3 DESCRIPTION OF PROPOSED FACILITY

Production of uranium by ISL mining techniques involves a mining step and a uranium recovery step. Mining is accomplished by installing a series of injection wells through which the leach solution is pumped into the ore body. Corresponding production wells and pumps promote flow through the ore body and allow for the collection of uranium-rich leach solution. Uranium is removed from the leach solution by IX, and then from the IX resin by elution. The leach solution can then be reused for mining purposes. The elution liquid containing the uranium (the "pregnant" eluent) is then processed by precipitation, dewatering, and drying to produce a transportable form of uranium called yellowcake.

The TCEA is being developed by Crow Butte Resources in conjunction with the CPF licensed under NRC Source Material License SUA-1534. The TCEA will be developed by constructing independent wellfields and mining support facilities while utilizing existing processing equipment for uranium recovery. Transfer of recovered leach solutions from the area is prohibitive because of the distance that a relatively large stream would have to be pumped. Therefore, a satellite facility will be constructed in the TCEA to provide chemical makeup of leach solutions, recovery of uranium by IX, and restoration capabilities. The IX processes at the satellite facility recover the uranium from the leach solution in a form (loaded IX resin) that is relatively safe and simple to transport by tanker truck to the CPF, which will serve as the CPF for elution and further processing of recovered uranium. Regenerated resin is then transported back to the satellite facility for reuse in the IX circuit.

3.1 Solution Mining Process and Equipment

3.1.1 Orebody

In the CPF license area, uranium is recovered by in-situ leaching from the Chadron Sandstone at a depth that varies from 400 feet to 900 feet. The overall width of the mineralized area varies from 1000 feet to 5000 feet. The orebody ranges in grade from less than 0.05 to greater than 0.5 percent U_3O, with an average grade estimated at 0.27 percent U_3O_8

In the TCEA, uranium will also be recovered from the Chadron Sandstone. The depth in the TCEA ranges from 580 to 940 feet. The width varies from 2,100 feet to 4,000 feet. The ore body ranges in grade from less than 0.05 percent to 0.5 percent U_3O_8, with an average grade estimated at 0.22 percent U_3O_8. Indicated ore resources as U_3O_8 for the TCEA are 3,750,481 pounds (lbs) with an additional inferred estimate of 1,135,452 lbs. Total reserves are estimated at 4,900,000 lbs. The expected annual production rate will be approximately 600,000 pounds U_3O_8.

Typical stratigraphic intervals to be mined by the in situ mining method are shown in the geologic cross sections contained in Section 2.6. For ISL wellfields, the production zone is the geological sandstone unit where the leaching solutions are injected and recovered.

3.1.2 Well Construction and Integrity Testing

Three well construction methods and appropriate casing materials are used for the construction and installation of production and injection wells.

3.1.2.1 Well Materials of Construction

The well casing material will be polyvinyl chloride (PVC). PVC well casing is 4.5 inch SDR-17 (or equivalent). The PVC casing joints normally have a length of approximately 20 feet each. With SDR-17 PVC casing, each joint is connected by a water tight o-ring seal which is located with a high strength nylon spline.

There are two types of well screen that will be used for development of the TCEA – polyvinyl chloride (PVC) and stainless steel (SS). Both types of screens have been used historically for the existing Crow Butte production, injection and monitor wells. SS screens are more durable than PVC screens, are rated for greater depths than PVC screens, easier to install and can achieve better flow. The SS screens are significantly more expensive than the PVC screens. Currently CBR primarily uses SS screens, but would maintain the option to use PVC screens as necessary at the satellite facility based on site conditions and purpose of the borehole. For example, PVC well screens are currently used in both shallow observation monitor wells and commercial production monitor wells. This practice will be continued as an option for Three Crow. The primary reason for use of the PVC screens for these types of wells is because these types of monitor wells typically have much longer screen intervals than other types of wells. This results in employee safety issues due to the handling of the heavy stainless steel screens. In addition, flow rate using PVC screens is less of a concern for these types of wells.

The PVC well screen consists of a perforated 3-inch PVC pipe. PVC rods run longitudinally along the sides of the pipe. Keystone shaped PVC wire is helically wrapped around the outsides of the pipe and ribs and solvent-welded to the pipe. Spacing between consecutive wraps of the wire varies depending upon the screen ordered. Slot sizes from 0.010 to 0.020 inches have been used successfully at Crow Butte. In most cases, a slot size of 0.020 inches is sufficient to prevent sand entering the screens.

The SS well screen consists of longitudinal ribs of SS with a SS "V" shaped wire wrapped helically around the interior ribbing. The wire is welded to the circular rib array for support. As with PVC screens, slot sizes of 0.010 to 0.020 inches have been used historically at Crow Butte.

3.1.2.2 Well Construction Methods

Pilot holes for monitor, production, and injection wells will be drilled through the target completion interval with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The hole will be logged, reamed, casing set, and cemented to isolate the completion interval from all other aquifers. Three well construction methods are described. Any of the methods is appropriate for monitor wells and have been approved by the NDEQ under the current Crow Butte Class III UIC Permit. Final, detailed engineering drawings depicting the construction details of the Class III wells will be submitted to the NRC and NDEQ for approval prior to commencement of construction.

Three well construction methods are described in this section. Of the three methods, CBR primarily uses Method 1 shown in **Figure 3.1-1** on a routine basis. Method 2 shown in **Figure 3.1-2** may be used by the CBR Geology staff when there is a need to study the geology of an area and to determine the best placement of the screens without having to attach screens to the casing string. Method 3 shown in **Figure 3.1-3** is not routinely used, but this method is maintained as an option so that the method (including minor modifications) can be used if warranted for specific geological formations. All of these methods are appropriate for monitor wells and have been approved by the NDEQ under the UIC Permit.

- Method 1

For this method, the well is drilled to depth in the Pierre Shale, and then logged. Based upon the e-log, geological staff will pick a casing depth, and will then begin to review the local area wells for the best location (depth) to pick the screened interval. The well is cased through the mining zone and cemented in place. Cement flows down the inside of the casing, exits out the bottom, and flows back up the annulus to the surface. Cement may be pushed out of the bottom of the casing by use of a rubber cement plug that is pushed to the bottom and stays in the bottom of the well, or cement may be displaced using fresh water. If the cement is displaced with water, a rig will need to drill the excess cement out of the casing prior to under-reaming and setting screens. If the cement is displaced using a cement plug, then nothing further is required prior to under-reaming. The under-reaming process begins with a rig tripping (inserting in borehole) a specialized drill bit into the depths to be screened. Blades on the bit open outward and cut away and remove the casing and cement grout from the area to be screened. When the interval to be screened has been cut away, the drill rig removes the drill pipe, and the hole is logged to make certain that the cut is accurate. If the cut-check depths are determined to be satisfactory, the rig is used to place the screen assembly at the selected depth and then develop the well.

Method 1 is the primary method used for all injection and production wells. A slight variation of this method is used for monitor wells. Monitor wells are cased to the top of the mining zone, and cemented using water displacement. Allowing for time for the cement to set up (harden), the excess cement is drilled out of the casing and the well is logged to determine where to place the well screens.

Method 1 is similar to Method 2, except that a plug and weep holes are not used.

- Method 2

Method 2 uses a screen telescoped down inside the cemented casing. A hole is drilled and geophysically logged to locate the desired screen interval. The hole is then reamed if necessary only to the top of the desired screen interval. Next a string of casing with a plug at the lower end and weep holes just above the plug is set into the hole. Cement is then pumped down the casing and out the weep holes. It returns to the surface through the annulus. After the cement has cured, the residual cement in the casing and plug are drilled out, with the drilling continuing through the desired zone. The screen with a K-packer and/or shale traps is then telescoped through the casing and set in the desired interval. The packer and/or shale traps serve to hold the screen in the desired position while acting as a fluid seal. Well development is again accomplished by airlifting or pumping. Minor variations from these procedures may be used as conditions require.

Method 2 is an improvement over Method 3 due to drilling only to the top of the mining zone. At that point the well is cased and cemented. Because the drill hole does not penetrate through the mining zone, no cement basket must be used. A cement plug and weep holes are used to place the cement.

- Method 3

  This method involves the setting of an integral casing/screen string. The method consists of drilling a hole to the Pierre Shale, geophysically logging the hole to define the desired screen interval, and reaming the hole, if necessary, to the desired depth and diameter. Next, a string of casing with the desired length of screen attached to the lower end is placed into the hole. A cement basket is attached to the blank casing just above the screen to prevent plugging of the screen interval during cementing. The cement is pumped down the inside of the casing to a plug set just below the cement basket. The cement passes out through weepholes in the casing and is directed by the cement basket back to the surface through the annulus between the casing and the drill hole. After the cement has cured sufficiently, the residual cement and plug are drilled out, and the well is developed by airlifting or pumping.

For all three well completion methods, casing centralizers, located at a maximum 100-foot spacing, are run on the casing to ensure it is centered in the drill hole and that an effective cement seal is provided. The purpose of the cement is to stabilize and strengthen the casing and plug the annulus of the hole to prevent vertical migration of solutions. The volume of cement used in each well is determined by estimating the volume required to fill the annulus and ensure cement returns to the surface. In almost all cement jobs, returns to the surface are observed. In rare instances, however, the drilling may result in a larger annulus volume than anticipated and cement may not return all the way to the surface. In these cases the upper portion of the annulus will be cemented from the surface to backfill as much of the well annulus as possible and stabilize the wellhead. This procedure is performed by placement of a tremie hose from the surface as far down into the annulus as possible. Cement is pumped into the annulus until return to the surface is observed.

<u>Screening</u>

The exact size of the screen slot is determined by analyzing the formation samples brought to the surface during the drilling process, and is selected at the discretion of the Crow Butte Geology staff. The location and amount of drill screen to be set in a well is based upon the geologic and economic factors. Well screens are placed at a selected depth using the drilling rig. The screens are secured in place using a rubber K-packer and blank assembly that is attached to the top of the screens. The K-packer suspends the screens in the open portion of the well until well development creates a natural gravel pack surrounding the screen.

For injection and production wells, the screen interval is determined by the Geologic staff based on the location of sands and ore grade material. Correlating and selecting the zones to be mined and making certain that the screened intervals between wells are hydrologically connected are completed by reviewing geophysical logs. Typically, an interval of approximately 18 feet is screened; however, individual intervals may range from 6 feet to 35 feet in length.

For monitor wells, a slightly different process is followed for placement of the screens. When the monitor well is drilled, the total thickness of the production zone is calculated. The amount of screens to be placed in the well must cover the production zone and the screen-to-blank ratio must exceed 50%. Care should be taken to ensure that those zones impacted by nearby wells are covered by screens, not blank. A well completion report is completed on each well and submitted to the NDEQ. These data are kept available on-site for review. All wells are constructed by a licensed/certified water well contractor, as defined by the Nebraska Health and Human Services System, Water Well Standards and Licensing Act, Article 46.

3.1.2.3 Cement/Grout Specifications

All cement will be American Society for Testing Materials (ASTM) Type I, II or American Petroleum Institute (API) Class B or G and meet the following criteria:

- A density of no less than 11.5 lbs/gal.
- A bentonite grout shall be mixed as close as possible to a concentration of 1.5 lb. bentonite per gallon of water (1 quart polymer per 100 gallons of water may be premixed to prevent the clays from hydrating prematurely) and shall have a density of 9.2 lbs./gal or higher.

3.1.2.4 Logging Procedures and Other Tests

Appropriate geophysical logs and other tests are conducted during the drilling and construction of new Class III wells. The logs and other tests are determined based on the intended function, depth, construction, and other characteristics of the well, availability of similar data in the area of the drilling site, and the need for additional information that may arise from time to time as the construction of the well progresses.

Logging Equipment

CBR currently owns three operational logging units. These units are capable of logging drill holes to a depth of approximately 2,000 feet. These trucks are capable of using a wide variety of tools. All of the probes used by CBR, measure Single Point Resistance (RES), spontaneous Potential (SP), Natural Gamma (GAM[NAT]), and Deviation. Some of the probes used by CBR also are capable of measuring temperature, 16-inch normal resistance, and 64-inch normal resistance. Probes used at CBR include the 9060, 9055, 9144, and 9057 types. Deviation with these units is measured using a slant angle and azimuth technique. Standardized procedures are used by trained personnel to carry out the logging tasks.

Additional discussions as to borehole geophysical logging equipment, procedures and other tests are presented in Section 2.6

Groundwater Measurements

Groundwater sampling and water level measurements are two tests typically conducted for new wells. Results of the groundwater sampling and analysis are used to evaluate water quality baseline values for future restoration to groundwater standards, and water level measurements provide for a more detailed understanding of the hydraulic gradient within the TCEA. Groundwater monitoring for new wells is discussed below.

3.1.2.5 Well Development

Following well construction (and before baseline water quality samples are taken for restoration and monitoring wells), the wells must be developed to restore the natural hydraulic conductivity and geochemical equilibrium of the aquifer. All wells are initially developed immediately after construction using airlifting or other accepted development techniques. This process is necessary to allow representative samples of groundwater to be collected. Well development removes water and drilling fluids from the casing, formation and borehole walls along the screened interval. The primary goal for well development is to allow formation water to enter the well screen.

Initially well development is generally performed by air lifting and cleanup with a drill rig. The well is developed until the water produced is clear. This can be determined visually or with a turbidimeter. During the final stages of initial development, water samples will be collected in a transparent or translucent container and visually examined for turbidity (i.e., cloudiness and visual suspended solids). Development is continued until clear, sediment-free formation water is produced.

When the water begins to become clear, the development flow will be temporarily stopped and/or the flow rate will be varied. Sampling and examination for turbidity will continue. When varying the development rate no longer causes the sample to become turbid, the initial development will be deemed complete.

