to production flow and following repairs or maintenance.

7.2.6 Surface Water Impacts of Operations

7.2.6.1 Surface Water Impacts from Sedimentation

Protection of surface water from stormwater runoff during on-going wellfield construction related to operations is regulated by the NDEQ as discussed in section 7.1.3.

7.2.6.2 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as an evaporation pond leakage or failure or an uncontrolled release of process liquids due to a wellfield accident. Section 7.2.5.3 discussed the operation of the ponds and measures to prevent and control wellfield spills. An additional measure to protect surface water is that wellfield areas are installed with dikes or berms. The berms prevent surface spills from entering all surface water bodies and drainages that connect to surface water bodies and eliminate public dose and contaminant pathways to surface water. Process buildings are constructed with secondary containment, and a regular program of inspections and preventive maintenance is in place.

7.2.7 Ecological Impacts of Operations

7.2.7.1 Impact Significance Criteria

The following criteria were used to determine the significance of construction and operation of the proposed project on wildlife and vegetation resources within the project area. These criteria were developed based on professional judgment, involvement in other NEPA projects throughout the West, and state and federal regulations.

- Removal of vegetation such that following reclamation, the disturbed area(s) would not have adequate cover (density) and species composition (diversity) to support pre-existing land uses, including wildlife habitat;
- Unauthorized discharge of dredged or fill materials into, or excavation of, waters of the U.S., including special aquatic sites, wetlands, and other areas subject to the Section 404 of the Clean Water Act, Executive Order 11988 - flood plains, and Executive Order 11990 - wetlands and riparian zones;
- Reclamation is not accomplished in compliance with Executive Order 13112 (Invasive Species);
- Introduction and establishment of noxious or other undesirable invasive, non-native plant species to the degree that such establishment results in listed invasive, non-native species occupying any undisturbed rangeland outside of established disturbance areas or hampers successful revegetation of desirable species in disturbed areas;
- Whether or not a substantial increase in direct mortality of wildlife caused by road kills, harassment, or other causes would occur;
- Incidental take of a special-status species to the extent that such impact would threaten the viability of the local population;
- Whether or not an officially-designated critical wildlife habitat was eliminated, sustained a permanent reduction in size, or was otherwise rendered unsuitable;
- Whether or not any effect, direct or indirect, results in a long-term decline in recruitment and/or survival of a wildlife population; and
- Construction disturbance during the breeding season or impacts to reproductive success which could result in the incidental loss of fertile eggs or nestlings, or otherwise lead to nest abandonment in accordance with regulations prescribed by the Migratory Bird Treaty Act.

7.2.7.2 Vegetation

As described in detail in Section 3, a total of 9 wellfields and the satellite processing facility will be constructed during the next 11 years with an expected mine life operation of 15 years. Well placement within the project area is not known at this time; however, it was assumed that agricultural fields within Sections 21, 22, 27, 28, 33, and 34 (Township 32N, Range 52W) will be developed and contain a significant amount of project-related infrastructure. Production facilities are not anticipated to be constructed within the mixed-grass prairie vegetation community, which is primarily located in the north ½ of Section 21 (Township 32N, Range 52W).

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) from soil disturbance and grading. Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

Vegetation removal and soil handling associated with the construction and installation of wellfields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, because most project-related infrastructure will be constructed within cultivated agricultural fields, vegetation impacts will be negligible. If the mixed-grass prairie vegetation community were to be developed, direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics.

During the anticipated life of the project (15 to 18 years), an estimated 1,041.7 acres of cultivated agricultural fields would be affected by surface-disturbing production facilities. The likelihood of impact is greatest for the primary vegetation cover types of cultivated fields, which occupies 62 percent of the total impacted area. As stated above, clearing of mixed-grass prairie vegetation community types is not anticipated.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in western states. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. Currently, the project area is relatively free of noxious and other unwanted invasive, non-native species.

In general, the duration of effects on cultivated agricultural land and mixed-grass prairie vegetation are significantly different. Cropland areas can be readily returned to production through fertilizer treatments and compaction relief. However, disturbed native prairie tracts require reclamation treatments and natural succession to return to predisturbance conditions of diversity (both species and structural). Reestablishment of mixed-grass prairie to predisturbance conditions would be influenced by climate (growing season, temperature, and precipitation patterns) and edaphic (physical, chemical, and biological) conditions in the soil.

Previously planted agricultural fields would be recontoured to approximate precontours and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts were disturbed by surface activities, these areas would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) completing cleanup of the disturbed areas (well fields and access roads); (2) restoring the disturbed areas to the approximate ground contour that existed before construction; (3) replacing topsoil, if removed, over all disturbed areas; (4) ripping disturbed areas to a depth of 12 to 18 inches; and (5) seeding recontoured areas with a locally adapted, certified weed-free seed mixture.

7.2.7.3 Surface Waters and Wetlands

Surface disturbances associated with the proposed facilities would not affect either Spring Creek or the White River. In addition, no wetlands have been identified within the project area. Therefore, impacts to wetlands and surface waters are not anticipated.

7.2.7.4 Wildlife and Fisheries

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of some individuals of some wildlife species, loss of wildlife habitats, and an increase in the potential for collisions between wildlife and motor vehicles. Other potential effects include a rise in the potential for illegal kill, harassment, and disturbance of wildlife because of increased human presence primarily associated with increased vehicle traffic. The magnitude of impacts to wildlife resources would depend on a number of factors, including the time of year, type and duration of disturbance, and species of wildlife present.

7.2.7.5 Small Mammals and Birds

The direct disturbance of wildlife habitat in the project area likely would reduce the availability and effectiveness of habitat for a variety of common small mammals, birds, and their predators. The initial phases of surface disturbance and increased noise would result in some direct mortality to small mammals and would displace some bird species from disturbed areas. In addition, a slight increase in mortality from increased vehicle use of roads in the project area would be expected.

The temporary disturbances that occur during the construction period would tend to favor generalist wildlife species such as ground squirrels and horned larks, and would have more impact on specialist species such as western meadowlarks, lark buntings, and grasshopper sparrows. Overall, the long-term disturbance of 1,310 acres would have a low effect on common wildlife species. Songbirds that may be affected by the reduction in cultivated fields would be horned larks, sage sparrows, sage thrashers, and vesper sparrows. Although there is no way to accurately quantify these changes, the impact is likely to be low in the short term and be reduced over time as reclaimed areas begin to provide suitable habitats.

Because of the high reproductive potential of these species, they would rapidly repopulate reclaimed areas as habitats become suitable. Birds are highly mobile and would disperse into surrounding areas and utilize suitable habitats to the extent that they are available. The primary small mammals found on the project area include, but are not limited to, eastern cottontail, deer mice, thirteen-lined ground squirrel, white-footed mouse, meadow jumping mouse, and northern pocket mouse. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be low, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area once reclamation efforts are initiated.

7.2.7.6 Big Game Mammals

The principal wildlife impacts likely to be associated within the project area include: (1) a direct loss of certain wildlife habitat, (2) the displacement of some wildlife species, (3) an increase in the potential for collisions between wildlife and motor vehicles, and (4) an increase in the potential for the illegal kill and harassment of wildlife.

In general, direct removal of habitat used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Because a substantial proportion of the project area is used for seasonal crop production, only a small proportion of the available wildlife habitat in the project area would be affected. The capacity of the project area to support big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat because of the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect utilization of the habitat immediately adjacent to these areas. However, big game mammals are adaptable and may adjust to non-threatening, predictable human activity. It is envisioned that most big game mammal responses will consist of avoidance of areas proximal to the operational facilities, with most individuals carrying out normal activities of feeding and bedding within adjacent suitable habitats. In addition, the magnitude of displacement would decrease over time as: (1) the animals have more time to adjust to the operational circumstances, and (2) the extent of the most intense activities such as drilling and road building diminishes and the wellfields are put into production. By the time the wellfields are under full production, construction will have ceased, and traffic and human activities in general would be greatly reduced. As a result, this impact would be minimal and it is unlikely that big game mammals would be significantly displaced under full field development. The level of big game mammal use of the project area is more likely to be determined by the quantity and quality of forage available.

The potential for vehicle collisions with big game mammals would increase as a result of increased vehicular traffic associated with the presence of construction crews and would continue (although at a reduced rate) throughout all phases of the wellfield operations. Development of new roads would allow greater access to more areas and may lead to an increased potential for poaching of big game animals. However, because of the proximity to Crawford and locations of farm residences in the project area, the incidence of vehicle collision impacts to big game mammals is anticipated to occur infrequently and no long-term adverse effects are expected.

Based on the foregoing, long-term adverse effects are not expected for any local big game mammal populations.

7.2.7.7 Upland Game Birds

The potential effects of the operation and maintenance of project facilities on upland game birds may include nest abandonment and reproductive failure caused by project-related disturbance and increased noise. Other potential effects involve increased public access and subsequent human disturbance that could result from new construction and production activities.

7.2.7.8 Sharp-tailed Grouse

No sharp-tailed grouse leks are known to occur within the project area. However, noise related to drilling and production activities may affect sharp-tailed grouse utilization of leks or reproductive success. Reduction of noise levels in areas near leks would minimize this potential impact. If leks are found, surface disturbance should be avoided within 0.25 miles of leks. If disturbance within the buffer areas is avoided, no impacts are expected.

Areas with large tracts of mixed-grass prairie would provide the best quality nesting habitat. To protect sharp-tailed grouse nesting habitats, construction should be limited within a 1-mile radius of an active lek between March 1 and June 30. Significant impacts to leks and subsequent reproductive success are not expected if these guidelines are implemented.

7.2.7.9 Raptors

Potential impacts to raptors within the project area include: (1) nest desertions or reproductive failure as a result of project activities and increased public access, (2) temporary reductions in prey populations, and (3) mortality associated with roads.

The primary potential impact to raptors from project activities is disturbance during nesting that might result in reproductive failure. To minimize this potential, construction would not be allowed during the critical nesting season (Feb. 1 - July 31, depending on species) within 0.5 mile of an active nest of listed or sensitive raptor species, and 0.25 mile (depending on species or line of sight) of an active nest of other raptor species. The nature of the restrictions, exclusion dates, and the protection radii would vary, depending on activity status of nests, species involved, and natural topographic barriers, and line-of-sight distances should be developed in coordination within the NGPC or USFWS.

Nests not used in 1 year, may potentially be used in subsequent years. Subsequent development within close proximity to these nests may preclude use of the nest in following years. Therefore, protection of nests that may potentially be used in the future may require limiting construction within 300 meters (depending on species or line of sight) to minimize impacts. If "take" of an inactive nest were unavoidable, development of artificial nesting structures would mitigate for the loss of the nest. In some instances, during the production phase when human activity is reduced, raptors may actually nest on artificial above-ground structures. Based on the foregoing, significant impacts to raptor nesting activities are not expected.

The development of proposed wellfields and satellite facilities would initially disturb an estimated 1,310 acres of potential habitat for several species of small mammals that serve as prey for raptors. This short-term impact would affect approximately 62 percent of the proposed license area, although this is not likely to limit raptor use within the project area. The small amount of short-term change in prey base populations created by construction is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations on the project area would likely sustain some impact during the initial phase of the project, prey numbers would be expected to soon rebound to pre-disturbance levels following reclamation or active agricultural uses. Once reclaimed or in active agricultural uses, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas. For these reasons, implementation of the project is not expected to produce any appreciable long-term negative changes to the raptor prey base within the project area.

The creation of new roads would increase public access to areas within the project area. As use of the project area increases, the potential for encounters between raptors and humans would increase and could result in increased disturbance to nests and foraging areas. Closure of roads located near active raptor nests to public vehicle use would offset this potential impact. Some raptor species feed on road-killed carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring drivers to follow all posted speed limits.

7.2.7.9 Fish and Macroinvertebrates

Suitable habitat for fish and macroinvertebrates exists within portions of Spring Creek and the White River. However, the construction, operation, and maintenance of the project is not expected to affect either of these habitats.

7.2.7.10 Threatened and Endangered Species

7.2.7.10.1 Bald Eagle (Federal Threatened)

Nebraska's wintering bald eagle population is highly variable, ranging from 409 in 1984 to 1,292 in 1992, with an average of 714 bald eagles counted in Nebraska during the annual midwinter surveys between 1980 and 1993[12]. Most of the wintering bald eagle population is found in close association with open water. However, bald eagles are known to occasionally occur in this region, primarily during the winter months (November through March). However, no bald eagle nests are known to occur within the project area. Moreover, no winter concentration areas or winter nighttime roosts have been documented within the project area[13].

Based on our analysis of the effects of project implementation and the current and potential status of this species in northwestern Nebraska, we conclude that the proposed alternative will have no adverse effect on the bald eagle.

7.2.7.10.2 Swift Fox (State Endangered)

The swift fox is widely distributed throughout the Great Plains and there are small, disjunct populations in the western third of Nebraska and Kansas[14]. There is high-quality swift fox habitat present within the Oglala National Grassland immediately northwest of the project area. In addition, swift fox are closely linked with lagomorph populations, prairie dog colonies, ground squirrels, and other small mammals, which exist in varying densities and abundance throughout the project area.

Based on our analysis of the effects of project implementation, the current and potential status of this species in the project area, and more suitable habitats in the region, we conclude that the proposed project will have no adverse effect on the swift fox.

7.2.7.11.3 Reptiles, Amphibians, and Fish

No threatened or endangered reptiles, amphibians, or fish species have been recorded in the project area, and none are expected to occur.

7.2.7.12 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated, as no substantive impairment of ecological stability or diminishing of biological diversity is expected within the project area.

7.2.8 Noise Impacts of Operations

Noise sources during operation are expected to increase due to increased vehicle travel and increased numbers of employees traveling to and from Crawford for work and from resin transfer to the main plant. Train usage would not increase as a result of operation. Processing equipment at the satellite site would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be less than noise levels generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad.

7.3 RADIOLOGICAL EFFECTS

CBR is proposing to develop a satellite plant with a production flow of approximately 4500 gpm and an average restoration rate of 500 gpm. An assessment of the radiological effects of the North Trend Satellite Plant and related facilities must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The North Trend Satellite Plant will have a production flow capacity of approximately 4,500 gpm and will use fixed bed downflow ion exchange columns to separate uranium from the pregnant production fluid. The Satellite facility will also have a capacity to treat 500 gpm of restoration solution. The restoration process will use fixed bed downflow ion exchange columns to remove the uranium and reverse osmosis to remove the dissolved solids. Waste disposal at the satellite will be via a deep injection well and solar evaporation ponds to provide surge capacity. The satellite plant will not have any precipitation equipment. The loaded ion exchange resin will be transferred from the columns to a resin trailer for transport to the current Crow Butte Facility for regeneration and stripping. The eluted resin will be transported back to the North Trend Satellite Plant and reused in ion exchange columns.

The uranium bearing eluent in the Crow Butte Central Plant is treated in the uranium precipitation circuit. The precipitated uranium is vacuum dried.

The only emission at the North Trend Satellite Facility will be radon-222 (radon) gas. Radon is present in the ore body and is formed from the decay of radium-226. Radon is dissolved in the lixiviant as it travels through the ore body to a production well, where the solution is brought to the surface. The concentration of radon in the production solution is calculated using methods found in NRC Regulatory Guide 3.59[15]. The details of this calculation are found in Attachment 7.3(A).

MILDOS-Area[16] was used to model radiological impacts on human and environmental receptors (e.g., air and soil) using site specific radon release estimates, meteorological and population data, and other parameters.

In the following sections, the assumptions and methods used to arrive at an estimate of the potential radiological impacts of the North Trend Satellite Facility is discussed briefly. A detailed presentation of the source term and other MILDOS-Area parameters is included in Attachment 7.3(A). The anticipated effects are compared to the naturally occurring background levels. This background radiation, arising from cosmic and terrestrial sources, as well as naturally occurring radon gas, comprises the primary radiological impact to the environment in the region surrounding the proposed project.

7.3.1 Exposure Pathways

The proposed North Trend Satellite Facility is an in-situ leach uranium facility. The only source of planned radioactive emissions from the satellite is radon gas, which is dissolved in the leaching solution. Radon gas may be released as the solution is brought to the surface and processed in the satellite facility. Unplanned emissions from the site are possible as a result of accidents and engineered structure failure but are not addressed in the MILDOS-Area modeling. A human exposure pathway diagram addressing planned and unplanned radiological emissions is presented in Figure 7.3-1

The North Trend Satellite Plant will have pressurized downflow ion exchange columns capable of processing 4,500 gpm of production solution. The satellite facility will also have ion exchange and reverse osmosis equipment with a capacity of 500 gpm to process restoration solutions.