Before obtaining baseline samples from monitor or restoration wells, the well must be further developed to ensure that representative formation water is available for sampling. Final development is performed by pumping the well or swabbing for an adequate period to ensure that stable formation water is present. Monitoring for pH and conductivity is performed during this process to ensure that development activities have been effective. The field parameters must be stable at representative formation values before baseline sampling will begin.

Following well installation, all well development water will be captured in water trucks specifically labeled and dedicated for such purpose, and equipped with signage indicating that these trucks may only discharge their contents to the lined evaporation ponds. Section 3.1.5 (Wellfield and Process Waste) has additional discussions as to process wastewaters generated by the wellfield and satellite facility.

3.1.2.6 Well Integrity Testing

Field-testing of all (i.e., injection, production, and monitor) wells is performed to demonstrate the mechanical integrity of the well casing. This mechanical integrity test is performed using pressure-packer tests. Every well will be tested after well construction is completed before it can be placed in service; after any workover with a drill rig or servicing with equipment or procedures that could damage the well casing; at least once every five years; and whenever there is any question of casing integrity. To assure the accuracy of the integrity tests, periodic comparisons are made between the field pressure gauges and a calibrated test gauge. The mechanical integrity test procedure has been approved by the NDEQ and are currently contained in the SHEQMS Volume III, *Operating Manual*. These same procedures will be used at the TCEA.

The following general mechanical integrity test procedure is used:

- The well is tested after well development and prior to the well being placed into service. The test consists of placement of two packers within the casing. The bottom packer is set just above the well screen and the upper packer is set at the wellhead. The packers are inflated with nitrogen and the casing is pressurized with water to 125 percent of the maximum operating pressure (i.e., 125 psi).

- The well is then "closed in" and the pressure is monitored for a minimum of twenty minutes.
- If more than ten percent of the pressure is lost during this time period, the well has failed the integrity test. When possible, a well that fails the integrity testing will be repaired and the testing repeated. If the casing leakage cannot be repaired or corrected, the well is plugged and reclaimed as described in Section 6.0.

CBR submits all integrity testing records to the NDEQ for review after the initial construction of a mine unit or wellfield. Test results are also maintained on site for regulatory review.

3.1.3 Wellfield Design and Operation

The proposed TCEA Mine Unit map and mine schedule are shown in **Figure 1.7-4** and **Figure 1.7-3**, respectively. The preliminary map and mine schedule are based on current knowledge of the area. As the TCEA is developed, the mine schedule and a mine unit map will be developed further. The TCEA will be subdivided into an appropriate number of mine units. Each mine unit will contain a number of wellhouses where injection and recovery solutions from the satellite facility building are distributed to the individual wells. The injection and production manifold piping from the satellite process facility to the wellfield houses will be either polyvinyl chloride (PVC) or high-density polyethylene (HDPE) with butt welded joints or an equivalent. In the wellfield house, injection pressure will be monitored on the injection trunk lines. Oxidizer will be added to the injection stream and all injection lines off of the injection manifold will be equipped with totalizing flowmeters, which will be monitored in the satellite Control Room. The TCEA wellfields will be designed in a manner consistent with the existing CBR wellfields.

CBR is proposing a restoration schedule of approximately 28 months for the TCEA individual mine units (**Figure 1.7-3**). Based on decommissioning timeline regulations specified in 10 CFR 40.42 (g) (2), the CBR schedule of 28 months, as opposed to the NRC requirement of 24 months for completion of decommissioning, will be considered an alternate restoration schedule. The NRC must approve such an alternate schedule, as per 10 CFR 40.42 (g) (2). CBR will request a formal alternate restoration schedule in the TCEA license application, with timeline deviations requiring a license amendment. Based on recent restoration experience, it is expected that full restoration of a mine unit will take 28 months.

The wellfield injection/production pattern employed is based on a hexagonal seven spot pattern, which is modified as needed to fit the characteristics of the ore body. The standard production cell for the seven spot pattern contains six injection wells surrounding a centrally located recovery well.

The cell dimensions vary depending on the formation and the characteristics of the ore body. The injection wells in a normal pattern are expected to be between 65 feet and 150 feet apart. A typical wellfield layout is shown in **Figure 3.1-4**. The wellfield is a repeated seven spot design, with the spacing between production wells ranging from 65 to 150 feet. Other wellfield designs include alternating single line drives.

All wells are completed so they can be used as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the groundwater in the most efficient manner. During operations, leaching solution enters the formations through the injection wells and flows to the recovery wells. Within each mine unit, more water is produced than injected to create an overall hydraulic cone of depression in the production zone. Under this pressure gradient the natural groundwater movement from the surrounding area is toward the wellfield providing additional control of the leaching solution movement. The difference between the amount of water produced and injected is the wellfield "bleed." The minimum over production or bleed rates will be a nominal 0.5% of the total wellfield production rate and the maximum bleed rate typically approaches 1.5%. Over-production is adjusted as necessary to ensure that the perimeter ore zone monitor wells are influenced by the cone of depression resulting from the wellfield production bleed.

Monitor wells will be placed in the Chadron Formation and in the first significant water-bearing Brule sand above the Chadron Formation. All monitor wells will be completed by one of the three methods discussed above and developed prior to leach solution injection. The development process for monitor wells includes establishing baseline water quality before the initiation of mining operations. The typical locations of monitor wells for the proposed Three Crow mine map are shown in **Figure 3.1-5**. As previously noted, the map is preliminary, based on current knowledge of the area. As the TCEA is developed, the mine unit map will be developed further.

Injection of solutions for mining will be at a rate of 6,000 gpm with a 0.5% to 1.5% production bleed stream. Production solutions returning from the wells to the production manifold will be monitored with a totalizing flowmeter. All pipelines and trunklines will be pressure checked for leaks and buried prior to production operations.

A water balance for the proposed satellite facility is shown on **Figure 3.1-6**. The liquid waste generated at the satellite facility will be primarily the production bleed which, at a maximum scenario, is estimated at 1.5% of the production flow. At 6,000 gpm (4,500 gpm process flow and 1,500 gpm restoration flow) the maximum volume of liquid waste would be approximately 35,500,000 per year. CBR proposes to adequately handle the liquid waste through the combination of deep disposal well injection and evaporation ponds.

Regional information, previous CBR license and permit submittals, and historical operational practices indicate that the minimum pressure that could initiate hydraulic fracture is 0.63 psi per foot of well depth. This value has historically and successfully been applied to CBR operations. Calculations for TCEA result in a value of 0.62 psi. As such, the injection pressure is limited to less than 0.63 psi per foot of well depth. Injection pressures also will be limited to the pressure at which the well was integrity tested.

As discussed in Section 2.7, a regional pumping test has been conducted to assess the hydraulic characteristics of the Basal Chadron Sandstone, and overlying confining units. Pumping tests also will be performed for each mine unit to demonstrate hydraulic containment above the production zone, demonstrate communication between the production zone mining and exterior monitor wells, and to further evaluate the hydrologic properties of the Basal Chadron Sandstone.

A full and detailed analysis of the potential impacts of the mining operations at Three Crow on surrounding water users will be provided in an Industrial Groundwater Use Permit application. A similar permit application was submitted by Ferret Exploration of Nebraska (predecessor to Crow Butte Resources) in 1991, and that application provides a reasonable analogy between the current licensed area and satellite facility. The application states that water levels in the City of Crawford (approximately three miles northwest of the mining area) could potentially be impacted by approximately 20 feet by consumptive withdrawal of water from the Basal Chadron Sandstone during mining and restoration operations (based on a 20-year operational period).

A similar order of magnitude impact (drawdown) exists for the TCEA operations. No impact to other users of groundwater is expected because there is no documented existing use of the Basal Chadron in the proposed TCEA.

Because the Basal Chadron Sandstone (production zone) is a deep confined aquifer, no surface water impacts are expected. Based on the observed groundwater flow directions in the Basal Chadron Sandstone in the TCEA and review of the regional bedrock geology, the recharge zone for the TCEA appears to be located as far as 20 to 30 miles north and northwest of the TCEA license boundary. Based on available information, all water supply wells within the TCEA and AOR are completed in the relatively shallow Brule Formation, with no domestic or agricultural use of groundwater from the Basal Chadron Sandstone.

Further, the geologic and hydrologic data presented in Sections 2.6 and 2.7, respectively, demonstrate that (1) the occurrence of uranium mineralization is limited to the Basal Chadron Sandstone, and (2) the Basal Chadron is isolated from underlying and overlying sands. Hence, the mining operations are expected to impact water quality only in the Basal Chadron Sandstone, and restoration operations will be conducted in the Basal Chadron following completion of mining.

Based on a bleed of 0.5% to 1.5% which has been successfully applied in the current licensed area, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected (**Figure 3.1-6**). Potential impacts on groundwater quality due to consumptive use outside the license area are expected to be negligible.

Table 3.1-1 presents the assumptions used to generally quantify the potential impact of drawdown due to mining and restoration operations.

The data were evaluated using a Theis semi-steady state analytical solution, which includes the following assumptions:

- The aquifer is confined and has apparent infinite extent;
- The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping;
- The piezometric surface is horizontal prior to pumping;
- The well is pumped at a constant rate;
- No recharge to the aquifer occurs;
- The pumping well is fully penetrating; and,
- Well diameter is small, so well storage is negligible.

Based on these assumptions and results from the Three Crow Trend Pumping Test, drawdown after 20 years of operation at 2- and 3-mile radial distances from the centroid of pumping was estimated to be 65 and 55 feet, respectively. This amount of drawdown is approximately 10 percent of the available drawdown in the Basal Chadron Sandstone.

As discussed in Section 5.7 of this application, an extensive water-sampling program will be conducted prior to, during and following mining operations at the satellite facility to identify any potential impacts to water resources of the area.

The groundwater monitoring program is designed to establish baseline water quality prior to mining; detect excursions of lixiviant either horizontally or vertically outside of the production zone; and determine when the production zone aquifer has been adequately restored following mining. The program will include sampling of monitoring wells and private wells within and surrounding the permit area to establish pre-mining baseline water quality. Water quality sampling will be continued throughout the operational phase of mining for detection of excursions. Water quality sampling will also be conducted during restoration, including stabilization monitoring at the end of restoration activities, to determine when baseline or otherwise acceptable water quality has been achieved.

During operation, the primary purpose of the wellfield monitoring program will be to detect and correct conditions that could lead to an excursion of lixiviant or detect such an excursion, should one occur. The techniques employed to achieve this objective include monitoring of production and injection rates and volumes, wellhead pressure, water levels and water quality.

Monitoring of production (extraction) and injection rates and volumes will enable an accurate assessment of water balance for the wellfields. A bleed system will be employed that will result in less leach solution being injected than the total volume of fluids (leach solution and native groundwater) being extracted. A bleed of 0.5% to 1.5% will be maintained during production. Maintenance of the bleed will cause an inflow of groundwater into the production area and prevent loss of leach solution.

Wellhead pressure will be monitored at all injection wells. Pressure gauges will be installed at each injection wellhead or on the injection manifold and monitored at least daily. Wellhead pressure will be restricted to less than 0.63 pounds per square inch (psi) per foot of well depth. Injection rates will be adjusted to maintain wellhead pressure below that level.

Each new production well (extraction and injection) will be pressure tested to confirm the integrity of the casing prior to being used for mining operations. Wells that fail pressure testing will be repaired or abandoned and replaced as necessary.

Water level measurements will be routinely performed in the production zone and overlying aquifer. Sudden changes in water levels within the production zone may indicate that the wellfield flow system is out of balance. Flow rates would be adjusted to correct this situation. Increases in water levels in the overlying aquifer may be an indication of fluid migration from the production zone. Adjustments to well flow rates or complete shutdown of individual wells may be required to correct this situation. Increases in water levels in the overlying aquifer may also be an indication of casing failure in a production, injection or monitor well. Isolation and shut down of individual wells can be used to determine the well causing the water level increases.

To ensure the leach solutions are contained within the designated area of the aquifer being mined, the production zone and overlying aquifer monitor wells will be sampled once every two weeks as discussed in Section 5.7.

Flooding Potential

There is a minimum potential for flooding throughout the TCEA. As shown in **Tables 2.7-1** and **2.7-2**, the average monthly stream flow of the White River at the Crawford gauge station is approximately 20 ft^3/sec. The highest discharge and gauge height on record between 1920 and 2004 occurred on May 10, 1991. On that date, severe thunderstorms resulted in significant rainfall, the gauge height was 16.32 feet and the stream flow exceeded 13,300 ft^3/sec. Several city facilities were damaged by floodwaters and hail, including the local golf course and fishery, and the event was considered a "100 year" flood. However, it is noted that, while there are certainly historical extremes, the average gauge height on the While River at Crawford is less than 5 feet, with an average annual stream flow of 20.2 ft^3/sec.

An assessment of the potential for flooding or erosion that could impact the in-situ mining processing facilities and surface impoundments has been performed based on data from the Federal Emergency Management Agency (FEMA 2010). FEMA has not mapped unincorporated Dawes County south of Crawford, Nebraska; however, FEMA maps are available for the City of Crawford, and an analogy can be drawn between the flooding potential in Crawford and that southeast of Crawford adjacent to the proposed TCEA. As shown in **Figure 2.7-4**, FEMA has classified the portion of Crawford between the D M & E Railroad (immediately west of First Street) as Zone A (i.e., an area that could be impacted by a 100-year flood) (FEMA 1995). The elevations of the White River in the Zone A classification ranges from 3,669 to 3,659 feet amsl. The surface elevation of the railroad tracks ranges from 3,678 to 3,671 feet amsl. These data suggest that significant flooding potential exists with a rise in the White River elevation of 9 to 12 feet above base flow conditions. This is consistent with the data from the 1991 100-year flood event, where the river elevation was approximately 11.3 feet above base gauge height (approximately 5 feet).