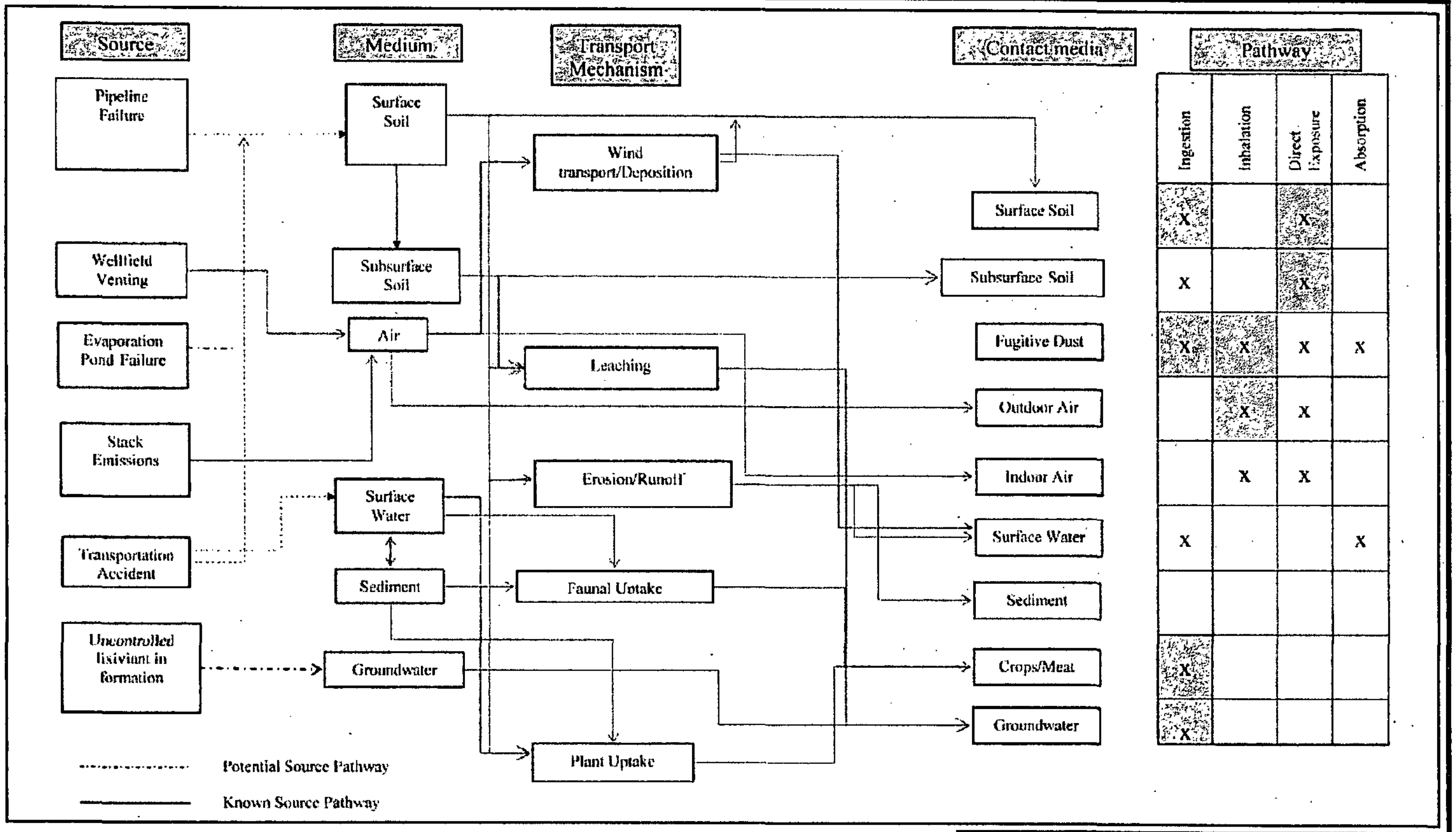
Within the pressurized columns, the radon will remain in solution and be returned to the formation. It will not be released to the atmosphere. There will be minor releases of radon gas during the air blowdown prior to resin transfer to the resin trailer. The air blowdown and the gas released from the vent during column filling will be vented into the exhaust manifold and discharged via the main radon exhaust stack. It is estimated that less than 10 percent of the radon contained in the process solutions will be vented to atmosphere.

In the source term calculation, CBR estimates that 10 percent of the contained radon found in the 4,500 gpm flow processed by pressurized downflow IX columns will be released to the environment

After the IX resin is loaded it will be transferred to a resin trailer. The trailer will transfer the resin to the main process facility for additional processing. The stripped and regenerated resin will be transferred to the trailer and returned to the satellite plant and transferred into a process column. It is anticipated that two round trips will occur per day.

The injection wells will generally be closed and pressurized, but periodically vented. It is estimated that 25 percent of the radon will be released in the wellfield.

Figure 7.3-1 Human Exposure Pathways for Known and Potential Sources from the North Trend Expansion Area



Contact media	Ingestion	Inhalation	Direct Exposure	Absorption
Surface Soil	X		X	
Subsurface Soil	X		X	
Fugitive Dust	X	X	X	X
Outdoor Air		X	X	
Indoor Air		X	X	
Surface Water	X			X
Sediment				
Crops/Meat	X			
Groundwater	X			

Note: X depicts the pathway that outlines the route which radiological emissions may follow to reach the public. Gray shading depicts predominant pathway.

CROW BUTTE RESOURCES, INC.

FIGURE 7.3-1
THREE CROW
HUMAN EXPOSURE PATHWAYS FOR KNOWN AND POTENTIAL SOURCES OF RADIOLOGICAL EMISSIONS

PROJECT: CO001398.00001 MAPPED BY: JC CHECKED BY: LW

ARCADIS 630 Plaza Drive, Ste. 100 Highlands Ranch, CO 80129 P: 720-344-3500 F: 720-344-3535 www.arcadis-us.com

K:\CBR_Projects\CO001398_ThreeCrow\3_IMAGES\Illustrator\TR Fig_7_3-1 Human Exposure Pathways.ai © 01/08/2010

Atmospheric emission of radon will lend its presence to all quadrants of the area surrounding the North Trend Expansion Area and the current Crow Butte Project. Radon itself impacts human health or the environment marginally, because it is an inert noble gas. Radon has a relatively short half-life (3.8 days) and its decay products are short lived, alpha-emitting, non-gaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. Figure 7.3-1 shows all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon were evaluated using MILDOS-Area.

7.3.2 Exposures from Water Pathways

The solutions in the zone to be mined will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

The North Trend Satellite Facility will have evaporation ponds used to store waste solutions prior to deep well injection. The ponds will be double-lined with impermeable synthetic liners. A leak detection system will be installed to provide a warning if the liner develops a leak. The ponds, therefore, are not considered a source of liquid radioactive effluents. The use of ponds to manage liquid waste was discussed in further detail in Section 4.

The primary method of waste disposal at the North Trend Satellite Facility will be by deep disposal well injection. The deep disposal well will be completed at an approximate depth of 3,500 to 4,000 ft, isolated from any underground source of drinking water by approximately 2,500 feet of shale (Pierre and Graneros Shales). The well will be constructed under a Class I Underground Injection Control (UIC) Permit issued by the NDEQ and will meet all requirements of the NDEQ UIC program. The use of a deep disposal well to manage liquid waste was discussed in further detail in Section 4.

The North Trend Satellite Facility will be located on a curbed concrete pad to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and be pumped to the ponds. The pad will be of sufficient size to contain the contents of the largest tank if it ruptures.

Since no routine liquid discharges of process water are expected from the North Trend Satellite Facility, there are no definable water-related pathways.

7.3.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon released into the atmosphere through a vent system or from the wellfields. As shown in Figure 7.3-1, atmospheric releases of radon can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure.

Based on the site specific data and the method of estimation of the source term presented in Attachment 7.3(A), the modeled emission rate of radon from the North Trend Satellite Facility is 1662 Ci/yr which includes releases from ion exchange, production and restoration activities. The complete results from MILDOS are contained in Appendix E.

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the North Trend Satellite and main processing site was also estimated using MILDOS-Area. Currently, CBR has a license amendment request pending to increase the annual plant throughput from 5,000 gpm, exclusive of restoration flow to 9,000 gpm exclusive of restoration flow. The license amendment was submitted on October 17, 2006 and the MILDOS-Area simulation included in this license amendment application reflects the requested flow increase. To show compliance with the annual dose limit found in 10 CFR § 20.1301, CBR has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the North Trend Satellite operation is less than 100 mrem per year. The results of the MILDOS-Area simulation are presented in Table 7.3-1. The coordinates of all receptors are listed in Attachment 7.3(A) along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown on Figure 7.3-2. Table 7.3-1 shows the estimated TEDE from operation of the main Crow Butte Project and the North Trend Satellite Plant.

No TEDE limits were exceeded. An evaluation of the TEDE follows:

1) The maximum TEDE is 31.7 mrem/yr.

2) Receptor #31 (NT-1) is the closest resident in the downwind direction for the North Trend Satellite Plant. The estimated TEDE at this location is 5.8 mrem/yr.

3) The effect of the North Trend Satellite operation on the nearby residents of the existing Crow Butte facility is less than 1 mrem/yr.

4) Since radon-222 is the only radionuclide emitted, public dose limits in 40 CFR 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 are not applicable to the CBR facility.

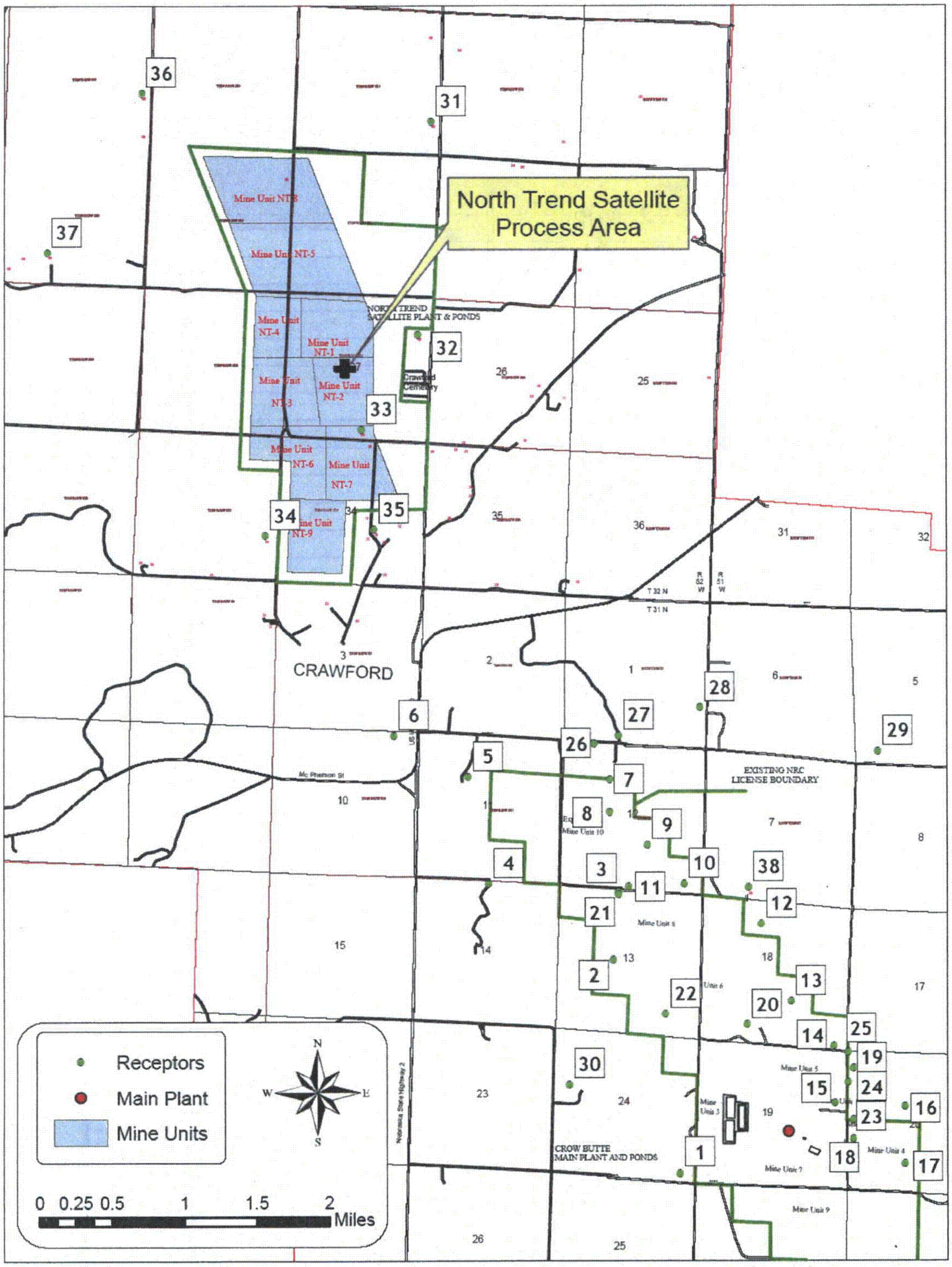


Figure 7.3-2 MILDOS Receptors for Main and Satellite Processing Facility

Table 7.3-1 Estimated Total Effective Dose Equivalent (TEDE) to Receptors Near the Crow Butte Uranium Processing Facility

Receptor #	Description	Distance from Main Plant (km)	TEDE* (mrem/y)
1	R1	1.29	6.64
2	R2	2.76	4.82
3	R3	3.30	6.14
4	R4	4.36	1.92
5	R5	5.35	1.98
6	Crawford	6.25	1.65
7	R7	4.43	4.87
8	R8	4.11	5.16
9	R9	3.59	8.12
10	R10	3.03	16.0
11	R11	3.29	7.34
12	R12	2.37	17.7
13	R13	1.49	28.1
14	R14	1.10	28.3
15	R15	0.62	31.7
16	R16	1.34	9.48
17	R17	1.35	6.06
18	Ehlers	0.73	15.5
19	Gibbons	1.03	24.9
20	Stetson	1.30	19.9
21	Knode	3.28	6.09
22	Brott	1.92	16.2
23	SP1	0.75	18.1
24	SP2	0.89	26.2
25	SP3	1.13	24.8
26	McDowell	4.87	4.24
27	Taggart	4.83	4.87
28	Franey	4.86	6.55
29	Bunch	4.39	7.54
30	Dyer	2.50	3.27
31	NT-1	12.01	5.84
32	NT-2	9.83	3.41
33	NT-3	9.19	3.09
34	NT-4	8.87	2.14
35	NT-5	8.18	2.42
36	NT-6	13.7	1.63
37	NT-7	12.86	1.04
38	NT-8	2.79	15.9

*No differences in TEDE between age classes were observed.

7.3.4 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Crow Butte Project is also predicted by the MILDOS-Area code. The results are listed in Table 7.3-2, where the dose to the bronchial epithelium is expressed in person-rem. For comparison, the dose to the population within 80 km of the facility due to natural background radiation is included in the table. These figures are based on the 1980 population and average radiation doses reported for the Western Great Plains.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 7.3-2 and also combined with dose to the region within 80 km of the facility to arrive at the total radiological effects of one year of operation at the Crow Butte Project.

For comparison of the values listed in Table 7.3-2, the dose to the continental population as a result of natural background radiation has been estimated. This estimate is based on a North American population of 346 million and a dose to each person of 500 mrem/yr to the bronchial epithelium. The maximum radiological effect of the combined operation of the North Trend Satellite Plant and the Crow Butte Project would be to increase the dose to the bronchial epithelium of the continental population by 0.0023 percent.

7.3.5 Exposure to Flora and Fauna

The exposure to flora and fauna was evaluated in the Environmental Report submitted to NRC in September of 1987[17] and the doses were found to be negligible. The proposed satellite facility will have no measurable impact on dose to flora and fauna.

Table 7.3-2: Dose to the Population Bronchial Epithelium and Increased Continental Dose from One Year's Operation at the Crow Butte Facility

Criteria	Dose (person rem/yr)
Dose received by population within 80 km of the facility	171
Natural background by population within 80 km of the facility	24025
Dose received by population beyond 80 km of the facility	224
Total continental dose	394
Natural background for the continental population	$1.73 \times 10^{+8}$
Fraction increase in continental dose	2.27×10^{-6}

7.4 NON-RADIOLOGICAL EFFECTS

There are two effluents expected from the North Trend Satellite.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as previously discussed in Sections 4 and 7.3. The gaseous and airborne effluent will not contain any non-radiological wastes.
- The liquid effluent will be managed in the solar evaporation ponds and the deep disposal well. There is no discharge from the evaporation ponds. The deep disposal well will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the NDEQ. The current Class I UIC Permit for the deep disposal well located at the Central Plant implements injection limits and requires monthly monitoring for RCRA Metals to ensure that hazardous waste is not injected. Based on the monitoring for the current deep disposal well, there is no non-radiological impact expected due to the liquid effluents from the North Trend Satellite Facility.