The proposed TCEA surface facilities are to be located in the north-west portion of Section 30. T31N R52W, approximately 0.72 miles south of the White River, and approximately 139 feet topographically above the common river elevation. Proposed wellfields are planned for portions of Sections 28, 29, 30 and 33 of T31N R52W, and Section 25 of T31N R53W (**Figure 1.7-4**). All of the wellfields are projected to be at least 116.6 feet above the White River elevation (**Table 2.7-6**).

There is no portion of the proposed TCEA with the reasonable potential of flooding due to flooding of the White River. Elevations of different points of the proposed TCEA license boundary and centerpoint of the assets (i.e., wellfields, satellite facility main building and evaporation ponds) indicate that elevations at these locations in relation to the nearest point on the White River range from 116.6 to 219.1 feet higher than the river (**Table 2.7-6**).

Based on these data, the Three Crow surface facilities occur outside of the 100 year-flood plain, and are not considered to be in a "flood prone" area. Therefore, consistent with NUREG-1623, erosion modeling was not considered necessary or performed.

3.1.4 Process Description

Uranium solution mining is a process that takes place underground, or in-situ, by injecting lixiviant (leach) solutions into the ore body and then recovering these solutions when they are rich in uranium. The chemistry of solution mining involves an oxidation step to convert the uranium in the solid state to a form that is easily dissolved by the leach solution. Hydrogen peroxide (H_2O_2) or gaseous oxygen (O_2) is typically used as the oxidant because both revert to naturally occurring substances. Carbonate species are also added to the lixiviant solution in the injection stream to promote the dissolution of uranium as a uranyl carbonate complex.

The reactions representing these steps at a neutral or slightly alkaline pH are:

Oxidation: $UO_{2\,(solid)} + H_2O_{2\,(in\ solution)} \longrightarrow UO_{3\,(at\ solid\ surface)} + H_2O$

$UO_{2\,(solid)} + \frac{1}{2}\,O_{2\,(in\ solution)} \longrightarrow UO_{3\,(at\ solid\ surface)}$

Dissolution: $UO_3 + 2\,HCO_3^{-1} \longrightarrow UO_2(CO_3)_2^{-2} + H_2O$

$UO_3 + CO_3^{-2} + 2HCO_3^{-1} \longrightarrow UO_2(CO_3)_3^{-4} + H_2O$

The principal uranyl carbonate ions formed as shown above are uranyl dicarbonate, $UO_2(CO_3)_2^{-2}$, (UDC), and uranyl tricarbonate $UO_2(CO_3)_3^{-4}$, (UTC). The relative abundance of each is a function of pH and total carbonate strength.

Solutions resulting from the leaching of uranium underground will be recovered through the production wells and piped to the satellite facility for extraction. The uranium recovery process utilizes the following steps:

1. Loading of uranium complexes onto an IX resin;
2. Reconstitution of the leach solution by addition of carbon dioxide and/or sodium bicarbonate and an oxidizer;
3. Elution of uranium complexes from the resin; and,
4. Precipitation of uranium.

The first two steps will be performed at the satellite facility. Steps 3 and 4 will be performed at the CPF. The process flow sheet for the above steps is shown in **Figure 3.1-7**. The left side of **Figure 3.1-7** depicts the uranium extraction process that is completed at the satellite facility. The right side of the figure shows the uranium recovery steps that will be performed at the CPF. Once the IX resin at the satellite facility is loaded to capacity with uranium complexes, the resin will be transferred to the CPF for the completion of uranium recovery.

3.1.4.1 Uranium Extraction

The recovery of uranium from the leach solution in the satellite facility will take place in the IX columns. The uranium-bearing leach solution enters the pressurized downflow IX column and passes through the resin bed. The uranium complexes in solution are loaded onto the IX resin in the column. This loading process is represented by the following chemical reaction:

$$2\,R\,HCO_3 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + 2HCO_3^{-1}$$

$$2\,RCl + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + 2Cl^-$$

$$R_2SO_4 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + SO_4^{-2}$$

As shown in the reaction, loading of the uranium complex results in simultaneous displacement of chloride, bicarbonate or sulfate ions.

The now barren leach solution passes from the IX columns to be reinjected into the formation. The solution is refortified with sodium and carbonate chemicals, as required, and pumped to the wellfield for reinjection into the formation. The expected lixiviant concentration and composition is shown in **Table 3.1-2.**

3.1.4.2 Resin Transport and Elution

Once the majority of the IX sites on the resin in an IX column are filled with uranium, the column will be taken out of service. The resin loaded with uranium will be transferred to a tanker truck for transport to the CPF for elution and final processing. Once the resin has been stripped of the uranium by the process of elution, the resin will be returned to the satellite facility for reuse in the IX circuit.

At the CPF, the loaded resin that has been transported from the satellite facility will be stripped of uranium by an elution process based on the following chemical reaction:

$$R_2UO_2(CO_3)_2 + 2Cl^- + CO_3^{-2} \longrightarrow 2\,RCl + UO_2(CO_3)_2^{-2}$$

After the uranium has been stripped from the resin, the resin is rinsed with a solution containing sodium bicarbonate. This rinse removes the high chloride eluent physically entrained in the resin and partially converts the resin to bicarbonate form. In this way, chloride ion buildup in the leach solution can be controlled.

3.1.4.3 Precipitation

When a sufficient volume of pregnant eluent is held in storage, it is acidified to destroy the uranyl carbonate complex ion. The solution is agitated to assist in removal of the resulting CO2. The decarbonization can be represented as follows:

$$UO_2(CO_3)_3^{-4} + 6H^+ \longrightarrow UO_2^{++} + 3\,CO_2\uparrow + 3H_2O$$

Sodium hydroxide (NaOH) is then added to raise the pH to a level conducive for precipitating pure crystals.

Hydrogen peroxide is then added to the solution to precipitate the uranium according to the following reaction:

$$UO_2^{++} + H_2O_2 + 2H_2O \longrightarrow UO_4 \bullet 2H_2O + 2H^+$$

The precipitated uranyl peroxide slurry is pH adjusted, allowed to settle, and the clear solution decanted. The decant solution is recirculated back to the barren makeup tank, sent to fresh salt brine makeup, or sent to waste. The thickened uranyl peroxide is further dewatered and washed. The solids discharge is either sent to the vacuum dryer for drying before shipping or is sent to storage for shipment as slurry to a licensed recovery or converting facility.

3.1.5 Wellfield and Process Wastes

All well development water will be captured in water trucks specifically labeled and dedicated for such purpose, and equipped with signage indicating that these trucks may only discharge their contents to the lined evaporation ponds.

The operation of the satellite facility will result in one source of liquid waste being generated at the satellite facility and an increase in the liquid waste at the CPF. A production bleed stream is continuously withdrawn from the recovered lixiviant stream at a rate that is expected to be 0.5 to 1.5 percent of the total volume of recovered lixiviant. The production bleed stream is taken following the recovery of uranium by IX and has the same chemical characteristics as the lixiviant. The production bleed waste stream will be managed by a combination of evaporation pond and deep disposal well injection, both of which will be constructed at the satellite facility.

The other source of wastewater resulting from uranium mining activities in the TCEA is the eluent bleed stream at the CPF. This is an existing source of wastewater at the CPF that is currently produced at a rate of approximately 5 to 10 gpm. It is likely that the eluent bleed stream will increase by a maximum of 10 percent due to processing of IX resin from the satellite facility. The eluent bleed waste stream will be managed by reuse in the processing facility or disposal in existing ponds and/or by deep disposal well injection at the CPF.

All byproduct material produced as a result of the operation of the satellite facility will be disposed of at a licensed facility approved for disposal of 11e.(2) byproduct material, similar to provisions made for the byproduct material currently produced. All solid waste will be disposed of in an approved landfill in accordance with current practice. There will be no on-site disposal of these materials.

3.2 Central Processing Facility, Satellite Facility, Wellfields, and Chemical Storage Facilities – Equipment Used and Material Processed

The uranium recovery process described in the preceding section will be accomplished in two steps. The uranium recovery from the leach solution by IX will be performed at the satellite facility. The subsequent processing of the loaded IX resin to remove the uranium (elution), the precipitation of uranium, and the dewatering and packaging of solid uranium (yellowcake) will be performed at the existing CPF. The capacity for resin handling and cleaning, elution, precipitation, dewatering and washing, and drying in the CPF will be increased appropriately to handle the processing of material from the TCEA in addition to the material that will continue to be produced in the current license area. Depending upon the mining schedules for the existing wellfield and the TCEA, it is possible that the belt filter and dryer capacity may be increased.

3.2.1 Three Crow Satellite Facility Equipment

Only the equipment proposed for the satellite facility is described in this section. The equipment and processes in the CPF are covered under the existing NRC Source Materials License Number SUA-1534. A general arrangement for the satellite facility is shown on **Figure 3.2-1**. The satellite facility equipment will be housed in a building approximately 130 feet long by 100 feet wide. The satellite facility equipment includes the following systems:

- Ion exchange;
- Filtration;
- Resin transfer; and,
- Chemical addition.

The satellite facility will be located within a 1.8 acre fenced area in Section 30, T31N, R52W. The evaporation pond will located a short distance away from the satellite facilities within an 11.6 acre fenced area. **Figure 3.2-2** shows the plan view of these facilities.

The satellite facility will house the IX columns, water treatment equipment, resin transfer facilities, pumps for injection of lixiviant, a small laboratory and an employee break room. Bulk soda ash and carbon dioxide and oxygen in compressed form and/or hydrogen peroxide will be stored adjacent to the satellite facility or in the wellfield. Sodium bicarbonate and/or gaseous carbon dioxide are added to the lixiviant as the fluid leaves the satellite facility for the wellfields. Gaseous oxygen is added to the injection line for each injection well at the wellhouses.

The IX system consists of eight fixed-bed IX columns. The IX columns will be operated as three sets of two columns in series with two columns available for restoration. The IX system is designed to process recovered leach solution at a rate of 6,000 gpm with each column sized at 11.5 foot diameter by 21 foot overall height with 500 cubic feet of resin operated downflow. Once a set of columns is loaded with uranium, the resin is transferred to a truck for transport to the CPF at the Crow Butte facility. The downflow columns are pressurized, sealed systems so there is no overflow of water, oxygen stays in solution and radon emissions are contained. Radon releases from the pressurized downflow columns occur only when the individual columns are disconnected from the circuit and opened to remove the resin for elution. One disadvantage of the downflow column is that there must be good pressure control. Exposure pathways associated with downflow columns to be used at TCEA are discussed in Section 7.3.1.

After the IX process, the barren leach solution recovered from the wellfield is replenished with an oxidant and leaching chemicals (i.e., sodium bicarbonate and/or carbon dioxide). The injection filtration system consists of optional backwashable filters, with an option of installing polishing filters downstream. The lixiviant injection pumps are centrifugal type.

A discussion of the areas in the proposed satellite facility where fumes or gases could be generated can be found in Section 7.3. The potential sources are minimal in the satellite facility since the mining solutions contained in the process equipment are maintained under a positive pressure. Building ventilation in the process equipment area will be accomplished by the use of an exhaust system that draws in fresh air and sweeps the satellite facility air to the atmosphere.

3.2.2 Chemical Storage Facilities

Chemical storage facilities at the satellite facility will include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, will be stored outside and segregated from areas where licensed materials are processed and stored (**Figure 3.2-1**). Other non-hazardous bulk process chemicals (e.g., sodium carbonate) that do not have the potential to impact radiological safety may be stored within the satellite facilities.

3.2.2.1 Process Related Chemicals

Process-related chemicals stored in bulk at the satellite facility will include carbon dioxide, oxygen, and or hydrogen peroxide. Sodium sulfide may also be stored for use as a reductant during groundwater restoration.

- Carbon Dioxide

Carbon dioxide is stored adjacent to the satellite facility where it will be added to the lixiviant prior to leaving the satellite facility.

- Oxygen

Oxygen is also typically stored at the satellite facility, or within wellfield areas, where it is centrally located for addition to the injection stream in each wellhouse. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility will be located a safe distance from the satellite facility and other chemical storage areas for isolation. The storage facility will be designed to meet industry standards in NFPA-50 (FPNA 1996).

Oxygen service pipelines and components must be clean of oil and grease since gaseous oxygen will cause these substances to burn with explosive violence if ignited. All components intended for use with the oxygen distribution system will be properly cleaned using recommended methods in CGA G-4.1 (CGA 2000). The design and installation of oxygen distribution systems is based on CGA-4.4 (CGA 1993).

The design location of the carbon dioxide and oxygen storage tanks are shown on **Figure 3.2-1.**

- Sodium Sulfide

Hazardous materials typically used during ground water restoration activities include the addition of a chemical reductant (i.e., sodium sulfide or hydrogen sulfide gas). To minimize potential impacts to radiological safety, these materials are stored outside of process areas. Sodium sulfide is currently used as the chemical reductant during groundwater restoration at the current license area. The material consists of a dry flaked product and is typically purchased on pallets of 55-pound bags or super sacks of 1,000 pounds. The bulk inventory is stored outside of process areas in a cool, dry, clean environment to prevent contact with any acid, oxidizer, or other material that may react with the product. Hydrogen sulfide gas has never been used at the CPF. In the event that CBR determines that use of hydrogen sulfide as a chemical reductant is necessary, proper safety precautions will be taken to minimize potential impacts to radiological and chemical safety.