7.5 EFFECTS OF ACCIDENTS

Accidents involving human safety associated with the in-situ uranium mining technology typically have far less severe consequences than accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for personnel and neighboring communities when compared to conventional mining methods or other energy-related industries. Accidents that may occur would generally be quite minor when compared to other industries, such as an explosion at an oil refinery or chemical plant. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the facility and the low level of radioactivity associated with the process both decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at uranium milling facilities in NUREG–0706[18] and specifically at in situ leach facilities in NUREG/CR-6733[19]. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The CBR emergency management procedures contained in SHEQ MS Program Volume VIII, *Emergency Manual,* have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in SHEQ MS Volume VII, *Training Manual,* have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. SHEQ MS Program Volume II, *Management Procedures,* requires periodic testing of emergency procedures and training by conducting drills.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISL facilities, such as transportation accidents; however, much of the analyses do not apply due to the significantly different mining and processing methods. ISL facilities do not handle large quantities of radioactive materials such as crushed ore and tailings, so the quantity of material that could be affected by an incident is significantly less than at a mill site.

NUREG/CR-6733 specifically addressed risks at ISL facilities and identified the following "risk insights".

7.5.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. The use of hazardous chemicals at Crow Butte is regulated by the Occupational Health and Safety Administration (OSHA). Crow Butte is subject to the Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119. Of the highly hazardous chemicals, toxics, and reactives listed in Appendix A to 29 CFR §1910.119, none will be used at the North Trend Satellite Plant. As a satellite plant, North Trend will use oxygen, carbon dioxide, and sodium carbonate for addition to the injection solution. Sodium sulfide may be used as a reductant during groundwater restoration activities. All other operations requiring process chemicals described in NUREG/CR-6733 will be performed at the Central Plant.

Crow Butte construction, operating, and emergency procedures have been developed to implement the codes and standards that regulate hazardous chemical use.

7.5.1.1 Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. As currently practiced at the Central Plant, CBR will install wellfield oxygen distribution systems at North Trend. Combustibles such as oil and grease will burn in oxygen if ignited. CBR ensures that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1[20]. Construction of oxygen systems in the wellfield are covered by procedures contained in SHEQ MS Program Volume III, *Operations Manual*. Emergency response instructions for a spill or fire involving oxygen systems are contained in SHEQ MS Program Volume VIII, *Emergency Manual*.

7.5.1.2 Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points is currently performed at the central plant to protect workers from undetected leaks of carbon dioxide. Operation of carbon dioxide systems is currently covered by procedures contained in SHEQ MS Program Volume III, *Operations Manual*. Emergency response instructions for a leak involving carbon dioxide are contained in SHEQ MS Program Volume VIII, *Emergency Manual*.

7.5.1.3 Sodium Carbonate

Sodium carbonate is primarily an inhalation hazard. CBR typically uses soda ash and carbon dioxide to prepare sodium carbonate for injection in the wellfield. Soda ash storage and handling systems are designed to industry standards to control the discharge of dry material. Operation of sodium carbonate systems is currently covered by procedures contained in SHEQ MS Program Volume III, *Operations Manual*. Emergency response instructions for a spill involving sodium carbonate or soda ash are contained in SHEQ MS Program Volume VIII, *Emergency Manual*.

7.5.2 Radiological Risk

7.5.2.1 Tank Failure

A spill of the materials contained in the process tanks at the North Trend Satellite Facility will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the process plant or in outside storage tanks. The tanks at the North Trend Satellite will contain injection and production solutions and ion exchange resin. Elution, precipitation, and drying will be performed at the central plant. The satellite plant will be designed to control and confine liquid spills from tanks should they occur. The plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, or double-walled tanks will perform a similar function for process vessels located outside the satellite building.

All tanks will be constructed of fiberglass or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

7.5.2.2 Plant Pipe Failure

The rupture of a pipeline within the process plant is easily visible and can be repaired quickly. Spilled solution will be contained and removed in the same fashion as for a tank failure.

Response procedures for the radiological risk from releases are currently contained in SHEQ MS Volume VIII, *Emergency Manual.* These procedures also provide instructions for emergency notification including notification to NRC in compliance with the requirements of 10 CFR 20.2202 and 20.2203.

7.5.3 Groundwater Contamination Risk

7.5.3.1 Lixiviant Excursion

Excursions of lixiviant at ISL facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the exempted portion of the ore-body aquifer. A vertical excursion is a movement of ISL fluids into overlying or underlying aquifers.

CBR controls lateral movement of lixiviant by maintaining wellfield production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution is either recycled in the plant or is sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the Mine Unit, the wellfield is said to be balanced.

CBR monitors for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. The current NRC License and NDEQ Class III UIC Permit require that Chadron aquifer monitor wells be located no more than 300 feet from the nearest mineral production wells and no more than 400 feet each other. These spacing requirements have proven effective for monitoring horizontal excursions at Crow Butte and will be employed at the North Trend Satellite. Monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite. The program was discussed in detail in section 5.7.8.

Section 7.2.5 provided a discussion of horizontal excursions reported at the current Crow Butte operation. The historical experience indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. CBR controls vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the NDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing is conducted in accordance with NDEQ regulations contained in Title 122[21] and methods approved by NRC and NDEQ. Construction and integrity testing methods were discussed in detail in section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the NDEQ and discussed in detail in section 6.2. Procedures for these activities are contained in SHEQ MS Program Volume III, *Operating Manual*.

CBR monitors for vertical excursions in the overlying aquifers using shallow monitor wells. These wells are located within the wellfield boundary at a density of one well per five acres. Shallow monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite. The program was discussed in detail in section 5.7.8.

7.5.3.2 Pond Failure

An accident involving a leak in a pond is detectable either from the regular visual inspections or through monitoring the leak detection system. The current pond operation and inspection program is contained in SHEQ MS Program Volume VI, *Environmental Manual,* and consists of daily, weekly, monthly and quarterly inspections in conjunction with an annual technical evaluation of the pond system. The CBR monitoring program was developed to meet the guidance contained in USNRC Regulatory Guides 3.11[22] and 3.11.1[23]. Any time six inches or more of fluid is detected in the standpipes, it is analyzed for specific conductance. If the water quality is degraded beyond the action level, it is sampled again and analyzed for chloride, alkalinity, sodium, and sulfate. In addition, monitor wells are installed downgradient of the pond in the first water bearing zone. These monitor wells are sampled and analyzed for the excursion parameters on a quarterly basis. The pond operation and monitoring program was discussed in detail in Section 4.2.

In the event of a leak, the contents of any one pond can be transferred to another pond cell while repairs are made. Freeboard requirements may be waived during this period. Catastrophic failure of a pond embankment is unlikely given the design and inspection requirements of the pond and the freeboard limitations.

7.5.4 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the North Trend Satellite plant would result in either a release of barren or pregnant lixiviant solution, which would contaminate the ground in the area of the break. All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines are constructed of PVC, high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines are pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each mine unit will have a number of wellhouses where injection and production wells will be continuously monitored for pressure and flow. With the control system currently employed at Crow Butte, individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the satellite control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective at the current operation in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the wellhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. CBR currently implements a program of continuous wellfield monitoring by roving wellfield operators and required periodic inspections of each well that is in service. Based on experience from the current operation, small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination based on monitoring using field survey instruments and soil samples for radium-226 and uranium. Following repair of a leak, CBR procedures require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

7.5.5 Transportation Accident Risk

Transportation of materials to and from the North Trend Satellite Plant can be classified as follows:

- Shipments of process chemicals or fuel from suppliers to the site.
- Shipment of radioactive waste from the site to a licensed disposal facility.
- Shipments of uranium-laden resin from the satellite plant to the central plant and return shipments of barren, eluted resin from the central plant back to the satellite plant.

The first two types of transportation risks do not present an increase over the risks associated with operation of the current Crow Butte facility since production from North Trend is planned to replace declining production at the current facility. The shipment of loaded ion exchange resin from North Trend and the return of barren, eluted resin represent an additional transportation risk that was not considered for the current operation.

NUREG-0706 concluded that the probability of a truck accident in any year is 11 percent for each uranium extraction facility or mill. This calculation used average accident probabilities (4.0×10^{-7}/km for rural interstate, 1.4×10^{-6}/km for rural two-lane road, and 1.4×10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative with respect to probability distributions used in a later NRC transportation risk assessment[24]. For North Trend, uranium-loaded and barren resin will be routinely transported by tank truck from the satellite plant to the Central Plant. For the Crown Point site, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[25].

Accident risks involving potential transportation occurrences and mitigating measures are discussed below:

7.5.5.1 Accidents Involving Shipments of Process Chemicals

Based on the current production schedule and material balance, it is estimated that approximately 150 bulk chemical deliveries per year will be made to the North Trend Satellite. This averages about one truck per working day for delivery of chemicals throughout the operational life of the project. Types of deliveries include carbon dioxide, oxygen, and soda ash.

7.5.5.2 Accidents Involving Radioactive Wastes

Low level radioactive 11(e)2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential impact in the event of an accident.

7.5.5.3 Accidents Involving Resin Transfers

One of the potential additional risks associated with operation of a satellite plant is the transfer of the ion exchange resin to and from the satellite plant.

Resin will be transported to and from the North Trend Satellite Plant in a 4,000 gallon capacity tanker trailer. It is currently anticipated that one load of uranium-laden resin will be transported to the Crow Butte central plant for elution and one load of barren eluted resin will be returned to the North Trend Satellite Plant on a daily basis. The transfer of resin between the two sites will occur on county and private roads. The planned transport route has been designed to avoid travel on U.S. Highway 20 and Nebraska State Highway 2/71. The planned transport route will cross these two highways.

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren eluted resin. Pertinent procedures, which Crow Butte will follow for a resin shipment, are listed as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.

- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.

- Trained CBR drivers will transport the resin between the North Trend Satellite Plant and the central plant.

- Crow Butte's current emergency response plan for yellowcake and other transportation accidents to or from the Crow Butte site is contained in SHEQ MS Program Volume VIII, *Emergency Manual*. This plan will be expanded to include an emergency resin transfer accident procedure. Personnel at both the satellite plant and the central plant will receive training for responding to a resin transfer transportation accident.

Currently, Crow Butte Resources intends to treat the eluted resin the same as the uranium loaded resin. It is possible that the eluted resin may be clean enough to be transported as non-radioactive material, as defined by DOT regulations. Operating experience will aid in the determination of the most practical and efficient way of dealing with the shipment of barren resin. Regardless, compliance with all applicable DOT and USNRC regulations will be the primary determining factor.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological or environmental impact of a similar accident with barren, eluted resin would be very minor. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, CBR will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each resin hauling truck will be equipped with a radio which can communicate with either the Crow Butte central plant or the North Trend Satellite plant. In the event of an accident and spill, the driver can radio to both sites to obtain help.
- A check-in and check-out procedure will be instituted where the driver will call the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, a crew would respond and search for this vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.
- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material.
- Both the satellite and central process facilities will be equipped with emergency response packages to quickly respond to a transportation accident.
- Personnel at the satellite and central process facilities as well as the designated truck drivers will have specialized training to handle an emergency response to a transportation accident.

7.5.6 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISL facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities and the possible reaction of process chemicals during either event. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities. CBR is committed to following these standards.

The project area along with most of Nebraska is in seismic risk Zone 1. Most of the central United States is within seismic risk Zone 1 and only minor damage is expected from earthquakes that occur within this area. Seismology was discussed in detail in section 2.6.

The Crow Butte operation is located in an area that is subject to tornadoes. CBR emergency procedures currently contained in SHEQ MS Program Volume VIII, *Emergency Manual,* provide instructions for response and mitigation of natural disasters and spills or radioactive materials.

7.6 ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

The preliminary evaluation of socioeconomic impacts of the commercial facility was completed in 1987 as reported in the original commercial license application. The preliminary evaluation was divided into two phases – construction and operation. The evaluation concluded that the construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

Since the inception of the operational phase, the overall effect of the current commercial facility operations on the local and regional economy has been beneficial. Purchases of goods and services by the mine and mine employees contribute directly to the economy. Local, state, and the federal governments benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, are also beneficial. These economic effects further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the current operation would continue for the life of the mine, estimated to be an additional twelve years as of January 2007. However, the positive impacts from the current operation will begin to decline as reserves are depleted in the next five years.

The current mine operation has not resulted in any significant impact to the community infrastructure (including schools, roads, water and sewage facilities, law enforcement, medical facilities, and any other public facility) in the town of Crawford or in Dawes County. As discussed in further detail below, the mine employs a workforce of approximately 52 employees and 20 contractors. The majority of these employees are hired from the surrounding communities.

In summary, monetary benefits accrue to the community from the presence of the Crow Butte Project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the economic impact of the project to date and projects the incremental impacts from operation of the proposed North Trend Satellite Facility.

7.6.1 Tax Revenues

The following table summarizes the recent tax revenues from the Crow Butte project.

	2006	2005	2004	2003
Property Taxes	627,000	351,000	144,000	65,000
Sales and Use Taxes	238,000	185,000	161,000	153,000
Severance Taxes	545,000	338,000	180,000	73,000
Total	**1,410,000**	**874,000**	**485,000**	**291,000**

Future tax revenues are dependent on uranium prices which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around $80 per pound U_3O_8 in mid-March 2007), the increased production from the satellite plants should contribute to higher tax revenues as well.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the satellite plants should be about 600,000 pounds per year. This additional production will eventually be offset by declining production from the original plant; however, the incremental contribution to taxes would be on the order of $1.0 million to $1.2 million per year in combined taxes.

7.6.2 Temporary and Permanent Jobs

7.6.2.1 Current Staffing Levels

CBR currently employs approximately 52 employees and 20 contractors on a full-time basis. Short-term contractors and part time employees are also used for specific projects and/or during the summer months and may add up to 10 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2006 was 2,189 out of a total labor force of 3,401[26]. Based on these statistics, CBR currently provides approximately 2.3 percent of the private employment in Dawes County. In 2006, CBR's total payroll was over $2,543,000. Of the total Dawes County wage and salary payments of $76,006,000 in 2006, the CBR payroll represented about 3.4 percent.

Total CBR payroll for the past four years was:

2003: $2,102,000
2004: $2,213,000

2005:	$2,382,000
2006:	$2,543,000

The average annual wage for all workers in Dawes County was $22,350 for 2006. By way of comparison, the average wage for CBR was about $51,000. Entry-level workers for CBR earn a minimum of $15.53 per hour or $32,300 per year, not including bonus or benefits.

7.6.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite plant(s) will provide approximately ten to fifteen temporary construction jobs for a period of up to one year for each satellite. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than five percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2006, total unemployment in Dawes County was 137 individuals, or 2.9 percent of the total work force of 4,799. CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by ten to twelve full-time CBR employees for each active satellite plant. These new employees will be needed for satellite plant and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) may also increase by four to seven employees depending on the desired production rate. The majority if not all of these new positions will be filled with local hires.

These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

7.6.3 Impact on the Local Economy

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area.

Total CBR payments made to Nebraska businesses for the past four years were:

2003:	$3,602,000
2004:	$3,597,000
2005:	$4,570,000
2006 (est):	$5,000,000

The vast majority of these purchases were made in Crawford and Dawes County.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the satellite plant, although not in strict proportion to production. While there are some savings due to some fixed costs (central plant utilities for instance), there are additional expenses that are expected to be higher (wellfield development for the satellites is expected to be more expensive). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3.65 to $4.35 million per year.

7.6.4 Economic Impact Summary

As discussed in this section, the Crow Butte Project currently provides a significant economic impact to the local Dawes County economy. Approval of this license amendment request would have a positive impact on the local economy as summarized in Table 7.6-1.

Table 7.6-1
Current Economic Impact of Crow Butte Uranium Project and Projected Impact from North Trend Expansion Area

	Current Crow Butte Operation	**Estimated Economic Impact due to North Trend Expansion Area**
Employment		
Full Time Employees	52	+ 10 to 12
Full Time Contractor employees	20	+ 4 to 7
Part Time Employees and Short Term Contractors	7	+ 10 to 15 (Satellite Construction)
CBR Payroll, 2006	$2,543,000	+ $400,000 to $480,000
Taxes		
Property Taxes	$627,000	-
Sales and Use Taxes	$238,000	-
Severance Taxes	$545,000	-
Total Taxes	$1,410,000	+ $1,000,000 to $1,200,000
Local Purchases		
Local Purchases, 2006 (est.)	$5,000,000	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts		
	$8,953,000	**+ $5,050,000 to $6,030,000**

7.7 REFERENCES

[1] Nebraska Department of Environmental Quality, *Title 119 – Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System*, May 16, 2005.

[2] Environmental Protection Agency. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Office of Noise Abatement and Control. EPA 550/9-74-004. March 1974.