As part of the SHEQMS, a risk assessment was completed to recognize potential hazards and risks associated with chemical storage facilities (and other processes) and to mitigate those risks to acceptable levels. The risk assessment process identified hydrochloric acid as the most hazardous chemical with the greatest potential for impacts to chemical and radiological safety. The hydrochloric acid storage and distribution system is located only at the CPF and will not be used at the satellite facility.

None of the hazardous chemicals used at the CPF are covered under the EPA Risk Management Program (RMP) regulations. The RMP regulations require certain actions by covered facilities to prevent accidental releases of hazardous chemicals and minimize potential impacts to the public and environment. These actions include measures such as accidental release modeling, documentation of safety information, hazard reviews, operating procedures, safety training, and emergency response preparedness.

3.2.2.2 Non-Process Related Chemicals

Non-process related chemicals that will be stored at the satellite facility include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of process areas at the satellite facility. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet EPA and Occupational Safety and Health Admistration (OSHA) requirements.

3.3 Instrumentation and Control

The wellfield houses will be located remotely from the satellite facility building. A distribution system will be used to control the flow to and from each well in the wellfield. Wellfield instrumentation will measure total production and injection flow and indicate the pressure that is being applied to the injection trunklines. Wellfield houses will be equipped with wet alarms to monitor the presence of liquids in the wellfield house sumps.

Instrumentation will monitor the total flow into the satellite facility, the total injection flow leaving the facility, and the total waste flow leaving the facility. Instrumentation on the facility injection manifold will record an alarm in the event of any pressure loss that might indicate a leak or rupture in the injection system. The instruments used for flow measurement will include, but are not limited to, turbine meters, ultrasonic meters, variable area meters, electromagnetic flow meters, differential pressure meters, positive displacement meters, piezoelectric and vortex flow meters. The injection pumps will be sized or equipped so that they are incapable of producing pressures high enough to exceed design pressure of the injection lines or the maximum pressure to be applied to the injection wells. Pressure gauges, pressure shutdown switches and pressure transducers will be used to monitor and control the trunkline pressures.

The basic control system at the satellite facility and associated wellfields will be built around a Sequential Control and Data Acquisition (SCDA) network. At the heart of this network is a series of programmable logic controllers. This system allows for extensive monitoring and control of all waste flows, wellfield flows, and facility recovery operations.

The SCDA system will be interconnected throughout the facility via a Local Area Network (LAN) to computer display screens. The software used to display facility processes and collect data incorporates a series of menus which allows the facility operators to monitor and control a variety of systems and parameters. Critical processes, pressures, and wellfield flows will have alarmed set-points that alert operators when any are out of tolerance. In addition, each wellfield house will contain its own processor, which will allow it to operate independent of the main computer. Pressure switches will be fitted to each injection manifold in the Header House to alert the facility and wellfield operators of increasing manifold pressures. All critical equipment will be equipped with uninterruptible power supply systems in the event of a power failure.

Through this system, not only will the facility operators be able to monitor and control every aspect of the operation on a real-time basis, but management will be able to review historical data to develop trend analysis for production operations. This will not only ensure an efficient operation, but will allow Crow Butte personnel to anticipate problem areas and to remain in compliance with appropriate regulatory requirements.

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks.

Detailed information on the instrumentation and controls will be developed as part of the final design activities prior to construction. This information will be made available to the NRC for review prior to any construction activities.

Handheld radiation detection instruments and portable samplers will be used to monitor radiological conditions at the satellite facility. Specifications for this equipment are included in the SHEQMS Volume IV, *Health Physics Manual,* and are discussed in further detail in Section 5. The location of monitoring points, monitoring procedures, and monitoring frequencies for in-plant radiation safety is also discussed in Section 5.

The types of health physics instrumentation that would be used at the proposed TCEA include the following:

Air Sampling Equipment

- Eberline RAS-1 or Aircon 2 samplers (0-100 lpm) or equivalent

  Calibrated semiannually or after repair-on site with a primary standard instrument or a properly calibrated secondary standard instrument

- BDX II or SKC lapel samplers (0-5 lpm) or equivalent

Calibrated daily before each use-on site with a primary standard instrument or a properly calibrated secondary standard instrument

External Radiation Equipment

- Ludlum Model 19 Gamma Meter (μR/hr) or equivalent

- Ludlum Model 3 Gamma Meter with Ludlum Model 44-38 G-M detector (mR/hr) or equivalent

- Ludlum Model 2221 Ratemeter/Scaler with a Ludlum Model 44-10 NaI detector (cpm) or equivalent

Calibrated annually or after repair-manufacturer or qualified accredited vendor

Surface Contamination Equipment

- Ludlum Model 2241 scaler or a Ludlum Model 12 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe or equivalent (Total Alpha)

- Ludlum Model 177 Ratemeter with a Ludlum Model 43-5 alpha scintillation probe or equivalent (Personnel Contamination)

- Ludlum Model 2000 Scaler or Model 2200 Scaler with an Eberline SAC-R5 or Ludlum Model 43-10 alpha scintillation sample counter or equivalent (Removable Alpha, Radon Daughters, Airborne Radioactivity)

Instruments will be calibrated annually or at a frequency recommended by the manufacturer, whichever is more frequent. Repairs will be by the manufacturer by or by a qualified accredited vendor, and the instrument will be calibrated following such repair. The calibration vendor shall provide the as-found calibration condition of each instrument. If greater than 10% of the instruments are out of calibration when received by the calibration vendor, consideration would be given to increasing the calibration frequency.

New radiation survey instruments will be acquired for use at the TCEA. The number of instruments purchased will be sufficient so that backup instruments are available in the event of failure of one, or if one instrument has been sent to the vendor for calibration or repair.

The manufacturer or a qualified accredited vendor shall calibrate portable survey instruments, counter/scalers, mass flow meters and/or dry cell calibrators, and calibration sources. Calibration will be performed as recommended in ANSI N323 and ANSI N323A. The ANSI standard requires that radiation detection instruments are performance tested on an annual basis to verify that they continue to meet operational and design requirements. Instruments must be tested for range, sensitivity, linearity, detection limit, and response to overload. The specific calibration requirements for various types of instruments are discussed in the SHEQMS Volume IV *Health Physics Manual.*

Reg. Guide 8.30 specifies requirements for routine maintenance and calibration of radiological survey instruments. Reg. Guide 8.30 references the standards contained in ANSI N323-1978, *Radiation Protection Instrumentation Test and Calibration.* ANSI is in the process of a major revision of this Standard that will result in three separate Standards that apply to radiological instrumentation. The first revision, ANSI-N323A-1997, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*, was incorporated in this Chapter. When conflicts arise between NRC Reg. Guide 8.30 and the ANSI Standard, the Reg. Guide recommendations will be followed.

Calibration vendors will provide a certificate of calibration for all instruments. These calibration certificates will be maintained by the Radiation Safety Officer (RSO) on file for that instrument. Records of repair completed by the calibration vendor will also be maintained in the instrument file.

Documentation of calibration of air samplers performed on site will be maintained. This documentation will be maintained by the RSO in the sampler file.

Record of instrument checks including the daily checks and initial checks will be maintained in a format determined by the RSO. These records will be readily available and in a format that will allow the RSO to review the records for the types of potential problems (e.g., background drift in a continuous direction, battery check that does not respond, ratemeter that does not zero and alpha background rates greater than 0.5 cpm).

All records of instrument calibration and checks will be retained until NRC License termination. The RSO will be responsible for record retention.

Details as to calibration, functional tests, procedures and recordkeeping/retention are discussed in the SHEQMS Volume IV *Health Physics Manual.*

3.4 References

National Fire Protection Association (NFPA). NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites*, (NFPA, 1996).

Compressed Gas Association. (CGA). CGA G-4.1, *Cleaning Equipment for Oxygen Service*, (CGA, 2000).

Compressed Gas Association. (CGA). CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*, (CGA, 1993).

Table 3.1-1 Assumptions Used for Quantification of Drawdown Impact due to Mining and Restoration

Activity	Assumption*
Mining/restoration	8 Years
Average net consumption use	50 gpm
Location of pumping centroid	Center of Section T31N R52W 30 (Mine Unit TC-3)
Radius of Influence	Greater than 4,600 feet**
Formation transmissivity	477 square feet /day
Formation thickness	64 feet
Formation hydraulic conductivity	7.5 feet/day
Formation storativity	8.8E-04

*Average values for pumping test.

**Based on drawdown response of 1.2 feet at distant monitor well COW 2006-1; suggests Radius of Influence (ROI) of greater than 4,600 feet.

Table 3.1-2 Typical Lixiviant Concentrations

SPECIES	RANGE	
	LOW	HIGH
Na	• 400	6000
Ca	• 20	500
Mg	• 3	100
K	• 15	300
CO_3	• 0.5	2500
HCO_3	• 400	5000
Cl	• 200	5000
SO_4	• 400	5000
U_3O_8	• 0.01	500
V_2O_5	• 0.01	100
TDS	• 1650	12000
pH	• 6.5	10.5

Note: All values in mg/l except for pH (standard units).
The above values represent the concentration ranges that could be found in barren lixiviant or pregnant lixiviant and would include the concentration normally found in "injection fluid".

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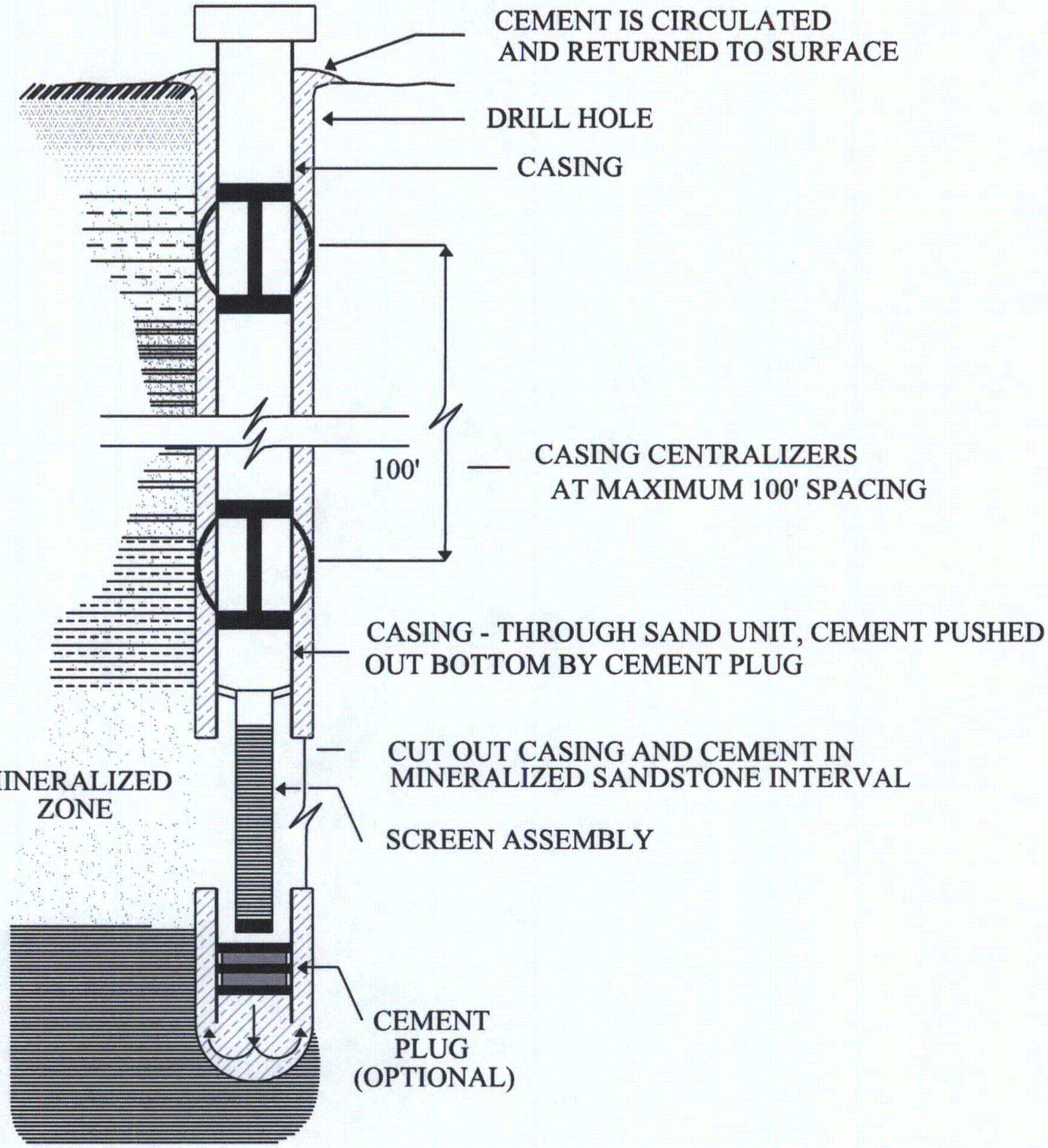

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-1

TYPICAL MINERALIZED ZONE COMPLETION FOR INJECTION/PRODUCTION WELLS

METHOD NO.1

PROJECT: CO001396.02	MAPPED BY: JC	CHECKED BY: JEC

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

PATH: K:\CBR\CO001396_ThreeCrow\1_ACAD\ARCADIS_NewDrawings\WellCompletionMethods.dwg LAYOUT: TechRpt_No1 TIME: 2/2/2010 2:24 PM

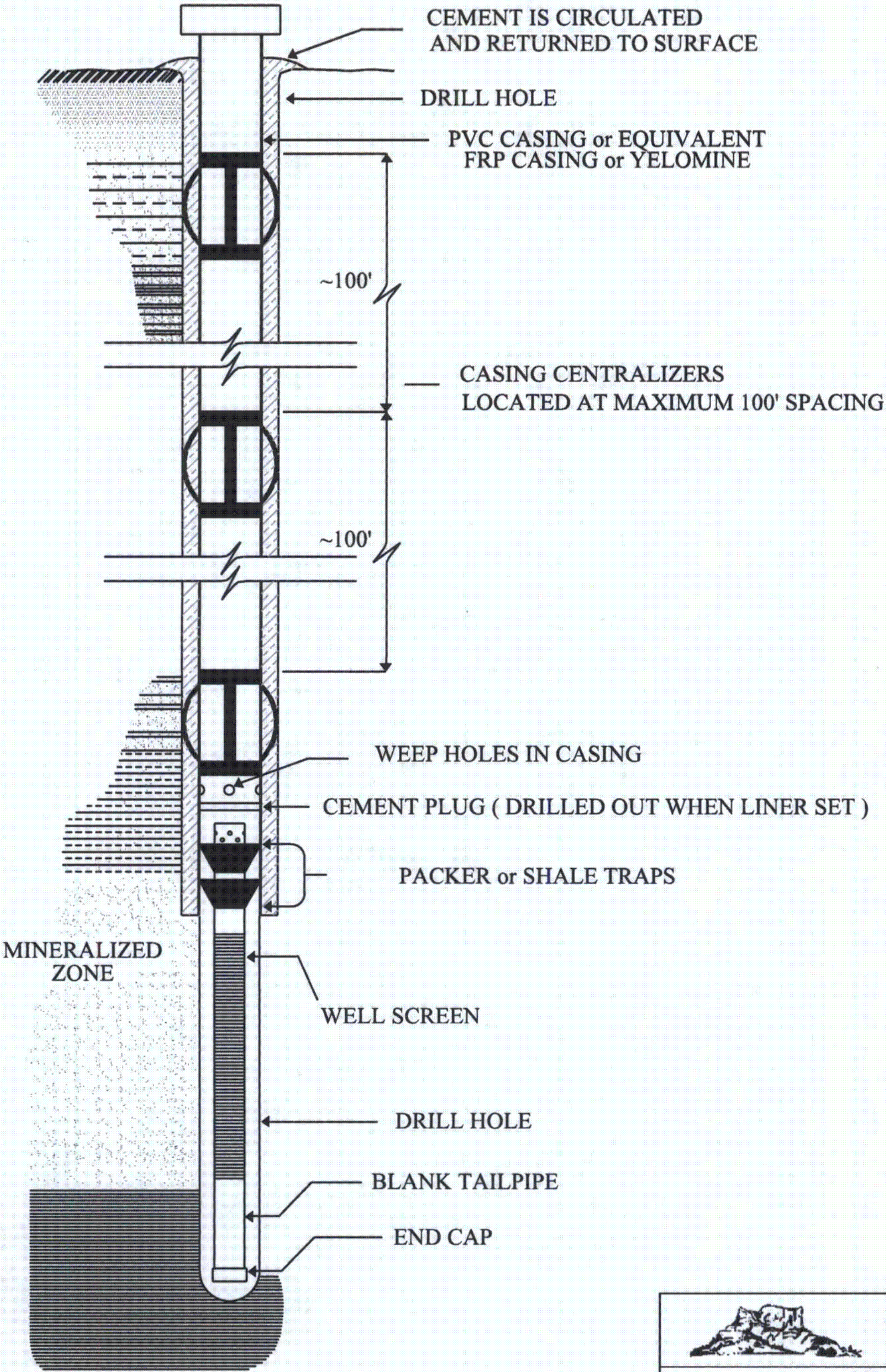

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FIGURE 3.1-2
TYPICAL LINER COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS
METHOD NO.2

PROJECT: CO001396.02 | MAPPED BY: JC | CHECKED BY: JEC

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
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PATH: K:\CBR_ \CO001396_ThreeCrow\1_ACAD\ARCADIS_NewDrawings\WellCompletionMethods.dwg LAYOUT: TechRpt_No2 TIME: 2/2/2010 2:24 PM

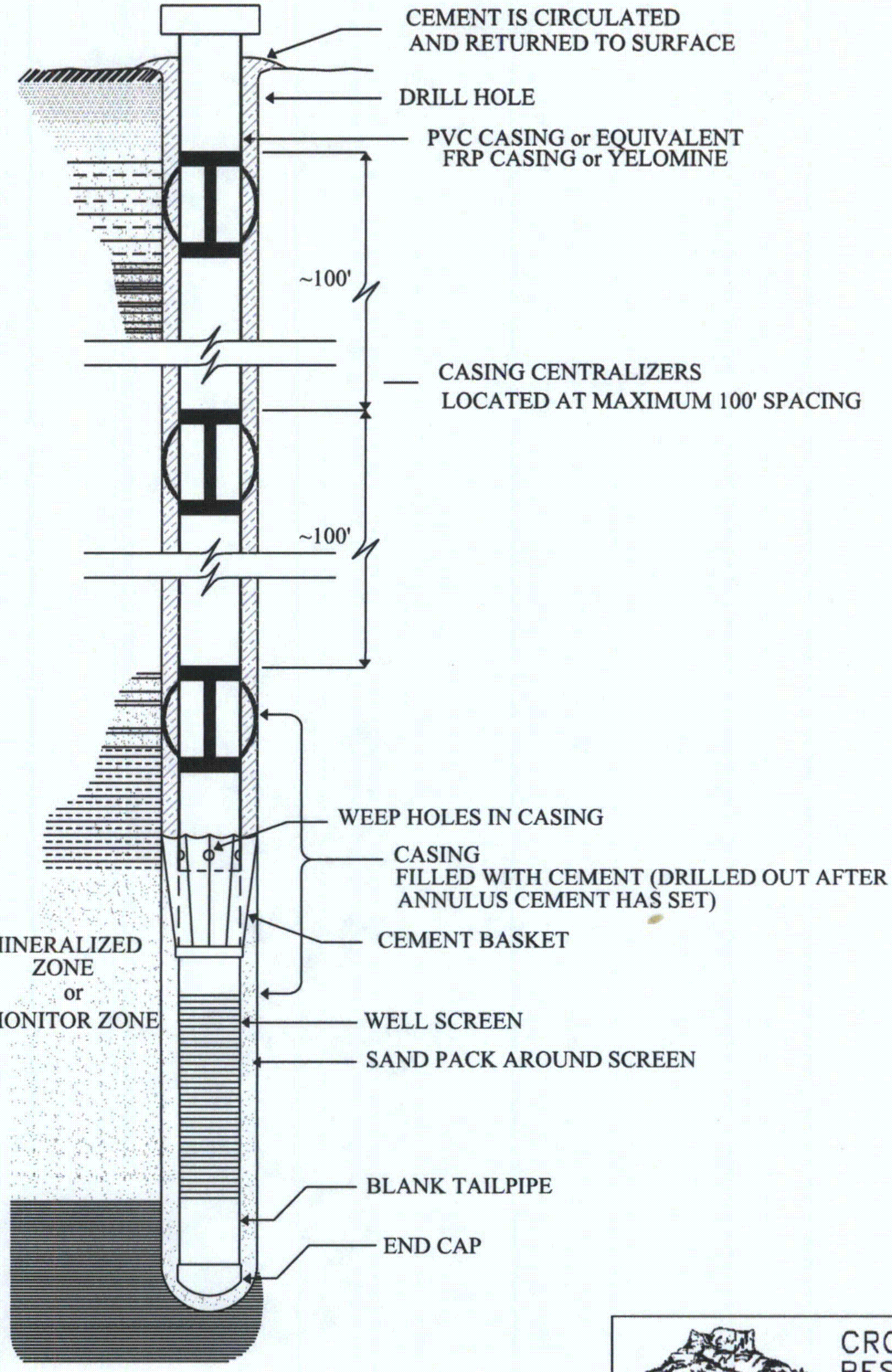

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FIGURE 3.1-3

TYPICAL CEMENT BASKET COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS

METHOD NO.3

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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

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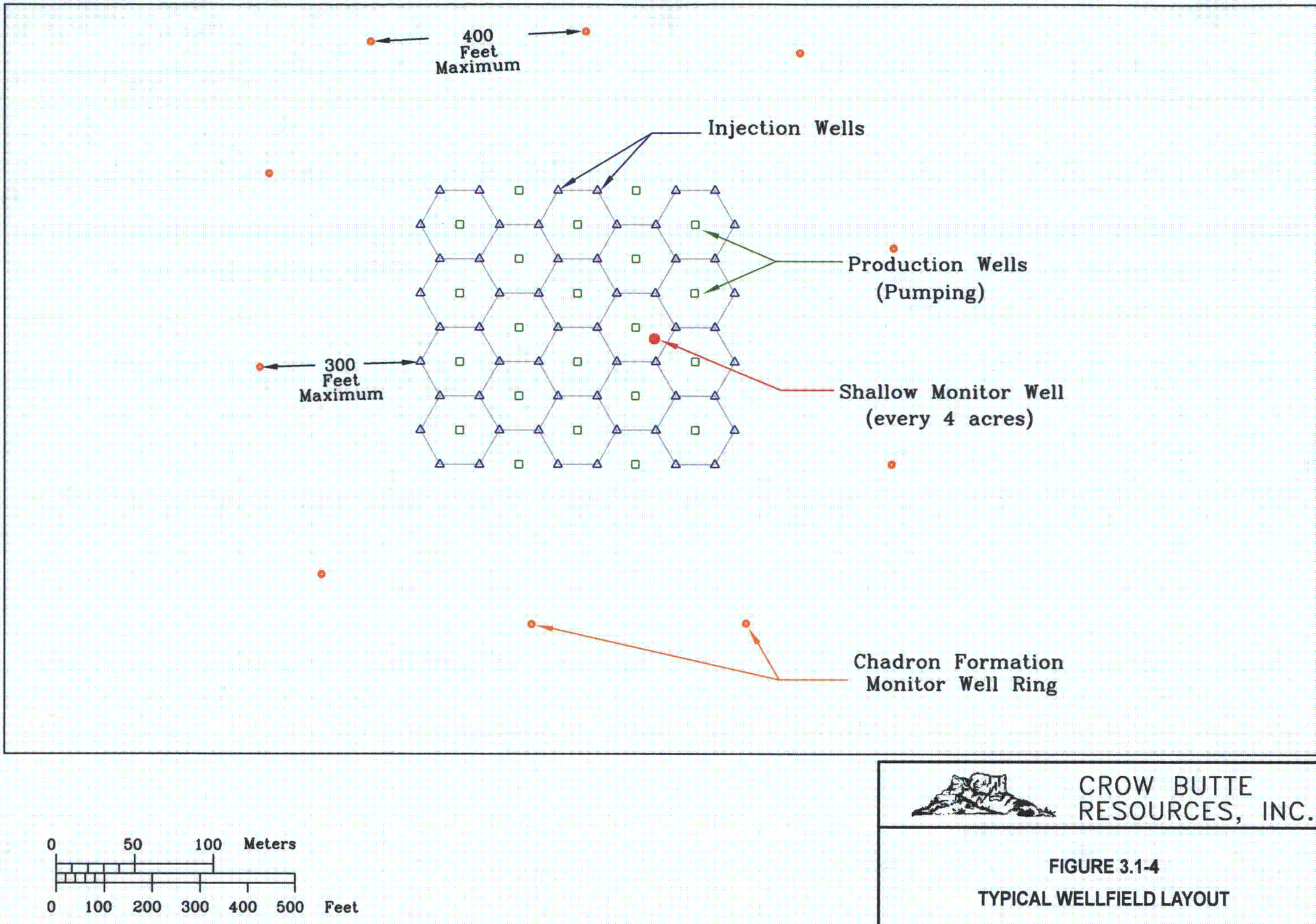

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FIGURE 3.1-4

TYPICAL WELLFIELD LAYOUT

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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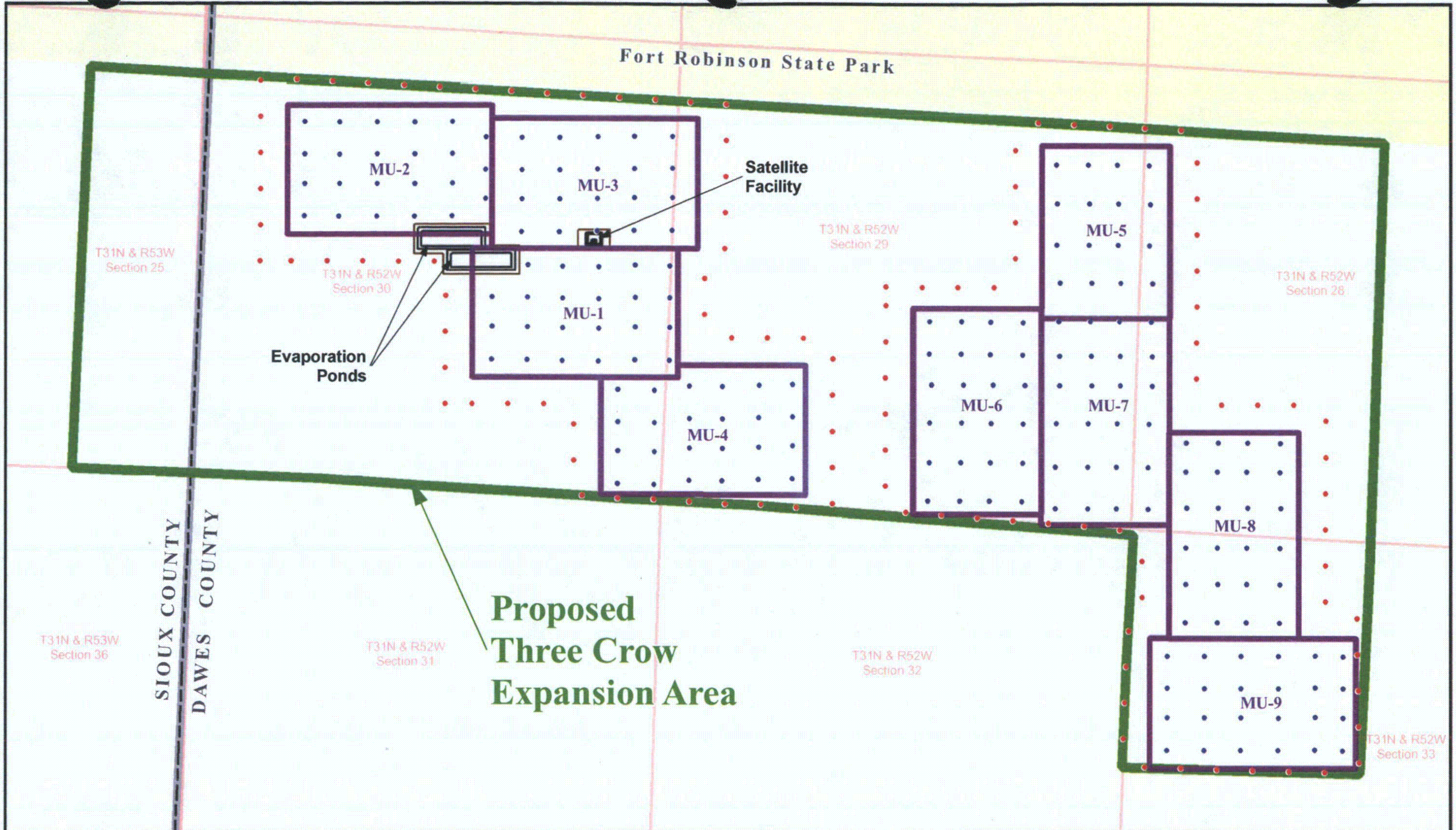
www.arcadis-us.com