[3] City of Crawford Nebraska (Crawford). 2007. Ordinances, [Web page]. Located at http://www.crawfordnebraska.net/depts/ordinances.html Accessed: March 7, 2007

[4] State of Nebraska, Department of Roads (Nebraska). 2007. NDOR Map Library, Traffic Volume Maps and Info. *2004 NE Highway Traffic Flow Map.* [Web page]. Located at http://www.nebraskatransportation.org/maps/#traffvol Accessed: March 7, 2007.

[5] U.S. Department of Transportation (USDOT), Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, June 1995.

[6] State of Nebraska, Department of Roads (Nebraska). NDOR Map Library, Miscellaneous Categories. *Current Nebraska Speed Limit Maps*. [Web page]. Located at http://www.nebraskatransportation.org/maps/#traffvol Accessed: March 7, 2007

[7] Harris, Cyril M. 1991. *Handbook of Acoustical Measurements and Noise Control.* McGraw-Hill, New York, New York.

[8] Bell, Lewis H. 1982. *Industrial Noise Control, Fundamentals and Applications*, Marcel Dekker, Inc., New York, New York.

[9] Crocker, M.J., Kessler, F.M. 1982. *Noise and Noise Control, Volume II.* CRC Press, Inc., Chemic Rubber Company, Cleveland, OH.

[10] U.S. Environmental Protection Agency, USEPA—2004. *Air Quality Monitoring Data Base.* [Web Page] http://www.epa.gov/air/data/. Accessed on March 2, 2007.

[11] U.S. Environmental Protection Agency, USEPA—1978, *Supplement No. 8 for Compilation of Air Pollutant Emission Factors Third Edition (Including Supplements, 1-7),* Research Triangle Park, North Carolina, May 1978

[12] Nebraska Game and Parks Commission, *Bird of Nebraska: an interactive guide* http://www.ngpc.state.ne.us/wildlife/guides/birds/showbird.asp?BirdID='98', accessed July 27, 2004.

[13] Fritz, M. 2004. Personal Communication [August 6 telephone conversation with R. Henning, Greystone Environmental Consultants, Inc. Greenwood Village, CO]. RE: Raptor species including Bald Eagle. Raptor Biologist, Nebraska Game and Parks Commission. Lincoln, NE. 1 Page.

[14] U.S. Department of Interior, Fish and Wildlife Service, *Endangered and Threatened Wildlife and Plants; 12-Month Finding for a Petition to List the Swift Fox as Endangered.* Federal Register Vol. 60, No. 116. 31663-31666

[15] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations*, March 1987.

[16] Argonne National Laboratory, *MILDOS-Area: An Enhanced Version of MILDOS For Large-Area Sources,* June 1989.

[17] Ferret Exploration of Nebraska, *Application and Supporting Environmental Report For USNRC Commercial Source Material License*, September 1987.

[18] U.S. Nuclear Regulatory Commission, NUREG–0706, *Final Generic Environmental Impact Statement on Uranium Milling—Project M–25*, September 1980.

[19] Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*, 2001.

[20] Compressed Gas Association, Inc., CGA-G-4.1, *Cleaning Equipment for Oxygen Service*, 1996.

[21] Nebraska Department of Environmental Quality, Title 122 *Rules and Regulations for Underground Injection and Mineral Production Wells* (April 2002).

[22] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

[23] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

[24] U.S. Nuclear Regulatory Commission, NUREG/CR—6672, *Reexamination of Spent Fuel Shipment Risk Estimates*, SAND2000—0234, 2000.

[25] U.S. Nuclear Regulatory Commission, NUREG—1508, *Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico*, 1997.

[26] US Department of Labor, Bureau of Labor Statistics, as of March 5, 2007.

Red-line Version of Replacement Pages

7 ENVIRONMENTAL EFFECTS

The objective of the mining and environmental monitoring program is to conduct an operation that is economically viable and environmentally responsible. The environmental monitoring programs, which are used to ensure that the potential sources of land, water and air pollution are controlled and monitored, are presented in Section 5.7, Radiation Safety Control and Monitoring.

This section discusses and describes the degree of unavoidable environmental impacts, the short and long term impacts associated with operations and the consequences of possible accidents at the current Crow Butte project and the North Trend Expansion Area.

7.1 ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND CONSTRUCTION

The initial site preparation and construction associated with the North Trend Expansion Area will include the following:

- Construction of a satellite process facility located approximately 3 miles west and 5 miles north of the current process plant. This satellite facility will be housed in a building approximately 130 feet long by 100 feet wide and will contain ion exchange and associated equipment capable of processing 4,500 gpm of production flow and 500 gpm of restoration flow.

- Construction of solar evaporation ponds located in conjunction with the satellite facility to be used as a feed pond for the deep injection well.

- Expansion of the main process facility in response to the increase in the ion exchange resin handling, elution, precipitation, thickening, and drying circuits to handle the additional production from the North Trend. Initial estimates are that this expansion may require an additional process area of 2,500 square feet.

- A deep well injection building(s).

- Access roads, as required.

Site preparation and construction activities will include topsoil salvaging, pond excavation, building erection, and access road construction. Note that wellfield construction activities and completion of injection, production and monitor wells are discussed in section 7.2 since these are ongoing activities at an ISL facility. This section strictly discusses the short-term impacts of initial site preparation and construction where they differ from the impacts of operations.

Environmental impacts of construction projected for the North Trend Expansion Area are based on the studies conducted by CBR and discussed in Section 2. The impacts are also projected based on experience with the current operation and the impacts that have been associated with this type of construction at the Crow Butte project over the past fifteen years of commercial operation.

The total area impacted by initial construction activities is approximately 30 acres. All areas disturbed will be reclaimed during final decommissioning activities. The planned schedule for construction, production, restoration, and decommissioning was presented in Section 1.

7.1.1 Air Quality Effects of Construction

Construction activities at the North Trend Expansion Area site would cause minimal effects on local air quality. Effects to air quality would be increased suspended particulates from vehicular traffic on unpaved roads, in addition to existing fugitive dust caused by wind erosion, and diesel emissions from construction equipment. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

7.1.2 Land Use Impacts of Construction

The principal land uses for the 30-acre site associated with the proposed North Trend Satellite Plant is as cropland, primarily for raising alfalfa for livestock feed. As a result of site preparation and construction, crop production will be excluded from the area that is under development. In 2001 Dawes County had 77,000 acres harvested for 123,800 tons of hay. This harvest resulted in yields of 1.6 tons of hay per acre harvested. Based on this average yield, construction activities in a 30-acre area would result in the lost production of up to 48 tons of hay per year. Considering the relatively small size of the area impacted by construction, the exclusion of agricultural activities from this area over the course of the North Trend project should not have a significant impact on local agricultural production.

7.1.3 Surface Water Impacts of Construction

When stormwater drains off a construction site, it carries sediment and other pollutants that can harm lakes, streams and wetlands. The U.S. Environmental Protection Agency

(EPA) estimates that 20 to 150 tons of soil per acre is lost every year to stormwater runoff from construction sites. For this reason, stormwater runoff is controlled by National Pollutant Discharge Elimination System (NPDES) regulations.

Construction activities at the Crow Butte project to date have had a minimal impact on the local hydrological system. CBR conducts construction activities under NDEQ permitting regulations for control of construction stormwater discharges contained in Title 119[1]. CBR is required by NDEQ General Construction Stormwater NPDES Permit NER 100000 to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in ~~EHSMS~~SHEQ MS Volume VI, *Environmental Manual* and require active engineering measures, such as berms, and administrative measures, such as work activity sequencing to control runoff and sedimentation of surface water features. CBR must annually submit a construction plan for the coming year and obtain authorization from the NDEQ under the general permit.

In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from initial site preparation and construction of the North Trend Satellite Plant and related facilities will be minimal since there are no nearby surface water features.

7.1.4 Population Impacts of Construction

The effects of construction of the proposed North Trend Satellite Facility on the immediate population will be an unavoidable impact, although a temporary one. Construction activities will require additional temporary construction workers. Many of these positions will likely be filled by local labor. Any additional workers that may not be from the immediate area will cause a short-term increase in housing demand. The population impacts of construction are discussed in more detail in section 7.6.

7.1.5 Social and Economic Impacts of Construction

The social and economic impacts to the town of Crawford and surrounding areas during the construction of the original facility were slight given the relatively small scale of activities. The future construction activities for the North Trend Satellite Facility will be even smaller in scope. CBR estimates that ten to fifteen temporary construction workers will be involved in constructing the North Trend Satellite facilities. The social and economic impacts of construction are discussed in more detail in section 7.6.

7.1.6 Noise Impacts of Construction

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. This varying sensitivity is accommodated by applying "A-Weighted" correction factors. This correction de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. The primary assumption is that the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise. In general, a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a rural area during the day is 40 dBA and a typical construction site is 80 dBA (EPA 1974[2]). As a comparison, a normal conversation at 5 feet is 60 dBA (EPA 1974).

The nearest noise receptor (residence) to the Crow Butte North Trend Project (Project) is on State Highway (SH) 2/71 along the eastern project boundary. This residence is located approximately ½ mile from the proposed satellite plant. The next closest residence is located along the southern project boundary at a distance of approximately 1.5 miles south of the satellite plant. The town of Crawford is located approximately 2.5 miles south of the satellite plant.

According to Sandy Seidel, Crawford City Clerk, the City of Crawford does not have a noise ordinance. A review of the City of Crawford Municipal Code revealed a noise ordinance related to industrial equipment. Section 2-103, Excessive Noise Control (Crawford 2007[3]) reports that it is "unlawful to operate industrial equipment, heavy machinery, jack hammer and other industrial equipment emitting loud noise or to race automobile engines within the City between the hours of 8:00 P.M. and 7:00 A.M., in such a manner so as to disturb the ... peace ... unless such activity has been approved in advance by the City Council." Construction activities associated with the project would be conducted outside of the City of Crawford limits. The Dawes County Clerk's office did not know of a noise ordinance for Dawes County.

The project area is bounded on the west by the Burlington Northern Santa Fe (BNSF) rail line and on the east by Nebraska SH 2/71. Therefore, the existing ambient noise in the vicinity of the Project area is dominated by the traffic noise from SH 2/71 and trains on the BNSF rail line.

The State of Nebraska, Department of Roads, reports that the annual 24-hour average number of total vehicles to travel SH 2/71 along the eastern project boundary in 2004 was 265 (Nebraska 2007[4]). Thirty-five of these vehicles were reported to be heavy commercial vehicles. Table 7.1-1 (USDOT 1995[5]) presents typical noise levels for automobiles at a distance of 15 meters (45 feet) at speeds ranging from 50 miles per hour (mph) to 70 mph.

Table 7.1-1
Typical Automobile Noise Levels

Speed (mph)	Noise Level at 45 ft (dBA)
50	62
55	64
60	65
65	66.5
70	68

Traffic noise is a combination of traffic density and vehicle speed. The speed limit along SH 2/71 near the project area is 60 miles per hour (Nebraska 2007[6]). The closest noise receptor (residence) to SH 2/71 is located adjacent to the road. Therefore, the existing noise level at that receptor due to existing traffic noise alone would be expected to be 65 dBA.

The precise noise levels from trains is a complex calculation that considers the train speed, the train length, the conditions of the wheels, and the condition of the track (Harris 1991[7]). Noise from trains has been measured (Harris 1991) to range from 87 to 96 dBA at 100 feet from a track. The BSNF rail line runs through the town of Crawford. Assuming that a resident may live as close as 100 feet from the track, the existing noise for that receptor would be expected to be at least 87 dBA due to train noise alone.

The propagation of noise depends on many factors including atmospheric conditions, ground cover, and the presence of any natural or man-made barriers. As a general rule, noise decreases by approximately 6 dBA with every doubling of the distance from the source (Bell 1982[8]). Therefore, noise levels at various distances can be predicted. The closest noise receptor, residence along SH 2/71, is located approximately 1.2 mile east of the BNSF. Using the doubling rule, the train noise at the residence would be 51 dBA, assuming a distance of 6400 feet. Because the effect of multiple noise sources is not a simple addition, but rather is a logarithmic addition, the existing noise levels at the closest receptor, based on noise from highway traffic and the BNSF, is likely to be 65 dBA or greater.

Noise sources during construction are expected to increase due to increased vehicle travel on SH 2/71. It is estimated that as many as 20 additional vehicles would travel along SH 2/71 each day as employees travel to and from Crawford for work. Additionally, heavy equipment used during construction may include bull dozers, scrapers, graders, front-end loaders, and cranes. Train usage would not increase as a result of construction.

Noise generated during the construction phase would result from vehicle travel and the operation of construction equipment. Table 7.1-2 presents typical noise levels for construction equipment at a distance of 15 meters (45 feet) (Crocker 1982[9]). These values assume the equipment is operating at full power.

Table 7.1-2
Typical Construction Noise Levels

Equipment Category	Noise Level at 45 ft (dBA)
Grader	85
Front-End Loader	84
Mobile Crane	83
Excavator	82
Backhoe	81
Bull Dozer	78

Using the doubling rule, noise impacts at a distance of 2880 feet, the approximate location of the closest receptor from construction equipment located at the satellite site, is calculated to be 49 dBA.

Increased vehicle travel during the construction phase of the project may result in a slight increase in noise impacts to residents. However, noise from construction would not be generated during nighttime hours and increases in noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction traffic, (including movement of heavy equipment, which would be much less dense and slower than highway traffic) would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad. Noise from construction would be temporary and would briefly add to existing highway noise. Construction would be completed in a timely manner.

7.2 ENVIRONMENTAL EFFECTS OF OPERATIONS

The major environmental concerns during the operation of the North Trend Satellite Facility will be air quality effects, land use and water quality impacts, ecological impacts, and radiological impacts.

7.2.1 Air Quality Impacts of Operations

The primary new emission source of non-radiological pollutants will be tailpipe emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), non-methane-ethane volatile organic compounds (VOC), and particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the North Trend Expansion Area. Approximately 6-8 vehicle trips per day (VTPD) are anticipated as part of regular operations. These vehicles are expected to be light duty pick-up style trucks. Heavy equipment in the form of drill rigs, equipment haulers, or water trucks will be used as necessary and are anticipated to average less than one VTPD. These emissions are expected to be minor and should not affect the local ambient air quality.

Although there are no ambient air quality monitoring data for these non-radiological pollutants in the license area, PM_{10} concentrations have been measured in Rapid City, South Dakota and Badlands National Park in South Dakota. Both locations are geographically similar to the license area.

The Rapid City data were collected at the National Guard Camp Armory site about 2 miles west of the city. This are is classified as suburban. The Badlands data were collected in an area classified as rural. Because of the degree of urbanization, the air quality at the license area would probably fall somewhere between the air quality at these two locations. These data were obtained from the United States Environmental Protection Agency (USEPA) air quality monitoring database (USEPA 2007[10]), and are presented in Table 7.2-1.

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (24-hour average), and 50 micrograms per cubic meter (annual average). All counties within the 80 km radius of the project are in attainment of NAAQS.

TABLE 7.2-1
PM_{10} MONITORING SUMMARY
(MICROGRAMS PER CUBIC METER)

Year	Maximum 24-hr Average		Annual Average	
	Black Hills, SD	Rapid City, SD	Black Hills, SD	Rapid City, SD
1998	-	87.4	-	30.7
1999	-	116.9	-	28.2
2000	38.5	97.4	12.0	31.3
2001	47.9	81.5	12.6	34.6
2002	26.0	104.7	9.9	34.9
2003	74.4	91.8	16.3	36.2
2004	24.0	72.0	10.0	30.0
2005	40.0	94.00	9.0	27.0
2006	30.0	124.0	10.0	29.0

There will be an increase in the total suspended particulates (TSP) in the region as a result of the North Trend Expansion Area. This increase in TSP will be greatest during the site preparation phase of the satellite facility. Revegetation will be performed where possible to mitigate the problems associated with the resuspension of dust and dirt from disturbed areas. All areas disturbed during construction are revegetated with the exception of plant pad areas, roads, and areas covered by the pond liners. Of these, the only significant source of TSP is dust emissions from unpaved roads. The amount of dust can be estimated from the following equation taken from "Supplement No. 8 For Compilation of Air Pollutant Emission Factors" (USEPA, 1978[11]).

$$E = (0.81s) \frac{S}{30} \frac{365 - w}{w}$$

Where:

E	=	emission factor, lb per vehicle-mile
s	=	silt content of road surface material, 40%
S	=	average vehicle speed
w	=	mean number of days with 0.01 inches or more of rainfall, 85

Using the values stated above, the emission factor is equal to 0.27lb/vehicle-mile. The distance from the town of Crawford to the North Trend Satellite Plant is approximately 7.6 miles. Approximately 4 miles of this distance is on improved roads and 3.6 miles is on dirt or trail roads. CBR expects that most employees at the North Trend Satellite Plant will be from the town of Crawford. Assuming ten employees and a 7 day workweek, there would be 140 trips per week and the weekly mileage on dirt or trail roads would be 504 miles. Deliveries and other travel may require up to 50 trips per week which would be an additional 360 miles per week on dirt or trail roads.

The distance from the satellite plant to the Crow Butte Main Plant is 8.1 miles of which 7.1 miles are on dirt or trail roads. Assuming 2 trips per day for resin transfer and an additional 10 trips per day for plant personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1200 miles per week. This estimate is based on a 7 day work week.

The total travel on dirt and trail roads for personnel, resin transfer, deliveries and incidental travel will be approximately 2,060 miles per week. With an emission factor of 0.27 lb. TSP per vehicle-mile there will be a total dust emission of approximately 14.5 tons per year as a result of increased traffic on dirt and trail roads.

Any increase in fugitive dust emissions resulting from operational activities within the North Trend Expansion Area would be minimal. Implementation of mitigation measures such as the application of water or dust control chemicals to unpaved roads would ensure that the ambient air quality standards of the State of Nebraska would not be exceeded at any time during the life of the project.

Other operational activities may have impacts on surrounding air quality. The only atmospheric emission from the production and process facilities will be radon gas, which is discussed at length in Section 7.3.

7.2.2 Land Use Impacts of Operations

The principal land uses for the North Trend Expansion Area and the 2.25-mile review area is grazing livestock. Rangeland accounted for 55.7 percent of the land use in the North Trend Expansion Area and the review area as discussed in Section 2.2. The secondary land use within this area is cropland, primarily for wheat, although a small proportion is used for alfalfa. Cropland accounted for 29.9 percent of the land use in the North Trend Expansion Area and the review area. Land use was discussed in detail in Section 2.2.

For the 1,310 acre proposed wellfield areas, cropland accounts for 1,041.7 acres or 79.5 percent of the total area. Rangeland accounts for 267.9 acres or 20.5 percent of the total area. Figure 7.2-1 depicts the proposed wellfield areas and the current types of land use.

Figure 7.2-1: North Trend Wellfield Land Use

This is a new figure prepared by Petrotek

As a result of site preparation and construction, cattle production will be excluded from the areas that are under development. The total estimated area that will be impacted during the course of the project is the 267.9 acres associated with the satellite plant and wellfields. As discussed in section 2.2, livestock and livestock products had a value of $28.81 per acre, indicating that livestock production on rangeland within the impacted wellfield area has a potential value of more than $7,770.

As a result of site preparation and construction, crop production will be excluded from the areas that are under development. The total estimated cropland area that will be impacted during the course of the project is the 1,041.7 acres associated with the satellite plant and wellfields. In 2001 Dawes County had 77,000 acres harvested for 123,800 tons of hay and 33,700 acres harvested for 1,198,700 bushels of winter wheat. These harvests resulted in yields of 1.6 tons of hay and 35.6 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the North Trend Expansion Area would be up to 1,666 ton of hay and up to 37,085 bushels of wheat.

Considering the relatively small size of the area impacted by operations, the exclusion of agricultural activities from this area over the course of the North Trend project should not have a significant impact on local agricultural production. These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation.

The current operations in the licensed area have shown that CBR can successfully restore the land surface following mining operations. Surface reclamation activities including contouring and revegetation have been performed routinely following initial mine unit construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of Mine Unit 1 following approval of groundwater restoration. These areas have been successfully recontoured and revegetation has been completed in accordance with NDEQ requirements.

7.2.3 Geologic and Soil Impacts of Operations

7.2.3.1 Geologic Impacts of Operations

Geologic impacts are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the Basal Chadron Sandstone will be on the order of 1% or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10% of the available head, or less. Further, once mining and restoration operations are completed and restoration approved, groundwater levels will return to near original conditions under a natural gradient.

If the White River structural feature is in fact a fault, changes in aquifer pressure potentially could impact activity related to the fault and the transmissive characteristics of the fault (e.g., resistance to flow). There are numerous documented cases where injection in the immediate vicinity of a fault has caused an increase in seismic activity. However, such response typically occurs when injection operations have increased the pressure in the aquifer by a significant amount (e.g., 40 to 200 percent pressure increase over initial conditions). The pressure in the Basal Chadron will be increased by localized scale by injection operations during mining and restoration operations, and will be more than offset by production within each wellfield pattern.

7.2.3.2 Soil Impacts of Operations

Construction of the facilities at the North Trend site will affect soils. Effects to soils would be significant on approximately 30 fenced acres of the 1,310 acres that will be disturbed by construction of the North Trend Satellite Plant and associated facilities. Much of the remaining 1,280 acres will be devoted to wellfield production where effects to soils would be much lower.

The severity of soil impacts would depend on the number of acres disturbed and the type of disturbance. Potential impacts include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Effects to soils at the North Trend site would result from the clearing of vegetation, excavating, leveling, stockpiling, compacting, and redistributing soils during construction and reclamation. Disturbance related to the construction and operation of the North Trend site would be long-term.

Wind erosion is a concern at the North Trend site. Various soils meet the criteria for severe wind erosion hazard (USDA 1977). These soils have one or more major constituents that are fine sand or sandy loam that can easily be picked up and spread by wind. Construction presents the greatest threat to soils with potential for wind erosion. Wind erosion will be controlled by removing vegetation only where it is necessary, avoiding clearing and grading on erosive areas, surfacing roads with gravel, and timely reclamation.

Water erosion is also a concern at the North Trend site. Various soils meet the criteria for severe water erosion hazard (USDA 1977). These soils have low permeability and high K-factors, making them susceptible to water erosion. The K-factor is used to describe a soil's erodibility; it represents both susceptibility of soil to erosion and the rate of runoff. It is calculated from soil texture, organic matter, and soil structure. Construction and operation would increase soil loss through water erosion. Removal of vegetation for any activity exposes soils to increased erosion. Excavation could break down soil aggregates, increasing runoff and gully formation. Soil loss will be reduced substantially by avoiding highly erosive areas such as badlands and steep drainages. Locating roads in areas where cuts and fills would not be required, surfacing roads, installing drainage controls, and reseeding and installing water bars across reclaimed areas will also aid in reducing soil loss.

Sedimentation in streams and rivers at the North Trend site could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of drainages in the area. Installation of appropriate erosion control measures as required by CBR's Construction Stormwater NPDES authorization (see section 7.1.3) and avoidance of erosive soils will aid in reducing sedimentation.

Activity on the site has the potential to compact soils. While soils sensitive to compaction, such as clay loams, do not exist on the site, the intense volume and degree of activity at the North Trend site could damage soil properties and cause compaction. Compaction of the soils could decrease infiltration, promoting high runoff. If compaction occurs, reduced infiltration capacity could persist for over 50 years in some soils. Construction and traffic will be minimized where possible, and soils will be loosened for reseeding during reclamation to control the effects of soil compaction.

Any soil on the site can be saline depending on site-specific soil conditions, such as permeability, clay content, quality of nearby surface waters, plant species, and drainage characteristics. Saline soils are extremely susceptible to soil loss caused by development. Soil erosion in areas with high salt content would contribute to salinity in the White River Basin. Reclamation of saline soils can be difficult, and no method that works in all situations has yet been found.

Facility development would displace topsoil, which would adversely affect the structure and microbial activity of the soil. Loss of vegetation would expose soils and could result in a loss of organic matter in the soil. Excavation could cause mixing of soil layers and breakdown of the soil structure. Removal and stockpiling of soils for reclamation could result in mixing of soil profiles and loss of soil structure. Compaction of the soil could decrease pore space and cause a loss of soil structure as well. This would result in a reduction of natural soil productivity.

A number of erosion and productivity problems resulting from the North Trend site may cause a long-term declining trend in soil resources. Long-term impacts to soil productivity and stability would occur as a result of large scale surface grading and leveling, until successful reclamation would be accomplished. Reduction in soil fertility levels and reduced productivity would affect diversity of reestablished vegetative communities. Moisture infiltration would be reduced, creating soil drought conditions. Vegetation would undergo physiological drought reactions.

Surface spillage of hazardous materials could occur at the North Trend site. If not remediated quickly, these materials have the potential to adversely impact soil resources.

In order to minimize potential impacts from spills, a Spill Prevention, Control, and Countermeasure (SPCC) Plan will be implemented. The SPCC plan will include accidental discharge reporting procedures, spill response, and cleanup measures.

7.2.3.2.1 Soil Impact Mitigation Measures

Best Management Practices (BMPs) have been included in the project description and will be followed for site preparation to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the North Trend site. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document.

Sediment Control

- Divert surface runoff from undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Surface drainage shall not be directed over the unprotected face of the fill.
- Operations and disturbance on slopes greater than 40 percent need special sediment controls and should be designed and implemented appropriately.
- Avoid continuous disturbance that provides continuous conduit for routing sediment to streams.
- Inspect and maintain all erosion control structures.
- Repair significant erosion features, clogged culverts, and other hydrological controls in a timely manner.
- If best management practices do not result in compliance with applicable standards, modify or improve such best management practices to meet the controlling standard of surface water quality.

Topsoil

- Topsoil to be removed should be removed prior to any development activity to prevent loss or contamination.
- When necessary to substitute for or supplement available topsoil, use overburden that is equally conducive to plant growth as topsoil.
- To the extent possible, directly haul (live handle) topsoil from site of salvage to concurrent reclamation sites.
- Avoid excessive compaction of topsoil and overburden used as plant growth medium by limiting the number of vehicle passes, and handling soil while saturated and scarifying compacted soils.

- Time topsoil redistribution so seeding, or other protective measures, can be readily applied to prevent compaction and erosion.

Roads

Construct and maintain roads to minimize soil erosion by:

- Restricting the length and grade of roadbeds;
- Surfacing roads with durable material;
- Creating cut and fill slopes that are stable;
- Revegetating the entire road prism including cut and fill slopes; and,
- Creating and maintaining vegetative buffer strips, and constructing sediment barriers (e.g. straw bales, wire-backed silt fences, check dams) during the useful life of roads.

Regraded Material

- Design regraded material to control erosion using activities that may include slope reduction, terracing, silt fences, chemical binders, seeding, mulching etc.
- Divert all surface water above regarded material away from the area and into protected channels.
- Shape and compact regraded material to allow surface drainage and ensure long-term stability.
- Concurrently reclaim regarded material to minimize surface runoff.

Potential long-term effects include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Potential short-term effects include reduced soil productivity, erosion, compaction and soil contamination. Implementation of BMPs, SPCCs, and SWPPPs will minimize effects to soils associated with the construction of the North Trend production facilities.

7.2.4 Archeological Resources Impacts of Operations

Field investigations were conducted in July 2004 on a 1,190-acre area of anticipated potential development. Three historic sites and three isolated prehistoric artifacts were located and identified. As noted in Section 2.4, these resources are not likely to yield information important in prehistory or history and are considered not eligible for the National Register of Historic Places. Because these resources are considered not eligible, they are not historic properties and the proposed North Trend Expansion Area will have no effect on historic properties.

7.2.5 Groundwater Impacts of Operations

Potential impacts to water resources from mining and restoration activities include the following:

7.2.5.1 Groundwater Consumption

Groundwater impacts and consumption related to the North Trend operation will be fully assessed in an Industrial Groundwater Permit application that is required by NDEQ. Information from the existing Groundwater Permit for the current license area indicates that the drawdown from mining operations in the basal Chadron Formation is minimal (e.g., less than 10 percent of the available head). Based on drawdown data from years of operation in the current license area, and on the formation characteristics from the North Trend Pump Test, the drawdown effect on the Chadron aquifer as a result of operations has been and is expected to remain minimal.

Groundwater consumption from the North Trend operation is expected to be on the order of 0.5% to 1.5% of the total mining flow (4,500 gpm). Additional consumptive volume will be used during aquifer restoration, especially the groundwater sweep phase. However, it is expected that the net consumption for the entire operation will be on the order of 50 to 100 gpm.

7.2.5.2 Potential Declines in Groundwater Quality

Excursions represent a potential effect on the adjacent groundwater as a result of operations. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, and hydrofracturing of the ore zone or surrounding units.

To date, there have been several confirmed horizontal excursions in the Chadron sandstone in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In all but one case, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent upper control limits (UCLs). In no case did the excursions threaten the water quality of an underground source of drinking water since the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. Table 7.2-2 provides a summary of excursions reported for the current license area.

Table 7.2-2: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 20, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	May 6, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)

Table 7.2-2: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 28, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 7, 2006	Excursion of mining solutions
PR-15	September 26, 2006		See IJ-13 and PR-8

7.2.5.3 Potential Groundwater Impacts from Accidents

Groundwater quality could potentially be impacted during operations due to an accident such as evaporation pond leakage or failure, or an uncontrolled release of process liquids due to a wellfield accident. If there should be an uncontrolled pond leak or wellfield accident, potential contamination of the shallow aquifer (Brule), as well as surrounding soil, could occur. This could occur as a result of a slow leak or a catastrophic failure, a shallow excursion, an overflow due to excess production or restoration flow, or due to the addition of excessive rainwater or runoff.

To mitigate the likelihood of pond failure, all ponds at North Trend will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all ponds will be inspected on a regular basis. In the event that a problem is detected, the contents of any given pond can be transferred to another pond while repairs are made. The proposed pond design and operation was discussed in greater detail in Section 4.

Over the course of the current licensed operation, CBR has experienced several leaks associated with the inner pond liner on the commercial evaporation ponds. These small leaks are virtually unavoidable since the liners are exposed to the elements. In each case these leaks were quickly discovered during routine inspections, primarily due to a response in the underdrain system. Corrective actions included lowering the pond level and locating the leak to allow repairs. In none of these situations was the shallow groundwater affected since the outer pond liner functioned as designed and prevented a release of the pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ.

With respect to potential overflow of a pond, current standard operating procedures require that pond levels be closely monitored as part of the daily inspection. Process flow to the ponds will be minimal in comparison to the pond capacity, thus it can easily be diverted to another pond if necessary. In addition, sufficient freeboard will be maintained on all ponds to allow for a significant addition of rainwater with no threat of overflow. Finally, the dikes and berms around the ponds will channel runoff away from the ponds.

Another potential cause of groundwater impacts from accidents could be releases as a result of a spill of injection or production solutions from a wellfield building or associated piping. In order to control these types of releases, all piping is either PVC, high density polyethylene with butt welded joints, or equivalent. All piping is leak tested prior to production flow and following repairs or maintenance.

7.2.6 Surface Water Impacts of Operations

7.2.6

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7.2.6.1 Surface Water Impacts from Sedimentation

Protection of surface water from stormwater runoff during on-going wellfield construction related to operations is regulated by the NDEQ as discussed in section 7.1.3.

7.2.6.2 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as an evaporation pond leakage or failure or an uncontrolled release of process liquids due to a wellfield accident. Section 7.2.5.3 discussed the operation of the ponds and measures to prevent and control wellfield spills. An additional measure to protect surface water is that wellfield areas are installed with dikes or berms. ~~to prevent spilled process solutions from entering surface water features.~~ The berms prevent surface spills from entering all surface water bodies and drainages that connect to surface water bodies and eliminate public dose and contaminant pathways to surface water. Process buildings are constructed with secondary containment, and a regular program of inspections and preventive maintenance is in place.

7.2.7 Ecological Impacts of Operations

7.2.7.1 Impact Significance Criteria

The following criteria were used to determine the significance of construction and operation of the proposed project on wildlife and vegetation resources within the project area. These criteria were developed based on professional judgment, involvement in other NEPA projects throughout the West, and state and federal regulations.

- Removal of vegetation such that following reclamation, the disturbed area(s) would not have adequate cover (density) and species composition (diversity) to support pre-existing land uses, including wildlife habitat;
- Unauthorized discharge of dredged or fill materials into, or excavation of, waters of the U.S., including special aquatic sites, wetlands, and other areas subject to the Section 404 of the Clean Water Act, Executive Order 11988 - flood plains, and Executive Order 11990 - wetlands and riparian zones;
- Reclamation is not accomplished in compliance with Executive Order 13112 (Invasive Species);
- Introduction and establishment of noxious or other undesirable invasive, non-native plant species to the degree that such establishment results in listed invasive, non-native species occupying any undisturbed rangeland outside of established disturbance areas or hampers successful revegetation of desirable species in disturbed areas;
- Whether or not a substantial increase in direct mortality of wildlife caused by road kills, harassment, or other causes would occur;
- Incidental take of a special-status species to the extent that such impact would threaten the viability of the local population;
- Whether or not an officially-designated critical wildlife habitat was eliminated, sustained a permanent reduction in size, or was otherwise rendered unsuitable;
- Whether or not any effect, direct or indirect, results in a long-term decline in recruitment and/or survival of a wildlife population; and
- Construction disturbance during the breeding season or impacts to reproductive success which could result in the incidental loss of fertile eggs or nestlings, or otherwise lead to nest abandonment in accordance with regulations prescribed by the Migratory Bird Treaty Act.