K:\CBR_Projects\CO001396_ThreeCrow\3_IMAGES\Illustrator\TR_Fig_3_1-6 Typical Wellfield Layout.ai @ 02/02/2010



LEGEND

- Commercial Monitor Well
- Shallow Monitor Well
- Security Fence
- Satellite Facility
- Evaporation Ponds
- Proposed Three Crow Expansion Area
- Mine Unit Boundary
- Fort Robinson State Park

0 1,000 2,000
Scale in Feet

PROJECTION: NAD_1927_STATE_PLANE_NEBRASKA_NORTH_FIPS_2601

N W E

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FIGURE 3.1-5
THREE CROW MONITOR WELL LAYOUT

PROJECT: CO001396.00002 MAPPED BY: JC CHECKED BY: JEC

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Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
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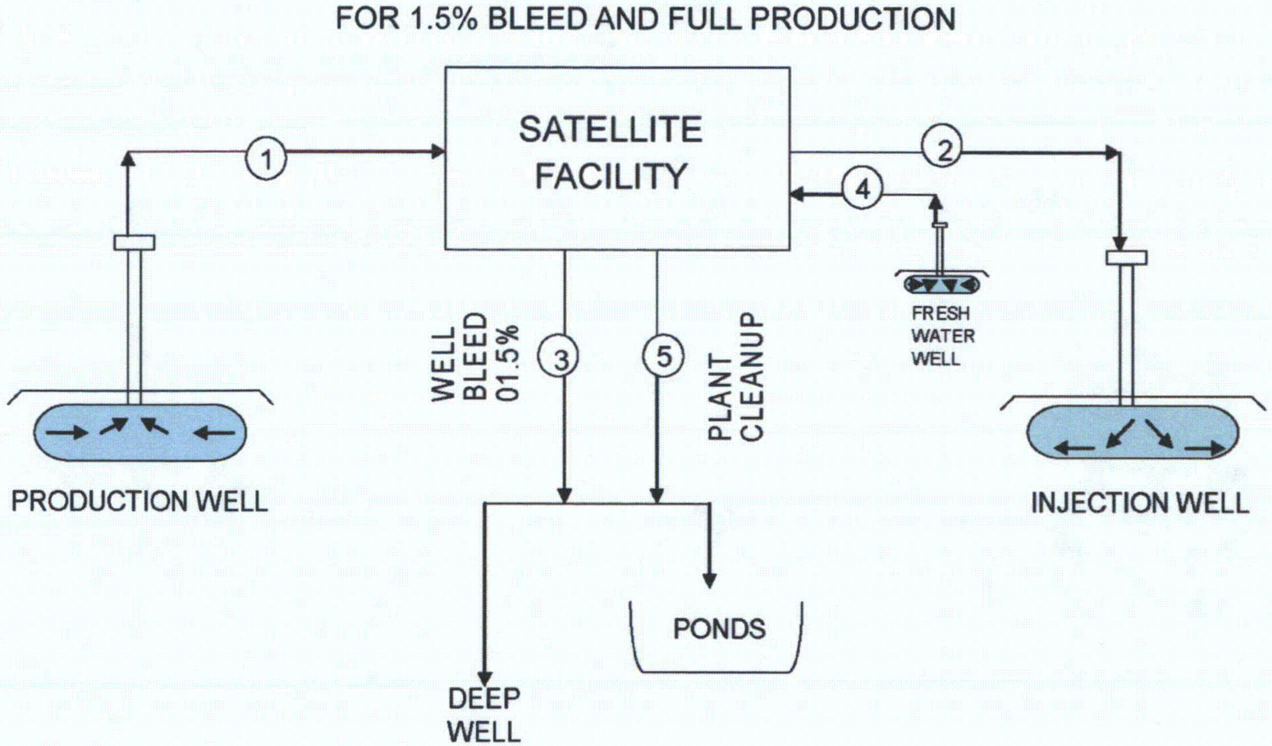

STREAM #	1	2	3	4	5
SOLUTION GPM*	6,000	5,910	90	2	2

*BALANCE IS NOMINAL FOR A 1.5% BLEED. ACTUAL BALANCE MAY VARY ACCORDINGLY.

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-6

THREE CROW WATER BALANCES

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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P: 720-344-3500 F: 720-344-3535
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K:\CBR_Projects\CO001396_ThreeCrow\3_IMAGES\Illustrator\TR_Fig_3_1-8 Three Crow Water Balances.ai @ 02/02/2010

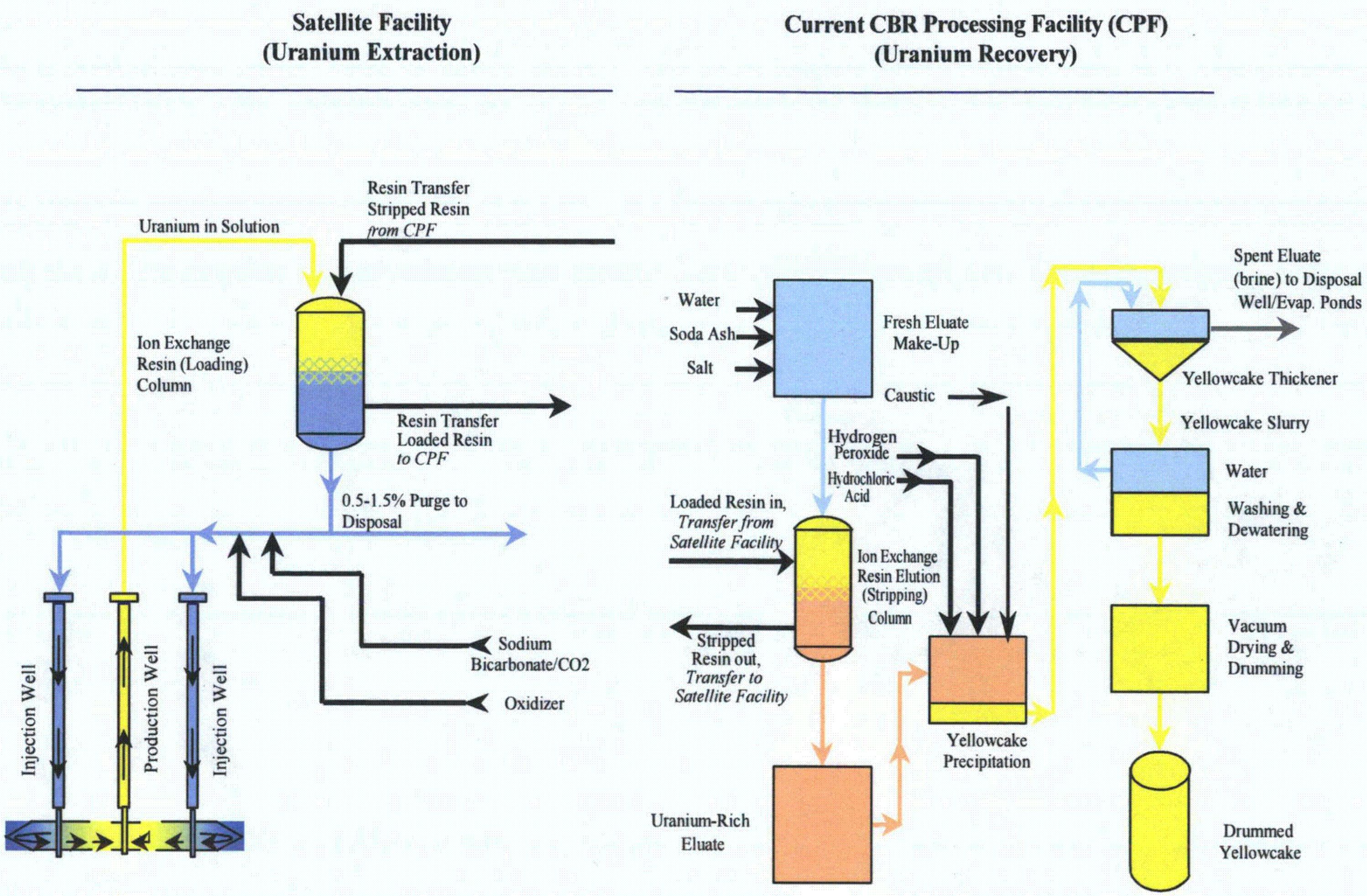

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FIGURE 3.1-7
THREE CROW SATELLITE FACILITY AND CURRENT CBR PROCESSING FACILITY PROCESS FLOW DIAGRAM

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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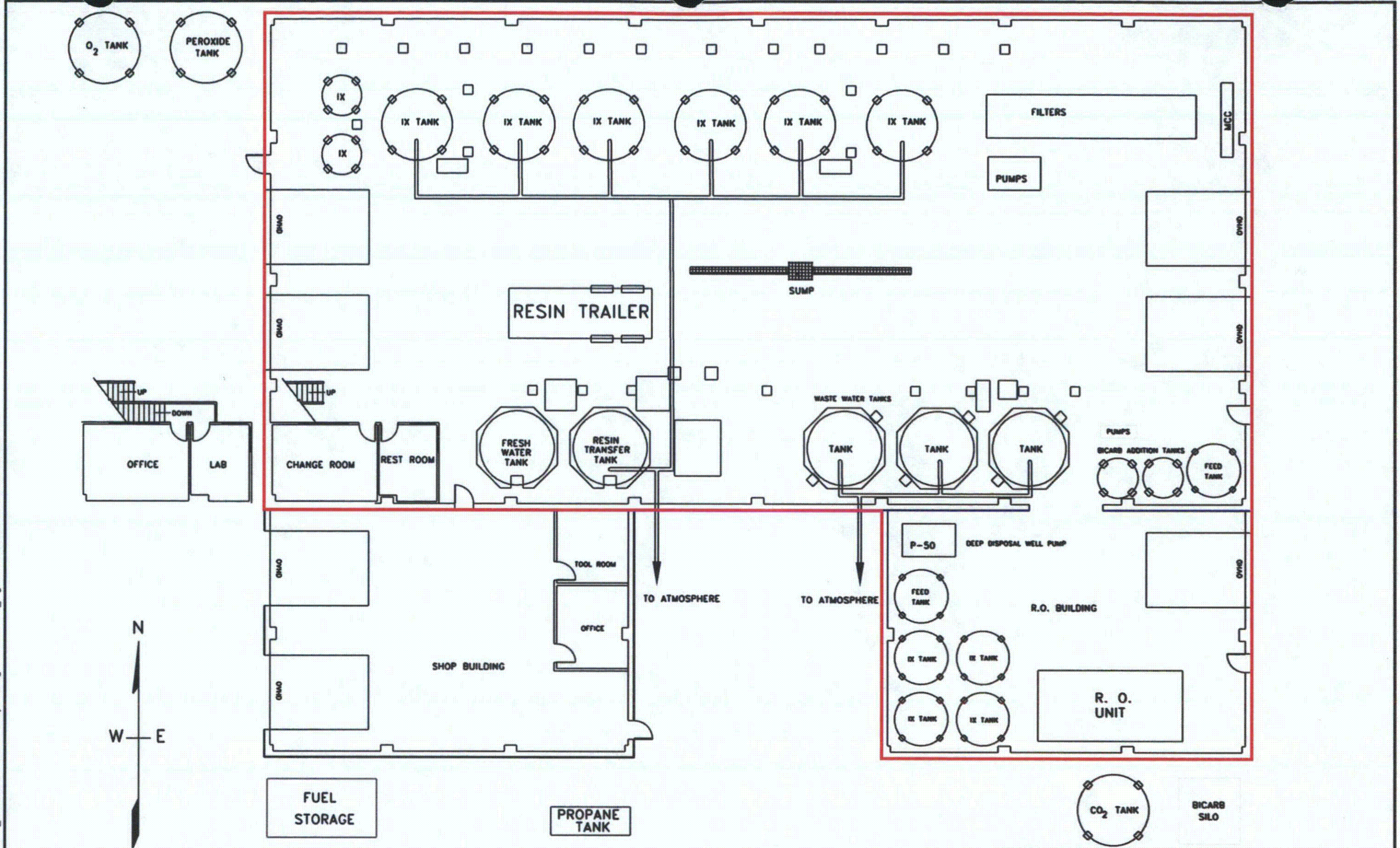
K:\CBR_Projects\CO001396_ThreeCrow\3_IMAGES\Illustrator\TR_Fig_3_1-7 Process Flow Diagram.ai @ 06/21/2010



RESTRICTED AREA BOUNDARY

10 0 10 20 30
Feet

CROW BUTTE RESOURCES, INC.