7.2.7.2 Vegetation

As described in detail in Section 3, a total of 9 wellfields and the satellite processing facility will be constructed during the next 11 years with an expected mine life operation of 15 years. Well placement within the project area is not known at this time; however, it was assumed that agricultural fields within Sections 21, 22, 27, 28, 33, and 34 (Township 32N, Range 52W) will be developed and contain a significant amount of project-related infrastructure. Production facilities are not anticipated to be constructed within the mixed-grass prairie vegetation community, which is primarily located in the north ½ of Section 21 (Township 32N, Range 52W).

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) from soil disturbance and grading. Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

Vegetation removal and soil handling associated with the construction and installation of wellfields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, because most project-related infrastructure will be constructed within cultivated agricultural fields, vegetation impacts will be negligible. If the mixed-grass prairie vegetation community were to be developed, direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics.

During the anticipated life of the project (15 to 18 years), an estimated 1,041.7 acres of cultivated agricultural fields would be affected by surface-disturbing production facilities. The likelihood of impact is greatest for the primary vegetation cover types of cultivated fields, which occupies 62 percent of the total impacted area. As stated above, clearing of mixed-grass prairie vegetation community types is not anticipated.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in western states. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. Currently, the project area is relatively free of noxious and other unwanted invasive, non-native species.

In general, the duration of effects on cultivated agricultural land and mixed-grass prairie vegetation are significantly different. Cropland areas can be readily returned to production through fertilizer treatments and compaction relief. However, disturbed native prairie tracts require reclamation treatments and natural succession to return to predisturbance conditions of diversity (both species and structural). Reestablishment of mixed-grass prairie to predisturbance conditions would be influenced by climate (growing season, temperature, and precipitation patterns) and edaphic (physical, chemical, and biological) conditions in the soil.

Previously planted agricultural fields would be recontoured to approximate precontours and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts were disturbed by surface activities, these areas would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) completing cleanup of the disturbed areas (well fields and access roads); (2) restoring the disturbed areas to the approximate ground contour that existed before construction; (3) replacing topsoil, if removed, over all disturbed areas; (4) ripping disturbed areas to a depth of 12 to 18 inches; and (5) seeding recontoured areas with a locally adapted, certified weed-free seed mixture.

7.2.7.3 Surface Waters and Wetlands

Surface disturbances associated with the proposed facilities would not affect either Spring Creek or the White River. In addition, no wetlands have been identified within the project area. Therefore, impacts to wetlands and surface waters are not anticipated.

7.2.7.4 Wildlife and Fisheries

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of some individuals of some wildlife species, loss of wildlife habitats, and an increase in the potential for collisions between wildlife and motor vehicles. Other potential effects include a rise in the potential for illegal kill, harassment, and disturbance of wildlife because of increased human presence primarily associated with increased vehicle traffic. The magnitude of impacts to wildlife resources would depend on a number of factors, including the time of year, type and duration of disturbance, and species of wildlife present.

7.2.7.5 Small Mammals and Birds

The direct disturbance of wildlife habitat in the project area likely would reduce the availability and effectiveness of habitat for a variety of common small mammals, birds, and their predators. The initial phases of surface disturbance and increased noise would result in some direct mortality to small mammals and would displace some bird species from disturbed areas. In addition, a slight increase in mortality from increased vehicle use of roads in the project area would be expected.

The temporary disturbances that occur during the construction period would tend to favor generalist wildlife species such as ground squirrels and horned larks, and would have more impact on specialist species such as western meadowlarks, lark buntings, and grasshopper sparrows. Overall, the long-term disturbance of 1,310 acres would have a low effect on common wildlife species. Songbirds that may be affected by the reduction in cultivated fields would be horned larks, sage sparrows, sage thrashers, and vesper sparrows. Although there is no way to accurately quantify these changes, the impact is likely to be low in the short term and be reduced over time as reclaimed areas begin to provide suitable habitats.

Because of the high reproductive potential of these species, they would rapidly repopulate reclaimed areas as habitats become suitable. Birds are highly mobile and would disperse into surrounding areas and utilize suitable habitats to the extent that they are available. The primary small mammals found on the project area include, but are not limited to, eastern cottontail, deer mice, thirteen-lined ground squirrel, white-footed mouse, meadow jumping mouse, and northern pocket mouse. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be low, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area once reclamation efforts are initiated.

7.2.7.6 Big Game Mammals

The principal wildlife impacts likely to be associated within the project area include: (1) a direct loss of certain wildlife habitat, (2) the displacement of some wildlife species, (3) an increase in the potential for collisions between wildlife and motor vehicles, and (4) an increase in the potential for the illegal kill and harassment of wildlife.

In general, direct removal of habitat used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Because a substantial proportion of the project area is used for seasonal crop production, only a small proportion of the available wildlife habitat in the project area would be affected. The capacity of the project area to support big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat because of the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect utilization of the habitat immediately adjacent to these areas. However, big game mammals are adaptable and may adjust to non-threatening, predictable human activity. It is envisioned that most big game mammal responses will consist of avoidance of areas proximal to the operational facilities, with most individuals carrying out normal activities of feeding and bedding within adjacent suitable habitats. In addition, the magnitude of displacement would decrease over time as: (1) the animals have more time to adjust to the operational circumstances, and (2) the extent of the most intense activities such as drilling and road building diminishes and the wellfields are put into production. By the time the wellfields are under full production, construction will have ceased, and traffic and human activities in general would be greatly reduced. As a result, this impact would be minimal and it is unlikely that big game mammals would be significantly displaced under full field development. The level of big game mammal use of the project area is more likely to be determined by the quantity and quality of forage available.

The potential for vehicle collisions with big game mammals would increase as a result of increased vehicular traffic associated with the presence of construction crews and would continue (although at a reduced rate) throughout all phases of the wellfield operations. Development of new roads would allow greater access to more areas and may lead to an increased potential for poaching of big game animals. However, because of the proximity to Crawford and locations of farm residences in the project area, the incidence of vehicle collision impacts to big game mammals is anticipated to occur infrequently and no long-term adverse effects are expected.

Based on the foregoing, long-term adverse effects are not expected for any local big game mammal populations.

7.2.7.7 Upland Game Birds

The potential effects of the operation and maintenance of project facilities on upland game birds may include nest abandonment and reproductive failure caused by project-related disturbance and increased noise. Other potential effects involve increased public access and subsequent human disturbance that could result from new construction and production activities.

7.2.7.8 Sharp-tailed Grouse

No sharp-tailed grouse leks are known to occur within the project area. However, noise related to drilling and production activities may affect sharp-tailed grouse utilization of leks or reproductive success. Reduction of noise levels in areas near leks would minimize this potential impact. If leks are found, surface disturbance should be avoided within 0.25 miles of leks. If disturbance within the buffer areas is avoided, no impacts are expected.

Areas with large tracts of mixed-grass prairie would provide the best quality nesting habitat. To protect sharp-tailed grouse nesting habitats, construction should be limited within a 1-mile radius of an active lek between March 1 and June 30. Significant impacts to leks and subsequent reproductive success are not expected if these guidelines are implemented.

7.2.7.9 Raptors

Potential impacts to raptors within the project area include: (1) nest desertions or reproductive failure as a result of project activities and increased public access, (2) temporary reductions in prey populations, and (3) mortality associated with roads.

The primary potential impact to raptors from project activities is disturbance during nesting that might result in reproductive failure. To minimize this potential, construction would not be allowed during the critical nesting season (Feb. 1 - July 31, depending on species) within 0.5 mile of an active nest of listed or sensitive raptor species, and 0.25 mile (depending on species or line of sight) of an active nest of other raptor species. The nature of the restrictions, exclusion dates, and the protection radii would vary, depending on activity status of nests, species involved, and natural topographic barriers, and line-of-sight distances should be developed in coordination within the NGPC or USFWS.

Nests not used in 1 year, may potentially be used in subsequent years. Subsequent development within close proximity to these nests may preclude use of the nest in following years. Therefore, protection of nests that may potentially be used in the future may require limiting construction within 300 meters (depending on species or line of sight) to minimize impacts. If "take" of an inactive nest were unavoidable, development of artificial nesting structures would mitigate for the loss of the nest. In some instances, during the production phase when human activity is reduced, raptors may actually nest on artificial above-ground structures. Based on the foregoing, significant impacts to raptor nesting activities are not expected.

The development of proposed wellfields and satellite facilities would initially disturb an estimated 1,310 acres of potential habitat for several species of small mammals that serve as prey for raptors. This short-term impact would affect approximately 62 percent of the proposed license area, although this is not likely to limit raptor use within the project area. The small amount of short-term change in prey base populations created by construction is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations on the project area would likely sustain some impact during the initial phase of the project, prey numbers would be expected to soon rebound to pre-disturbance levels following reclamation or active agricultural uses. Once reclaimed or in active agricultural uses, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas. For these reasons, implementation of the project is not expected to produce any appreciable long-term negative changes to the raptor prey base within the project area.

The creation of new roads would increase public access to areas within the project area. As use of the project area increases, the potential for encounters between raptors and humans would increase and could result in increased disturbance to nests and foraging areas. Closure of roads located near active raptor nests to public vehicle use would offset this potential impact. Some raptor species feed on road-killed carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring drivers to follow all posted speed limits.

7.2.7.10 Fish and Macroinvertebrates

Suitable habitat for fish and macroinvertebrates exists within portions of Spring Creek and the White River. However, the construction, operation, and maintenance of the project is not expected to affect either of these habitats.

7.2.7.11 Threatened and Endangered Species

7.2.7.11.1 Bald Eagle (Federal Threatened)

Nebraska's wintering bald eagle population is highly variable, ranging from 409 in 1984 to 1,292 in 1992, with an average of 714 bald eagles counted in Nebraska during the annual midwinter surveys between 1980 and 1993[12]. Most of the wintering bald eagle population is found in close association with open water. However, bald eagles are known to occasionally occur in this region, primarily during the winter months (November through March). However, no bald eagle nests are known to occur within the project area. Moreover, no winter concentration areas or winter nighttime roosts have been documented within the project area[13].

Based on our analysis of the effects of project implementation and the current and potential status of this species in northwestern Nebraska, we conclude that the proposed alternative will have no adverse effect on the bald eagle.

7.2.7.11.2 Swift Fox (State Endangered)

The swift fox is widely distributed throughout the Great Plains and there are small, disjunct populations in the western third of Nebraska and Kansas[14]. There is high-quality swift fox habitat present within the Oglala National Grassland immediately northwest of the project area. In addition, swift fox are closely linked with lagomorph populations, prairie dog colonies, ground squirrels, and other small mammals, which exist in varying densities and abundance throughout the project area.

Based on our analysis of the effects of project implementation, the current and potential status of this species in the project area, and more suitable habitats in the region, we conclude that the proposed project will have no adverse effect on the swift fox.

7.2.7.11.3 Reptiles, Amphibians, and Fish

No threatened or endangered reptiles, amphibians, or fish species have been recorded in the project area, and none are expected to occur.

7.2.7.12 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated, as no substantive impairment of ecological stability or diminishing of biological diversity is expected within the project area.

7.2.8 Noise Impacts of Operations

Noise sources during operation are expected to increase due to increased vehicle travel and increased numbers of employees traveling to and from Crawford for work and from resin transfer to the main plant. Train usage would not increase as a result of operation. Processing equipment at the satellite site would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be less than noise levels generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad.

7.3 RADIOLOGICAL EFFECTS

CBR is proposing to develop a satellite plant with a production flow of approximately 4500 gpm and an average restoration rate of 500 gpm. An assessment of the radiological effects of the North Trend Satellite Plant and related facilities must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The North Trend Satellite Plant will have a production flow capacity of approximately 4,500 gpm and will use fixed bed downflow ion exchange columns to separate uranium from the pregnant production fluid. The Satellite facility will also have a capacity to treat

500 gpm of restoration solution. The restoration process will use fixed bed downflow ion exchange columns to remove the uranium and reverse osmosis to remove the dissolved solids. Waste disposal at the satellite will be via a deep injection well and solar evaporation ponds to provide surge capacity. The satellite plant will not have any precipitation equipment. The loaded ion exchange resin will be transferred from the columns to a resin trailer for transport to the current Crow Butte Facility for regeneration and stripping. The eluted resin will be transported back to the North Trend Satellite Plant and reused in ion exchange columns.

The uranium bearing eluent in the Crow Butte Central Plant is treated in the uranium precipitation circuit. The precipitated uranium is vacuum dried.

The only emission at the North Trend Satellite Facility will be radon-222 (radon) gas. Radon is present in the ore body and is formed from the decay of radium-226. Radon is dissolved in the lixiviant as it travels through the ore body to a production well, where the solution is brought to the surface. The concentration of radon in the production solution is calculated using methods found in NRC Regulatory Guide 3.59[15]. The details of this calculation are found in Attachment 7.3(A).

MILDOS-Area[16] was used to model radiological impacts on human and environmental receptors (e.g., air and soil) using site specific radon release estimates, meteorological and population data, and other parameters.

In the following sections, the assumptions and methods used to arrive at an estimate of the potential radiological impacts of the North Trend Satellite Facility is discussed briefly. A detailed presentation of the source term and other MILDOS-Area parameters is included in Attachment 7.3(A). The anticipated effects are compared to the naturally occurring background levels. This background radiation, arising from cosmic and terrestrial sources, as well as naturally occurring radon gas, comprises the primary radiological impact to the environment in the region surrounding the proposed project.

7.3.1 Exposure Pathways

The proposed North Trend Satellite Facility is an in-situ leach uranium facility. The only source of planned radioactive emissions from the satellite is radon gas, which is dissolved in the leaching solution. Radon gas may be released as the solution is brought to the surface and processed in the satellite facility. Unplanned emissions from the site are possible as a result of accidents and engineered structure failure but are not addressed in the MILDOS-Area modeling. A human exposure pathway diagram addressing planned and unplanned radiological emissions is presented in Figure 7.3-1

The North Trend Satellite Plant will have pressurized downflow ion exchange columns capable of processing 4,500 gpm of production solution. The satellite facility will also have ion exchange and reverse osmosis equipment with a capacity of 500 gpm to process restoration solutions.

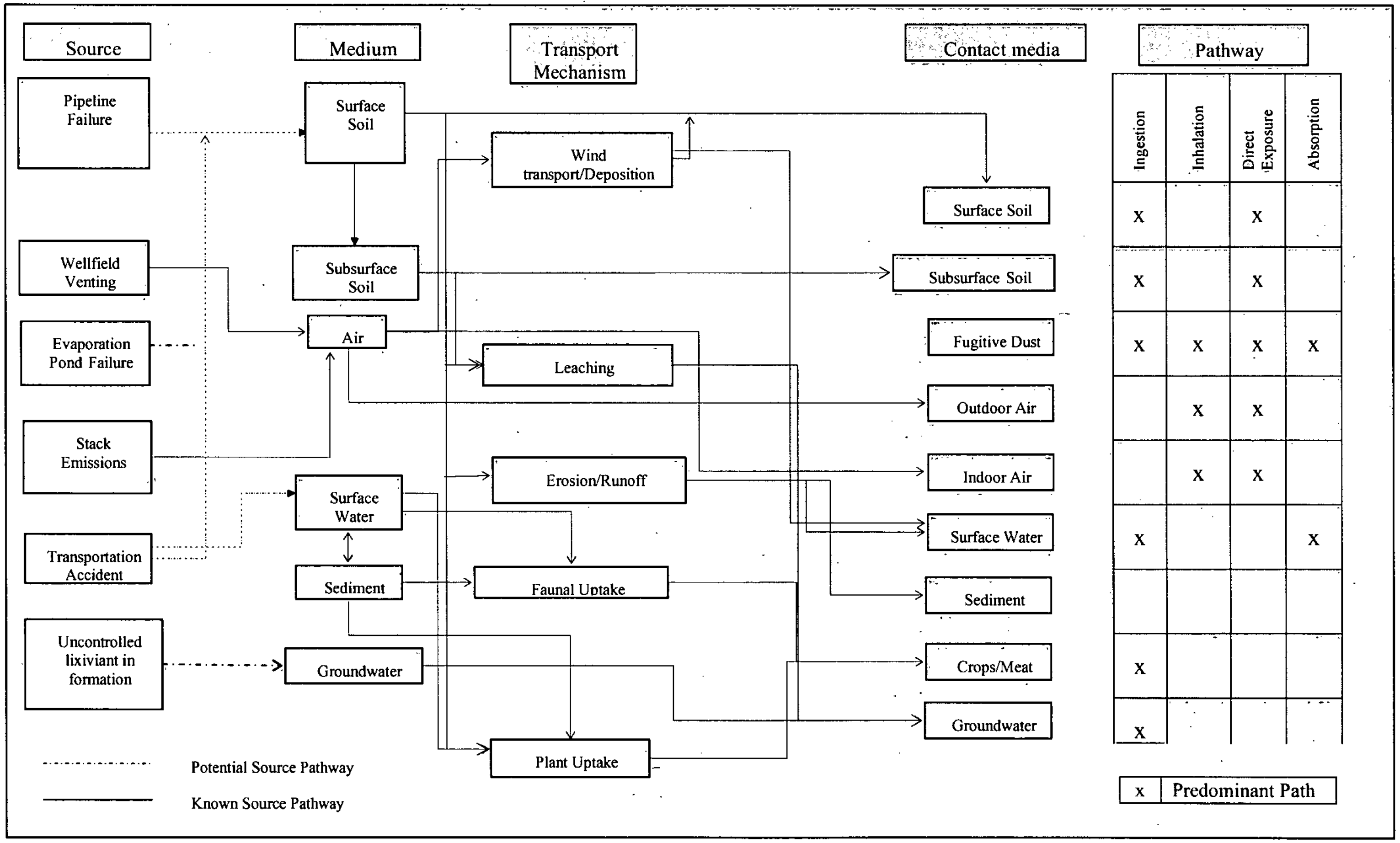
Within the pressurized columns, the radon will remain in solution and be returned to the formation. It will not be released to the atmosphere. There will be minor releases of radon gas during the air blowdown prior to resin transfer to the resin trailer. The air blowdown and the gas released from the vent during column filling will be vented into the exhaust manifold and discharged via the main radon exhaust stack. It is estimated that less than 10 percent of the radon contained in the process solutions will be vented to atmosphere.

In the source term calculation, CBR estimates that 10 percent of the contained radon found in the 4,500 gpm flow processed by pressurized downflow IX columns will be released to the environment

After the IX resin is loaded it will be transferred to a resin trailer. The trailer will transfer the resin to the main process facility for additional processing. The stripped and regenerated resin will be transferred to the trailer and returned to the satellite plant and transferred into a process column. It is anticipated that two round trips will occur per day.

The injection wells will generally be closed and pressurized, but periodically vented. It is estimated that 25 percent of the radon will be released in the wellfield.

Figure 7.3-1 Human Exposure Pathways for Known and Potential Sources from the North Trend Expansion Area



Contact media	Ingestion	Inhalation	Direct Exposure	Absorption
Surface Soil	X		X	
Subsurface Soil	X		X	
Fugitive Dust	X	X	X	X
Outdoor Air		X	X	
Indoor Air		X	X	
Surface Water	X			X
Sediment				
Crops/Meat	X			
Groundwater	X			

Atmospheric emission of radon will lend its presence to all quadrants of the area surrounding the North Trend Expansion Area and the current Crow Butte Project. Radon itself impacts human health or the environment marginally, because it is an inert noble gas. Radon has a relatively short half-life (3.8 days) and its decay products are short lived, alpha-emitting, non-gaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. Figure 7.3-1 shows all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon were evaluated using MILDOS-Area.

7.3.2 Exposures from Water Pathways

The solutions in the zone to be mined will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

The North Trend Satellite Facility will have evaporation ponds used to store waste solutions prior to deep well injection. The ponds will be double-lined with impermeable synthetic liners. A leak detection system will be installed to provide a warning if the liner develops a leak. The ponds, therefore, are not considered a source of liquid radioactive effluents. The use of ponds to manage liquid waste was discussed in further detail in Section 4.

The primary method of waste disposal at the North Trend Satellite Facility will be by deep disposal well injection. The deep disposal well will be completed at an approximate depth of 3,500 to 4,000 ft, isolated from any underground source of drinking water by approximately 2,500 feet of shale (Pierre and Graneros Shales). The well will be constructed under a Class I Underground Injection Control (UIC) Permit issued by the NDEQ and will meet all requirements of the NDEQ UIC program. The use of a deep disposal well to manage liquid waste was discussed in further detail in Section 4.

The North Trend Satellite Facility will be located on a curbed concrete pad to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and be pumped to the ponds. The pad will be of sufficient size to contain the contents of the largest tank if it ruptures.

Since no routine liquid discharges of process water are expected from the North Trend Satellite Facility, there are no definable water-related pathways.

7.3.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon released into the atmosphere through a vent system or from the wellfields. As shown in Figure 7.3-1, atmospheric releases of radon can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure.

Based on the site specific data and the method of estimation of the source term presented in Attachment 7.3(A), the modeled emission rate of radon from the North Trend Satellite Facility is 1662 Ci/yr which includes releases from ion exchange, production and restoration activities. The complete results from MILDOS are contained in Appendix E.

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the North Trend Satellite and main processing site was also estimated using MILDOS-Area. Currently, CBR has a license amendment request pending to increase the annual plant throughput from 5,000 gpm, exclusive of restoration flow to 9,000 gpm exclusive of restoration flow. The license amendment was submitted on October 17, 2006 and the MILDOS-Area simulation included in this license amendment application reflects the requested flow increase. To show compliance with the annual dose limit found in 10 CFR § 20.1301, CBR has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the North Trend Satellite operation is less than 100 mrem per year. The results of the MILDOS-Area simulation are presented in Table 7.3-1. The coordinates of all receptors are listed in Attachment 7.3(A) along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown on Figure 7.3-2. Table 7.3-1 shows the estimated TEDE from operation of the main Crow Butte Project and the North Trend Satellite Plant.

No TEDE limits were exceeded. An evaluation of the TEDE follows:

1) The maximum TEDE is 31.7 mrem/yr.

2) Receptor #31 (NT-1) is the closest resident in the downwind direction for the North Trend Satellite Plant. The estimated TEDE at this location is 5.8 mrem/yr.

3) The effect of the North Trend Satellite operation on the nearby residents of the existing Crow Butte facility is less than 1 mrem/yr.

4) Since radon-222 is the only radionuclide emitted, public dose limits in 40 CFR 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 are not applicable to the CBR facility.

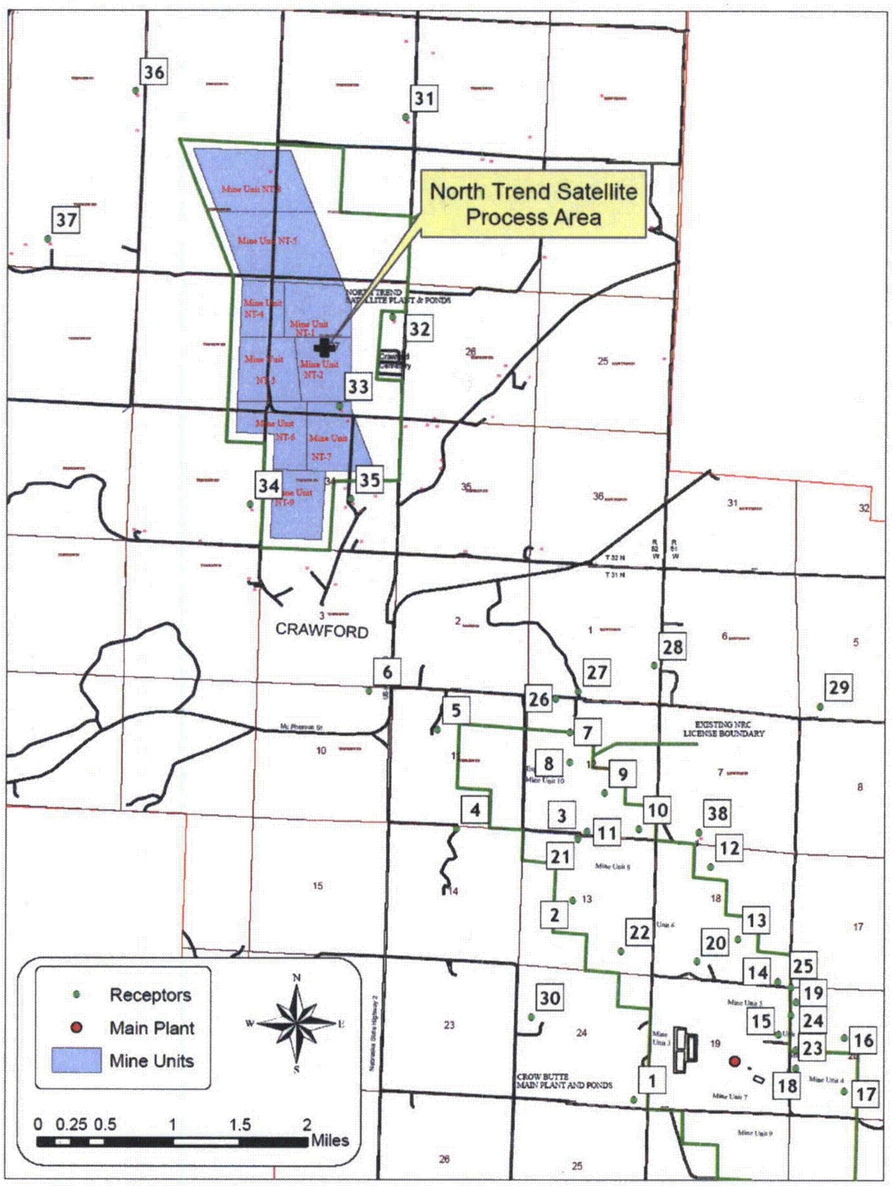


Figure 7.3-2 MILDOS Receptors for Main and Satellite Processing Facility

Table 7.3-1 Estimated Total Effective Dose Equivalent (TEDE) to Receptors Near the Crow Butte Uranium Processing Facility

Receptor #	Description	Distance from Main Plant (km)	TEDE* (mrem/y)
1	R1	1.29	6.64
2	R2	2.76	4.82
3	R3	3.30	6.14
4	R4	4.36	1.92
5	R5	5.35	1.98
6	Crawford	6.25	1.65
7	R7	4.43	4.87
8	R8	4.11	5.16
9	R9	3.59	8.12
10	R10	3.03	16.0
11	R11	3.29	7.34
12	R12	2.37	17.7
13	R13	1.49	28.1
14	R14	1.10	28.3
15	R15	0.62	31.7
16	R16	1.34	9.48
17	R17	1.35	6.06
18	Ehlers	0.73	15.5
19	Gibbons	1.03	24.9
20	Stetson	1.30	19.9
21	Knode	3.28	6.09
22	Brott	1.92	16.2
23	SP1	0.75	18.1
24	SP2	0.89	26.2
25	SP3	1.13	24.8
26	McDowell	4.87	4.24
27	Taggart	4.83	4.87
28	Franey	4.86	6.55
29	Bunch	4.39	7.54
30	Dyer	2.50	3.27
31	NT-1	12.01	5.84
32	NT-2	9.83	3.41
33	NT-3	9.19	3.09
34	NT-4	8.87	2.14
35	NT-5	8.18	2.42
36	NT-6	13.7	1.63
37	NT-7	12.86	1.04
38	NT-8	2.79	15.9

*No differences in TEDE between age classes were observed.

7.3.4 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Crow Butte Project is also predicted by the MILDOS-Area code. The results are listed in Table 7.3-2, where the dose to the bronchial epithelium is expressed in person-rem. For comparison, the dose to the population within 80 km of the facility due to natural background radiation is included in the table. These figures are based on the 1980 population and average radiation doses reported for the Western Great Plains.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 7.3-2 and also combined with dose to the region within 80 km of the facility to arrive at the total radiological effects of one year of operation at the Crow Butte Project.

For comparison of the values listed in Table 7.3-2, the dose to the continental population as a result of natural background radiation has been estimated. This estimate is based on a North American population of 346 million and a dose to each person of 500 mrem/yr to the bronchial epithelium. The maximum radiological effect of the combined operation of the North Trend Satellite Plant and the Crow Butte Project would be to increase the dose to the bronchial epithelium of the continental population by 0.0023 percent.

7.3.5 Exposure to Flora and Fauna

The exposure to flora and fauna was evaluated in the Environmental Report submitted to NRC in September of 1987[17] and the doses were found to be negligible. The proposed satellite facility will have no measurable impact on dose to flora and fauna.

Table 7.3-2: Dose to the Population Bronchial Epithelium and Increased Continental Dose from One Year's Operation at the Crow Butte Facility

Criteria	Dose (person rem/yr)
Dose received by population within 80 km of the facility	171
Natural background by population within 80 km of the facility	24025
Dose received by population beyond 80 km of the facility	224
Total continental dose	394
Natural background for the continental population	$1.73 \times 10^{+8}$
Fraction increase in continental dose	2.27×10^{-6}

7.4 NON-RADIOLOGICAL EFFECTS

There are two effluents expected from the North Trend Satellite.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as previously discussed in Sections 4 and 7.3. The gaseous and airborne effluent will not contain any non-radiological wastes.
- The liquid effluent will be managed in the solar evaporation ponds and the deep disposal well. There is no discharge from the evaporation ponds. The deep disposal well will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the NDEQ. The current Class I UIC Permit for the deep disposal well located at the Central Plant implements injection limits and requires monthly monitoring for RCRA Metals to ensure that hazardous waste is not injected. Based on the monitoring for the current deep disposal well, there is no non-radiological impact expected due to the liquid effluents from the North Trend Satellite Facility.

7.5 EFFECTS OF ACCIDENTS

Accidents involving human safety associated with the in-situ uranium mining technology typically have far less severe consequences than accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for personnel and neighboring communities when compared to conventional mining methods or other energy-related industries. Accidents that may occur would generally be quite minor when compared to other industries, such as an explosion at an oil refinery or chemical plant. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the facility and the low level of radioactivity associated with the process both decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at uranium milling facilities in NUREG–0706[18] and specifically at in situ leach facilities in NUREG/CR-6733[19]. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The CBR emergency management procedures contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual,* have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in ~~EHSMS~~SHEQ MS Volume VII, *Training Manual,* have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. ~~EHSMS~~SHEQ MS Program Volume II, *Management Procedures,* requires periodic testing of emergency procedures and training by conducting drills.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISL facilities, such as transportation accidents; however, much of the analyses do not apply due to the significantly different mining and processing methods. ISL facilities do not handle large quantities of radioactive materials such as crushed ore and tailings, so the quantity of material that could be affected by an incident is significantly less than at a mill site.

NUREG/CR-6733 specifically addressed risks at ISL facilities and identified the following "risk insights".

7.5.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. The use of hazardous chemicals at Crow Butte is regulated by the Occupational Health and Safety Administration (OSHA). Crow Butte is subject to the Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119. Of the highly hazardous chemicals, toxics, and reactives listed in Appendix A to 29 CFR §1910.119, none will be used at the North Trend Satellite Plant. As a satellite plant, North Trend will use oxygen, carbon dioxide, and sodium carbonate for addition to the injection solution. Sodium sulfide may be used as a reductant during groundwater restoration activities. All other operations requiring process chemicals described in NUREG/CR-6733 will be performed at the Central Plant.

Crow Butte construction, operating, and emergency procedures have been developed to implement the codes and standards that regulate hazardous chemical use.

7.5.1.1 Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. As currently practiced at the Central Plant, CBR will install wellfield oxygen distribution systems at North Trend. Combustibles such as oil and grease will burn in oxygen if ignited. CBR ensures that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1[20]. Construction of oxygen systems in the wellfield are covered by procedures contained in ~~EHSMS~~SHEQ MS Program Volume III, *Operations Manual.* Emergency response instructions for a spill or fire involving oxygen systems are contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual.*

7.5.1.2 Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points is currently performed at the central plant to protect workers from undetected leaks of carbon dioxide. Operation of carbon dioxide systems is currently covered by procedures contained in ~~EHSMS~~SHEQ MS Program Volume III, *Operations Manual.* Emergency response instructions for a leak involving carbon dioxide are contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual.*

7.5.1.3 Sodium Carbonate

Sodium carbonate is primarily an inhalation hazard. CBR typically uses soda ash and carbon dioxide to prepare sodium carbonate for injection in the wellfield. Soda ash storage and handling systems are designed to industry standards to control the discharge of dry material. Operation of sodium carbonate systems is currently covered by procedures contained in ~~EHSMS~~SHEQ MS Program Volume III, *Operations Manual.* Emergency response instructions for a spill involving sodium carbonate or soda ash are contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual.*

7.5.2 Radiological Risk

7.5.2.1 Tank Failure

A spill of the materials contained in the process tanks at the North Trend Satellite Facility will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the process plant or in outside storage tanks. The tanks at the North Trend Satellite will contain injection and production solutions and ion exchange resin. Elution, precipitation, and drying will be performed at the central plant. The satellite plant will be designed to control and confine liquid spills from tanks should they occur. The plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, or double-walled tanks will perform a similar function for process vessels located outside the satellite building.