FIGURE 3.2-1
THREE CROW
SATELLITE FACILITY LAYOUT

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

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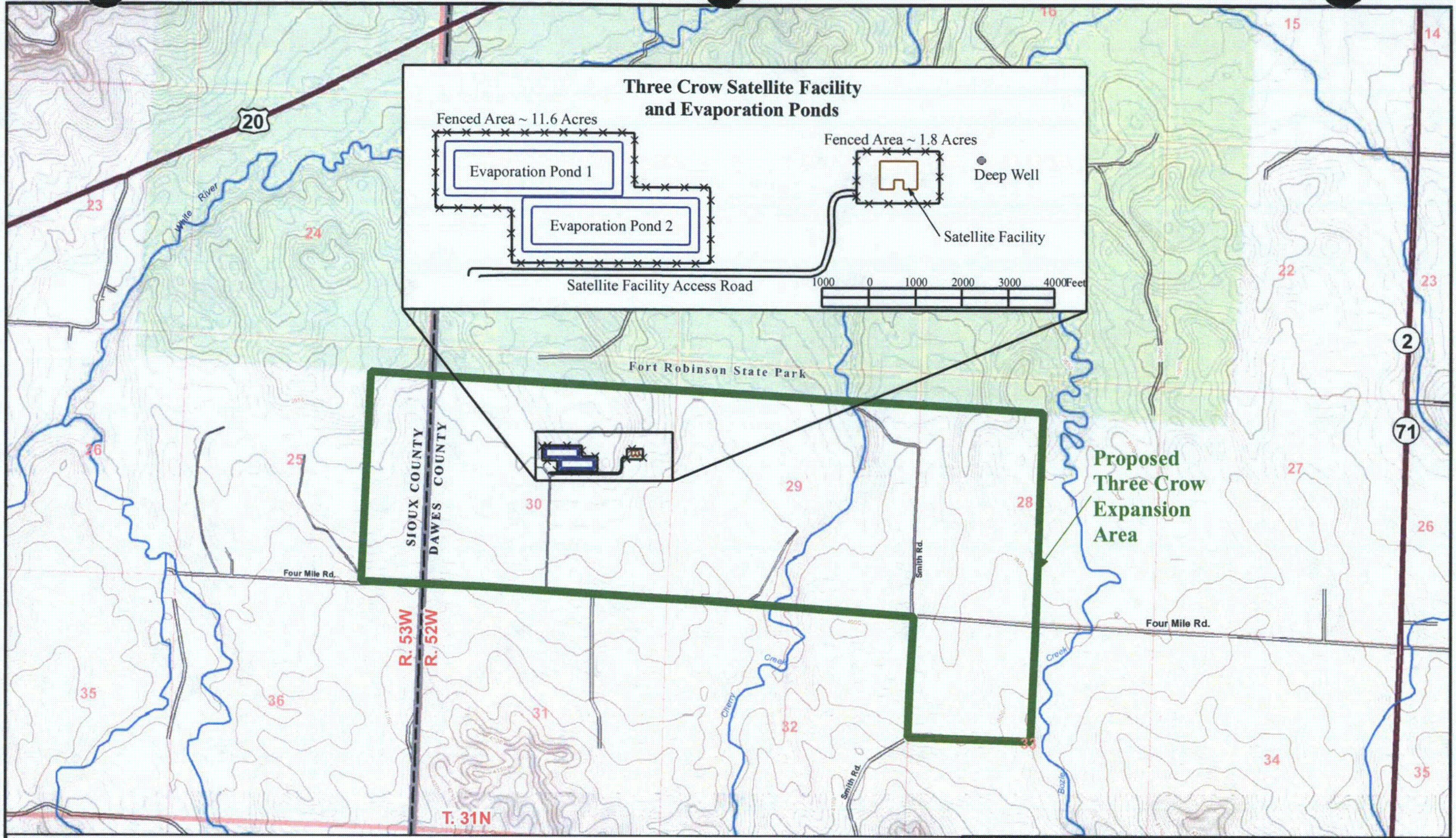

LEGEND

Proposed Three Crow Expansion Area
Fort Robinson State Park
River/Creek
Security Fence
Highway
County Boundary
Elevation Contour (10-Ft Interval)
Road

0 1,000 2,000
Scale in Feet

PROJECTION:
NAD 1927 STATE PLANE
NEBRASKA NORTH, FIPS 2601

N
W E

CROW BUTTE RESOURCES, INC.

FIGURE 3.2-2
GENERAL ARRANGEMENT
SATELLITE FACILITY VIEW

PROJECT: CO001396.00003 MAPPED BY: JC CHECKED BY: JEC

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4 EFFLUENT CONTROL SYSTEMS

The effluents of concern at the proposed satellite facility will include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake. Yellowcake processing and drying operations are conducted nearby at the CPF. Loaded IX resin from the satellite facility will be transported to the CPF for elution, precipitation, drying, and packaging. Effluent control systems will be used at the satellite facility to control the release of radioactive materials to the atmosphere.

The yellowcake drying facilities at the current CPF are comprised of one vacuum dryer. The current license allows for the addition of a second dryer. By design, vacuum dryers do not discharge any uranium when operating. Effluent controls for yellowcake drying at the current CPF have been reviewed by NRC and approved in the current license.

4.1 Gaseous and Airborne Particulates

The principal radioactive airborne gaseous radiological effluent at the TCEA will be radon-222 gas. Processing at the satellite facility will occur in the form of water based solutions or wet slurry (no yellowcake processing or drying); therefore, airborne uranium concentrations are expected to be at or near local background levels. Airborne releases from in situ leach facilities normally are radon-222 and its daughters from process fluids and particulates from yellowcake drying and packaging operations (NRC 2001). One process area at the proposed TCEA where small quantities of airborne uranium particulates have the potential for occurring is the resin transfer station where minor spills may occur. The loaded IX resin is transferred to a truck for transport to the CPF for completion of uranium recovery. Spills can occur during the transfer of this loaded resin to trucks, and this is where exposure to uranium particulates is possible. All spills will be cleaned up as soon as possible to avoid the wet materials from drying and creating the potential for airborne particulates. Spills associated with resin transfer would involve the impregnated resin itself. The uranium is still bound to the resin at this stage, reducing the potential of employee exposure.

There could also be maintenance activities on piping containing pregnant lixiviant that could result in the release of radon and uranium. Any spills or releases during maintenance of these potential sources would be cleaned up promptly to avoid drying of the material and creation of particulates subject to dispersion. All non-routine operations or maintenance activities where the potential exists for significant exposure to radioactive materials, and for which no Standard Operating Procedure (SOP) exists, require a Radiation Work Permit (RWP). The RWP ensures the applicable radiological safety measures are used by the workers, and identifies the type of personnel monitoring that would be required for determining radiation exposure (i.e., internal and external radiation).

One stationary sample point would be established near the resin transfer station and would be sampled monthly for potential airborne uranium particulates. Monitoring activities for routine operations, maintenance activities and spill cleanups are discussed in Section 5.7.

Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the satellite facility. The uranium is then separated from the lixiviant by passing the solution through fixed bed IX units operated in a pressurized downflow mode. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the satellite building. Venting any released radon-222 gas to atmosphere outside the satellite facility via high-volume exhaust fans minimizes employee exposure. Small amounts of radon-222 may be released via solution sampling and spills, filter changes, IX resin transfer, RO system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The general building ventilation system in the satellite facility will further reduce employee exposure. The air in the satellite facility is sampled for radon daughters (see Section 5.0) to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

Injection wells would generally be closed and pressurized, but periodically vented releasing radon to the atmosphere. Production wells will be continually vented to the surface, but water levels will typically be low and radon venting will be minimal. All of the well releases would be outside of buildings and directly vented to the atmosphere. Some venting would also occur from the well houses. Well houses would be vented so as to remove any radon releases from the building to the surrounding atmosphere. The exhaust fans are located in the wall directly opposite the entryway. Releases to the atmosphere from wells and well houses would result in radon emissions dispersing rapidly. Wellfield offgassing is not considered a significant source of radon or a safety issue. This statement is supported by MILDOS-AREA calculations (Section 7.3) and by monitoring at the current Crow Butte operations. Radon individual exposure levels from 1994 through 2006 for Crow Butte employees ranged from 5 to 16 percent of the occupational exposure limit of 4 working level months, Exposure to radon is reported as working level months, a unit commonly used in occupational environments and refers to exposure to a set concentration of radon and its associated progeny. Exposures at the proposed the satellite facility would be expected to be less than for the current operations, due to lack of uranium recovery operation activities such as elution, precipitation, and drying. Discussions of radiological exposure pathways are presented in Section 7.3.

4.1.1 Tank and Process Vessel Ventilation Systems

A separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the process tanks having the potential to produce radon (i.e., up-flow IX columns, resin transfer tank, and wastewater tanks). Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere by forced air ventilation. The design of the fans will be such that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Reg. Guide 8.31 (NRC 2002) Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the satellite facility.

A tank ventilation system of this type is utilized in the existing CPF. Operational radiological in-plant monitoring for radon concentrations has proven this system to be an effective method for minimizing employee exposure.

4.1.2 Work Area Ventilation System

The work area ventilation system would be designed to force air to circulate within the satellite facility process areas.

4.1.2.1 Ventilation System at Current Central Processing Facility

The ventilation system at the CPF has been shown to adequately ventilate areas where radon and daughter products could accumulate. The ventilation system maintains a negative pressure on the process building to prevent gases such as radon from accumulating in the work areas. The current ventilation system consists of 3 wall fans that exhaust air out of the building while drawing across the plant floor. Each fan has a capacity of 11,000 cubic feet per minute (cfm). The total facility air volume is approximately 988,949 cubic feet (ft^3). Based on the fan capacities and the total air volume of the facilities, the turnover of the complete facility air volume is approximately 29.97 minutes. Tanks with the process area having the potential for radon emissions have vent fans that discharge emissions outside of the building. For example the west IX column tanks (6,000 cfm) and east IX column tanks (6,000 cfm) have separate vent vans that discharge to a common vent system. There are also vent fans for the backwash tank (800 cfm), waste tank (1,500 cfm), eluant tank (1,500 cfm), precipitation tank (1,500 cfm), east resin screen (1,200 cfm) and west resin screen (1,200 cfm). These later fans vent emissions to the outside of the building.

Before any plant startup, after a power bump or outage and after any vent system has been shut down for any reason, the ventilation system is inspected and assessed as per multiple criteria identified in the SHEQMS. The ventilation system has an alarm that sounds in the event it ceases to work properly.

During favorable weather conditions, open doorways and convection vents in the roof assist in providing satisfactory work area ventilation. The design of the ventilation system is adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20.

Radon daughter monitoring results for the CPF for the year 2009 are show in **Table 4.1-1.** Monitoring is conducted monthly unless the results exceed an action limit of 25% of the DAC. If this action level is triggered, then weekly monitoring is required until four consecutive weeks of radon daughter concentrations are below the 25% level. The DAC is 0.333 WL and 25% DAC is 0.08 WL. As can be seen in **Table 4.1-1**, the 25% action level and DAC were not exceeded in 2009. The method used to sample radon daughters is based on a simulated worst case scenario. All of the building doors are closed and time is allowed for the radon concentration to build up, if present. This is a very conservative estimate, because unless it is extremely cold, the doors are seldom closed. This enhances the building ventilation.

Airborne uranium monitoring results for the CPF for the year 2009 are shown in **Table 4.1-2.** Monitoring is conducted monthly. The DAC for soluble (D classification) natural uranium of 5×10^{-10} uCi/ml from Appendix B to 10 CFR 20.2401 is used. This is a conservative method because the gross alpha include Uranium-238 and several of its daughters (notably ra-226 and th-230), which are also alpha emitters. An action 25% of the DAC for soluble natural uranium is established at the current operations site. If airborne uranium exceeds the DAC, an investigation will be performed. As can be seen in **Table 4.1-2**, the measured concentrations are well below the action level and DAC. Concentrations at the Three Crow Facility would be expected to be lower since there will be no yellowcake production or packing.

4.1.2.2 Three Crow Ventilation System

The ventilation system at the proposed Three Crow Facilities would be similar to the ventilation system used at the CPF. Exhaust fans would exhaust air within the building outside to the top of the building, drawing in fresh air. The discharge stacks will be located away from the building ventilation intakes to prevent introducing exhausted emissions into the facility. These exhaust fans would be located at different levels to ensure areas where radon could accumulate are ventilated sufficiently to prevent radon accumulation. Storage tanks with the potential for radon emissions would also be vented to the outside of the building. Separate and independent local ventilation systems may be used temporarily as needed for non-routine activities such as maintenance. As discussed above for the CPF, radon daughter monitoring at the proposed satellite facility would be used to verify that radon daughters are maintained below the 25% DAC action level. Ongoing operations would ensure that the ventilation system would be operating satisfactorily and as designed through the use of SOPs.