All tanks will be constructed of fiberglass or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

7.5.2.2 Plant Pipe Failure

The rupture of a pipeline within the process plant is easily visible and can be repaired quickly. Spilled solution will be contained and removed in the same fashion as for a tank failure.

Response procedures for the radiological risk from releases are currently contained in ~~EHSMS~~SHEQ MS Volume VIII, *Emergency Manual.* These procedures also provide instructions for emergency notification including notification to NRC in compliance with the requirements of 10 CFR 20.2202 and 20.2203.

7.5.3 Groundwater Contamination Risk

7.5.3.1 Lixiviant Excursion

Excursions of lixiviant at ISL facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the exempted portion of the ore-body aquifer. A vertical excursion is a movement of ISL fluids into overlying or underlying aquifers.

CBR controls lateral movement of lixiviant by maintaining wellfield production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution is either recycled in the plant or is sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the Mine Unit, the wellfield is said to be balanced.

CBR monitors for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. The current NRC License and NDEQ Class III UIC Permit require that Chadron aquifer monitor wells be located no more than 300 feet from the nearest mineral production wells and no more than 400 feet each other. These spacing requirements have proven effective for monitoring horizontal excursions at Crow Butte and will be employed at the North Trend Satellite. Monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite. The program was discussed in detail in section 5.7.8.

Section 7.2.5 provided a discussion of horizontal excursions reported at the current Crow Butte operation. The historical experience indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. CBR controls vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the NDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing is conducted in accordance with NDEQ regulations contained in Title 122[21] and methods approved by NRC and NDEQ. Construction and integrity testing methods were discussed in detail in section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the NDEQ and discussed in detail in section 6.2. Procedures for these activities are contained in ~~EHSMS~~SHEQ MS Program Volume III, *Operating Manual.*

CBR monitors for vertical excursions in the overlying aquifers using shallow monitor wells. These wells are located within the wellfield boundary at a density of one well per five acres. Shallow monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite. The program was discussed in detail in section 5.7.8.

7.5.3.2 Pond Failure

An accident involving a leak in a pond is detectable either from the regular visual inspections or through monitoring the leak detection system. The current pond operation and inspection program is contained in ~~EHSMS~~SHEQ MS Program Volume VI, *Environmental Manual,* and consists of daily, weekly, monthly and quarterly inspections in conjunction with an annual technical evaluation of the pond system. The CBR monitoring program was developed to meet the guidance contained in USNRC Regulatory Guides 3.11[22] and 3.11.1[23]. Any time six inches or more of fluid is detected in the standpipes, it is analyzed for specific conductance. If the water quality is degraded beyond the action level, it is sampled again and analyzed for chloride, alkalinity, sodium, and sulfate. In addition, monitor wells are installed downgradient of the pond in the first water bearing zone. These monitor wells are sampled and analyzed for the excursion parameters on a quarterly basis. The pond operation and monitoring program was discussed in detail in Section 4.2.

In the event of a leak, the contents of any one pond can be transferred to another pond cell while repairs are made. Freeboard requirements may be waived during this period. Catastrophic failure of a pond embankment is unlikely given the design and inspection requirements of the pond and the freeboard limitations.

7.5.4 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the North Trend Satellite plant would result in either a release of barren or pregnant lixiviant solution, which would contaminate the ground in the area of the break.

All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines are constructed of PVC, high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines are pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each mine unit will have a number of wellhouses where injection and production wells will be continuously monitored for pressure and flow. With the control system currently employed at Crow Butte, individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the satellite control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective at the current operation in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the wellhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. CBR currently implements a program of continuous wellfield monitoring by roving wellfield operators and required periodic inspections of each well that is in service. Based on experience from the current operation, small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination based on monitoring using field survey instruments and soil samples for radium-226 and uranium. Following repair of a leak, CBR procedures require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

7.5.5 Transportation Accident Risk

Transportation of materials to and from the North Trend Satellite Plant can be classified as follows:

- Shipments of process chemicals or fuel from suppliers to the site.
- Shipment of radioactive waste from the site to a licensed disposal facility.
- Shipments of uranium-laden resin from the satellite plant to the central plant and return shipments of barren, eluted resin from the central plant back to the satellite plant.

The first two types of transportation risks do not present an increase over the risks associated with operation of the current Crow Butte facility since production from North Trend is planned to replace declining production at the current facility. The shipment of loaded ion exchange resin from North Trend and the return of barren, eluted resin represent an additional transportation risk that was not considered for the current operation.

NUREG-0706 concluded that the probability of a truck accident in any year is 11 percent for each uranium extraction facility or mill. This calculation used average accident probabilities (4.0 x 10^{-7}/km for rural interstate, 1.4 x 10^{-6}/km for rural two-lane road, and 1.4 x 10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative with respect to probability distributions used in a later NRC transportation risk assessment[24]. For North Trend, uranium-loaded and barren resin will be routinely transported by tank truck from the satellite plant to the Central Plant. For the Crown Point site, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[25].

Accident risks involving potential transportation occurrences and mitigating measures are discussed below:

7.5.5.1 Accidents Involving Shipments of Process Chemicals

Based on the current production schedule and material balance, it is estimated that approximately 150 bulk chemical deliveries per year will be made to the North Trend Satellite. This averages about one truck per working day for delivery of chemicals throughout the operational life of the project. Types of deliveries include carbon dioxide, oxygen, and soda ash.

7.5.5.2 Accidents Involving Radioactive Wastes

Low level radioactive 11(e)2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential impact in the event of an accident.

7.5.5.3 Accidents Involving Resin Transfers

One of the potential additional risks associated with operation of a satellite plant is the transfer of the ion exchange resin to and from the satellite plant.

Resin will be transported to and from the North Trend Satellite Plant in a 4,000 gallon capacity tanker trailer. It is currently anticipated that one load of uranium-laden resin will be transported to the Crow Butte central plant for elution and one load of barren eluted resin will be returned to the North Trend Satellite Plant on a daily basis. The transfer of resin between the two sites will occur on county and private roads. The planned transport route has been designed to avoid travel on U.S. Highway 20 and Nebraska State Highway 2/71. The planned transport route will cross these two highways.

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren eluted resin. Pertinent procedures, which Crow Butte will follow for a resin shipment, are listed as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.

- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.

- Trained CBR drivers will transport the resin between the North Trend Satellite Plant and the central plant.

- Crow Butte's current emergency response plan for yellowcake and other transportation accidents to or from the Crow Butte site is contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual.* This plan will be expanded to include an emergency resin transfer accident procedure. Personnel at both the satellite plant and the central plant will receive training for responding to a resin transfer transportation accident.

Currently, Crow Butte Resources intends to treat the eluted resin the same as the uranium loaded resin. It is possible that the eluted resin may be clean enough to be transported as non-radioactive material, as defined by DOT regulations. Operating experience will aid in the determination of the most practical and efficient way of dealing with the shipment of barren resin. Regardless, compliance with all applicable DOT and USNRC regulations will be the primary determining factor.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological or environmental impact of a similar accident with barren, eluted resin would be very minor. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, CBR will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each resin hauling truck will be equipped with a radio which can communicate with either the Crow Butte central plant or the North Trend Satellite plant. In the event of an accident and spill, the driver can radio to both sites to obtain help.
- A check-in and check-out procedure will be instituted where the driver will call the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, a crew would respond and search for this vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.
- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material.
- Both the satellite and central process facilities will be equipped with emergency response packages to quickly respond to a transportation accident.
- Personnel at the satellite and central process facilities as well as the designated truck drivers will have specialized training to handle an emergency response to a transportation accident.

7.5.6 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISL facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities and the possible reaction of process chemicals during either event. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities. CBR is committed to following these standards.

The project area along with most of Nebraska is in seismic risk Zone 1. Most of the central United States is within seismic risk Zone 1 and only minor damage is expected from earthquakes that occur within this area. Seismology was discussed in detail in section 2.6.

The Crow Butte operation is located in an area that is subject to tornadoes. CBR emergency procedures currently contained in ~~EHSMS~~SHEQ MS Program Volume VIII, *Emergency Manual,* provide instructions for response and mitigation of natural disasters and spills or radioactive materials.

7.6 ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

The preliminary evaluation of socioeconomic impacts of the commercial facility was completed in 1987 as reported in the original commercial license application. The preliminary evaluation was divided into two phases – construction and operation. The evaluation concluded that the construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

Since the inception of the operational phase, the overall effect of the current commercial facility operations on the local and regional economy has been beneficial. Purchases of goods and services by the mine and mine employees contribute directly to the economy. Local, state, and the federal governments benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, are also beneficial. These economic effects further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the current operation would continue for the life of the mine, estimated to be an additional twelve years as of January 2007. However, the positive impacts from the current operation will begin to decline as reserves are depleted in the next five years.

The current mine operation has not resulted in any significant impact to the community infrastructure (including schools, roads, water and sewage facilities, law enforcement, medical facilities, and any other public facility) in the town of Crawford or in Dawes County. As discussed in further detail below, the mine employs a workforce of approximately 52 employees and 20 contractors. The majority of these employees are hired from the surrounding communities.

In summary, monetary benefits accrue to the community from the presence of the Crow Butte Project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the economic impact of the project to date and projects the incremental impacts from operation of the proposed North Trend Satellite Facility.

7.6.1 Tax Revenues

The following table summarizes the recent tax revenues from the Crow Butte project.

	2006	2005	2004	2003
Property Taxes	627,000	351,000	144,000	65,000
Sales and Use Taxes	238,000	185,000	161,000	153,000
Severance Taxes	545,000	338,000	180,000	73,000
Total	**1,410,000**	**874,000**	**485,000**	**291,000**

Future tax revenues are dependent on uranium prices which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around $80 per pound U_3O_8 in mid-March 2007), the increased production from the satellite plants should contribute to higher tax revenues as well.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the satellite plants should be about 600,000 pounds per year. This additional production will eventually be offset by declining production from the original plant; however, the incremental contribution to taxes would be on the order of $1.0 million to $1.2 million per year in combined taxes.

7.6.2 Temporary and Permanent Jobs

7.6.2.1 Current Staffing Levels

CBR currently employs approximately 52 employees and 20 contractors on a full-time basis. Short-term contractors and part time employees are also used for specific projects and/or during the summer months and may add up to 10 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2006 was 2,189 out of a total labor force of 3,401[26]. Based on these statistics, CBR currently provides approximately 2.3 percent of the private employment in Dawes County. In 2006, CBR's total payroll was over $2,543,000. Of the total Dawes County wage and salary payments of $76,006,000 in 2006, the CBR payroll represented about 3.4 percent.

Total CBR payroll for the past four years was:

2003:	$2,102,000
2004:	$2,213,000
2005:	$2,382,000
2006:	$2,543,000

The average annual wage for all workers in Dawes County was $22,350 for 2006. By way of comparison, the average wage for CBR was about $51,000. Entry-level workers for CBR earn a minimum of $15.53 per hour or $32,300 per year, not including bonus or benefits.

7.6.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite plant(s) will provide approximately ten to fifteen temporary construction jobs for a period of up to one year for each satellite. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than five percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2006, total unemployment in Dawes County was 137 individuals, or 2.9 percent of the total work force of 4,799. CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by ten to twelve full-time CBR employees for each active satellite plant. These new employees will be needed for satellite plant and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) may also increase by four to seven employees depending on the desired production rate. The majority if not all of these new positions will be filled with local hires.

These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

7.6.3 Impact on the Local Economy

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area.

Total CBR payments made to Nebraska businesses for the past four years were:

2003:	$3,602,000
2004:	$3,597,000
2005:	$4,570,000
2006 (est):	$5,000,000

The vast majority of these purchases were made in Crawford and Dawes County.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the satellite plant, although not in strict proportion to production. While there are some savings due to some fixed costs (central plant utilities for instance), there are additional expenses that are expected to be higher (wellfield development for the satellites is expected to be more expensive). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3.65 to $4.35 million per year.

7.6.4 Economic Impact Summary

As discussed in this section, the Crow Butte Project currently provides a significant economic impact to the local Dawes County economy. Approval of this license amendment request would have a positive impact on the local economy as summarized in Table 7.6-1.

Table 7.6-1
Current Economic Impact of Crow Butte Uranium Project and Projected Impact from North Trend Expansion Area

	Current Crow Butte Operation	Estimated Economic Impact due to North Trend Expansion Area
Employment		
Full Time Employees	52	+ 10 to 12
Full Time Contractor employees	20	+ 4 to 7
Part Time Employees and Short Term Contractors	7	+ 10 to 15 (Satellite Construction)
CBR Payroll, 2006	$2,543,000	+ $400,000 to $480,000
Taxes		
Property Taxes	$627,000	-
Sales and Use Taxes	$238,000	-
Severance Taxes	$545,000	-
Total Taxes	$1,410,000	+ $1,000,000 to $1,200,000
Local Purchases		
Local Purchases, 2006 (est.)	$5,000,000	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts		
	$8,953,000	**+ $5,050,000 to $6,030,000**

7.7 REFERENCES

[1] Nebraska Department of Environmental Quality, *Title 119 – Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System*, May 16, 2005.

[2] Environmental Protection Agency. *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.* Office of Noise Abatement and Control. EPA 550/9-74-004. March 1974.

[3] City of Crawford Nebraska (Crawford). 2007. Ordinances, [Web page]. Located at http://www.crawfordnebraska.net/depts/ordinances.html Accessed: March 7, 2007

[4] State of Nebraska, Department of Roads (Nebraska). 2007. NDOR Map Library, Traffic Volume Maps and Info. *2004 NE Highway Traffic Flow Map.* [Web page]. Located at http://www.nebraskatransportation.org/maps/#traffvol Accessed: March 7, 2007.

[5] U.S. Department of Transportation (USDOT), Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, June 1995.

[6] State of Nebraska, Department of Roads (Nebraska). NDOR Map Library, Miscellaneous Categories. *Current Nebraska Speed Limit Maps.* [Web page]. Located at http://www.nebraskatransportation.org/maps/#traffvol Accessed: March 7, 2007

[7] Harris, Cyril M. 1991. *Handbook of Acoustical Measurements and Noise Control.* McGraw-Hill, New York, New York.

[8] Bell, Lewis H. 1982. *Industrial Noise Control, Fundamentals and Applications*, Marcel Dekker, Inc., New York, New York.

[9] Crocker, M.J., Kessler, F.M. 1982. *Noise and Noise Control, Volume II.* CRC Press, Inc., Chemic Rubber Company, Cleveland, OH.

[10] U.S. Environmental Protection Agency, USEPA—2004. *Air Quality Monitoring Data Base.* [Web Page] http://www.epa.gov/air/data/. Accessed on March 2, 2007.

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[11] U.S. Environmental Protection Agency, USEPA—1978, *Supplement No. 8 for Compilation of Air Pollutant Emission Factors Third Edition (Including Supplements, 1-7),* Research Triangle Park, North Carolina, May 1978

[12] Nebraska Game and Parks Commission, *Bird of Nebraska: an interactive guide* http://www.ngpc.state.ne.us/wildlife/guides/birds/showbird.asp?BirdID='98', accessed July 27, 2004.

[13] Fritz, M. 2004. Personal Communication [August 6 telephone conversation with R. Henning, Greystone Environmental Consultants, Inc. Greenwood Village, CO]. RE: Raptor species including Bald Eagle. Raptor Biologist, Nebraska Game and Parks Commission. Lincoln, NE. 1 Page.

[14] U.S. Department of Interior, Fish and Wildlife Service, *Endangered and Threatened Wildlife and Plants; 12-Month Finding for a Petition to List the Swift Fox as Endangered.* Federal Register Vol. 60, No. 116. 31663-31666

[15] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations*, March 1987.

[16] Argonne National Laboratory, *MILDOS-Area: An Enhanced Version of MILDOS For Large-Area Sources,* June 1989.

[17] Ferret Exploration of Nebraska, *Application and Supporting Environmental Report For USNRC Commercial Source Material License*, September 1987.

[18] U.S. Nuclear Regulatory Commission, NUREG–0706, *Final Generic Environmental Impact Statement on Uranium Milling—Project M–25*, September 1980.

[19] Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*, 2001.

[20] Compressed Gas Association, Inc., CGA-G-4.1, *Cleaning Equipment for Oxygen Service*, 1996.

[21] Nebraska Department of Environmental Quality, Title 122 *Rules and Regulations for Underground Injection and Mineral Production Wells* (April 2002).

[22] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

[23] U.S. Nuclear Regulatory Commission, Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

[24] U.S. Nuclear Regulatory Commission, NUREG/CR—6672, *Reexamination of Spent Fuel Shipment Risk Estimates*, SAND2000—0234, 2000.

[25] U.S. Nuclear Regulatory Commission, NUREG—1508, *Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico*, 1997.

[26] US Department of Labor, Bureau of Labor Statistics, as of March 5, 2007.