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. There are no significant amounts of process chemicals that will be used at the satellite facility. There are no significant combustion-related emissions from the process facility, as commercial electrical power is available at the site. The primary types of non-radiological pollutants that could occur during operations at the TCEA site are discussed in Section 7.2.1 (Air Quality Impacts of Operations). The satellite facility operational building would not have combustion devices, except for the propane heaters used for heating the building as needed.

Occupational and public exposures to radon emitted from the mine units and from the satellite processing facility were analyzed using the MILDOS-AREA computer model to ensure the discharged amount would be within regulatory dose limits. The results of this modeling are presented in Section 7.3.

4.1.3 Response to Emergency Events Associated with Effluent Control Systems

Currently, Crow Butte adheres to requirements in the SHEQMS Volume VIII, *Emergency Manual* (CBR 2010a) that provides guidance in responding to emergency situations that could occur at the site in the event of effluent system failures. The Three Crow project will also be subject to the requirements of this manual. It is understood that this manual is a guideline and that individuals charged with the responsibility of responding to and managing emergencies must use their best judgment when making decisions related to the emergency. The manual is designed to guide the employee on how to properly respond to an emergency.

In the event of a failure of an effluent control device or other mishap that could result in exposure of an individual to elevated quantities of radiation present in gases, liquids or solids, emergency procedures outlined in the emergency manual and other applicable procedural manuals will be implemented. Guidelines in these manuals, which employees receive training, will be implemented to minimize individual exposures. The emergency manual addressed emergency situations such as medical emergencies, fires and explosions, radiological emergencies, chemical emergencies, transportation emergencies, natural disasters, and security threats. Appendix A of the SHEQMS *Emergency Manual* provides detailed instructions for responding to an emergency involving bulk, petrochemical, and compressed gases used at the site. If needed, CBR maintains emergency evacuation procedures that all employees, contractors and visitors are trained in.

CBR also maintains the SHEQMS Volume III, *Operating Manual* (CBR 2010b) that address proper operations of effluent control devices, as well as procedures to take in the event of non-emergency failures of effluent control devices.

The implementation of the operational and emergency manuals supports CBR efforts to eliminate exposures under both normal and accident conditions. Effluent control techniques are discussed in subsection 5.7.1 of Section 5.7.

4.1.4 ALARA Evaluations of Effluent Control Systems

As with the current CBR operations, CBR will conduct operations of the effluent controls so that all airborne effluent releases are maintained ALARA. CBR maintains a strict ALARA policy to keep exposures to all radioactive material and other hazardous material as low as possible and to as few personnel as possible, as defined in the SHEQMS Volume IV, *Health and Physics Manual* (CBR 2010c). A comprehensive review of the project radiation control program and ALARA program is performed annually. Such a review would include exposures associated with the effluent control systems.

4.2 Liquids and Solids

4.2.1 Liquid Waste

As a result of in-situ leach mining, there are several sources of liquid waste. The potential wastewater sources that exist at the satellite facility include the following:

4.2.1.1 Water Generated During Well Development

This water is recovered groundwater and has not been exposed to any mining process or chemicals. However, the water may contain elevated concentrations of naturally-occurring radioactive material if the development water is collected from the mineralized zone. The water will be discharged directly to the solar evaporation pond and silt, fines and other natural suspended matter collected during well development will settle out in the pond. Well development water may also be treated with filtration and/or reverse osmosis and used as plant make-up water or disposed of in the deep disposal well.

4.2.1.2 Liquid Process Waste

The operation of the satellite facility results in one primary source of liquid waste, a production bleed, as previously discussed in Section 3.0. This bleed will be routed to either the deep disposal well or an evaporation pond.

4.2.1.3 Aquifer Restoration Waste

Following mining operations, restoration of the affected aquifer results in the production of wastewater. The current groundwater restoration plan consists of four activities:

1. Groundwater Transfer

2. Groundwater Sweep
3. Groundwater Treatment
4. Wellfield Circulation

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. As has been the case with past operations at Crow Butte, it is anticipated that during restoration groundwater at the TCEA will be treated using IX and 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 RO unit will be used to reduce the total dissolved solids (TDS) of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is either injected into the formation or disposed of in the wastewater disposal system. The brine is sent to the wastewater disposal system.

4.2.1.4 Stormwater Runoff

Stormwater may be contaminated by contact with industrial materials. Stormwater management is controlled under permits issued by the NDEQ. CBR is subject to stormwater National Pollutant Discharge Elimination System (NPDES) permitting requirements for industrial facilities and construction activities. The NDEQ NPDES regulatory program contained in Title 119 (NDEQ 2010a) requires that procedural and engineering controls be implemented such that runoff will not pose a potential source of pollution.

4.2.1.5 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Nebraska. The septic system will be designed with a capacity sufficient to handle the projected number of employees, contractors and visitors. CBR currently maintains a Class V UIC Permit issued by the NDEQ for operation of the septic system at the current license area. A similar permit will be required for the satellite facility.

4.2.1.6 Laboratory Waste

Liquid waste from the laboratory will be disposed of in either the evaporation pond or the deep disposal well.

4.2.1.7 Liquid Waste Disposal

Two methods of disposal are proposed for the satellite facility and are already permitted for use at the CPF:

- Deep disposal well injection; and
- Evaporation via evaporation ponds.

In addition to these two disposal methods, the NDEQ has issued CBR an NPDES permit for the CPF license area that allows land application of treated wastewater. CBR has not used this waste disposal method at the current operation. At this time, CBR does not intend to apply for an NPDES permit to allow land application at the satellite facility. It is expected that liquid waste generated in the TCEA will be managed in the same manner as at the existing CPF (i.e., by evaporation and deep well injection).

Deep Disposal Well

CBR currently operates a non-hazardous Class I injection well in the CPF license area for disposal of wastewater. The well is permitted under NDEQ regulations in Title 122 (NDEQ 2010b) and operated under a Class I UIC Permit. CBR has operated the deep disposal well at the current license area for over ten years with excellent results and no serious compliance issues. CBR expects that the liquid waste stream at the satellite facility will be chemically and radiologically similar to the waste disposed of in the current deep disposal well. Radiological data for the years 2008 and 2009 for current deep disposal well injection stream are shown in **Table 4.2-1**. The nonradiological data for the deep disposal well injection stream for 2009 is presented in **Table 4.2-2**.

CBR plans to install a deep disposal well at the satellite facility as the primary liquid waste disposal method. CBR has found that permanent deep disposal is preferable to evaporation in evaporation ponds. The basic reasons for this position are as follows:

- The potential for human contact while using a deep well is more limited due to the waste being handled in enclosed systems.
- The potential for emissions from the pond surface is greater than the enclosed deep well disposal system.
- Evaporation ponds have the potential for leaks and impacts to the environment.
- A larger amount of 11(e)(2) byproduct waste is created through the use of evaporation ponds.

All compatible liquid wastes at the satellite facility will be disposed of at a planned onsite Class I UIC deep disposal well. CBR will submit an application to the NDEQ for the construction and operation of a Class I UIC Permit at the satellite facility. The deep well will be installed in sufficient time to be used for wastewater disposal allowed by the permit.

Evaporation Pond

Evaporation pond design, installation and operation criteria are those found in Reg. Guide 3.11 (NRC 2008) The evaporation pond configuration at the satellite facility will be similar to the existing ponds at the CPF license area. The exact number and capacity of the ponds will depend upon the results of the determination of the performance of the deep disposal well as far as waste water disposal rate. In addition, final pond design cannot be completed until completion of the site geotechnical assessment, including site-specific sampling and testing. This information is currently not available due to the stage of project development. A license amendment application with pond design and specifications, which meet the requirements of the most current pond design and construction regulatory guides, will be submitted to the NRC prior to pond construction. In addition, plans for monitor wells used to demonstrate compliance with 10 CFR 40, Appendix A, Criterion 7a, will be submitted as part of the license amendment.

Each pond will have the capability of being pumped to a water treatment plant before disposal. 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 treat the water to a quality that falls well within NPDES criteria.

CBR maintains three commercial and two R & D evaporation ponds in the CPF license area. The ponds are constructed with a primary and secondary liner system. An underdrain system consisting of perforated piping between the primary and secondary liners is installed to monitor for leaks. The underdrain slopes gradually to the ends of the ponds where they are connected to a surface monitor pipe. Checking for an increase in measurable moisture inside the leak detection system and/or analyzing the water in the pipe can indicate a leak in the pond liner. The design of the Three Crow evaporation ponds will include similar features.

The current pond inspection program is based on NRC recommendations in Reg. Guide 3.11.1(NRC 1980) and is approved in SUA-1534. Routine inspections are required as follows:

- Daily Inspections

  Daily inspections consist of checking the pond depth and visually inspecting the pond embankments for slumping, movement, or seepage. The pond depth measurements will be checked against the freeboard requirements.

- Weekly Inspections

  Weekly inspections consist of checking the perimeter game-proof fence and restricted area signs, checking the pond inlet piping, making underdrain measurements, checking the pond enhanced evaporation system (if installed), visually inspecting the liner, and measuring the vertical depth of fluid in the pond underdrain standpipes. During periods of seismic activity, flooding, severe rainfall, or other event that could cause the pond to leak, underdrain measurements will be taken daily and recorded.

- Monthly Inspections

  During monthly inspections, the waste piping from the satellite facility building to the ponds will be visually inspected for signs of seepage indicating a possible pipeline break. Diversion channels surrounding the ponds will be examined for channel bank erosion, obstruction to flow, undesirable vegetation, or any other unusual conditions.

- Quarterly Inspections

  Quarterly inspections will check for embankment settlement and for irregularities in alignment and variances from originally constructed slopes (i.e., sloughing, toe movement, surface cracking or erosion). Embankments will be inspected for any evidence of seepage, erosion, and any changes to the upstream watershed areas that could affect runoff to the ponds. Emergency lines will be inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

- 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 will be 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 will also be submitted to the NRC.

- Pond Leak Corrective Actions

If six inches or more of fluid is present in the standpipes, the contents will be analyzed for specific conductance. If the water quality in the standpipe is degraded beyond the action level, the water will be further sampled for chloride, alkalinity, sodium, and sulfate. The action level is defined as a specific conductivity of the fluid of the standpipe that is 50 percent of the specific conductivity of the pond contents.

If there is an abrupt increase in both the vertical fluid depth of a standpipe and the specific conductance of the fluid of the standpipe, the liner will be immediately inspected for liner damage. Abnormal increases of these two indicators confirm a potential liner leak and agency reporting (i.e., NRC and NDEQ) will be required.

Upon verification of a liner leak, the fluid level will be lowered by transferring the cell contents to the other cell. Water quality in the affected standpipes will be analyzed for the five parameters listed above once every seven days during the leak period, and once every seven days for at least two weeks following repairs.

4.2.1.8 Potential Pollution Events Involving Liquid Waste

Although there are a number of potential sources of pollution present at the CPF, existing regulatory requirements from the NRC and NDEQ and provisions of the SHEQMS have established a framework that significantly reduces the possibility of an occurrence. Extensive training of all personnel is standard policy at the existing Crow Butte facility and will be implemented at the satellite facility. Frequent inspections of waste management facilities and systems will be conducted. Detailed procedures are included in the SHEQMS, which will be adapted for use at the satellite facility.

Potential sources of pollution include the following:

Solar Evaporation Pond

The solar evaporation pond could contribute to a pollution problem in several ways. First, a pond could fail, either in a catastrophic fashion or as a result of a slow leak. In addition, a pond could overflow due to excess production or restoration flow, as well as due to the addition of rainwater.

With respect to a pond failure, all ponds will be built to NRC standards, and will be equipped with leak detection systems. Standard operating procedures will require a periodic inspection of all ponds, liners, and berms. The inspection program will be similar to the program currently implemented by CBR for the commercial ponds at the CPF. In the event of a leak, the contents of the pond cell can be transferred to the other pond cell while repairs are made.

With respect to pond overflow, operating procedures will be such that no individual pond cell is allowed to fill to a point where overflow is considered a realistic possibility. Since the primary disposal method will be deep disposal, the flow rate of liquids to the pond cells is expected to be minimal and there will be ample time to reroute the flow to another pond. Regarding the addition of rainwater, the freeboards of ponds considered "full" will be sufficient to contain the addition of significant quantities of rainwater before an overflow occurs. The inclusion of the freeboard allowance also precludes over-washing of the walls during high winds.

4.2.1.9 Wellfield Buildings and Piping

Wellfield buildings are not considered to be a potential source of pollutants during normal operations, as there will be no process chemicals or effluents stored within them. The only instance in which a wellfield building could contribute to pollution would be in the event of a release of injection or recovery solutions due to pipe failure. The possibility of such an occurrence is considered to be minimal as the piping will be leak checked before it is initially placed into service. Piping from the wellfields will generally be buried, minimizing the possibility of an accident. In addition, the flows through the wellfield piping will be monitored and will be at a relatively low pressure. Flow monitoring will provide alarms in the event of a significant piping failure which will allow flow to be stopped, preventing any significant migration of process fluids. Wellfield buildings will also be equipped with wet alarms for early detection of leaks.

Satellite Facility

The satellite facility will serve as a central hub for the mining operations in the TCEA. Therefore, the satellite facility has the greatest potential for spills or accidents resulting in the release of potential pollutants. Spills could result from a release of solutions due to a piping failure or a process storage tank failure.

The design of the satellite facility building will be such that any release of liquid waste would be contained within the structure. A concrete curb will be built around the entire process building. This pad will be designed to contain the contents of the largest tank within the building in the event of a rupture. In the event of a piping failure, the pump system will immediately shut down, limiting any release. Liquid inside the building, both from a spill or from washdown water, will be drained through a sump and sent to the liquid waste disposal system.

Deep Well Pumphouse and Wellhead

The design of the deep well pumphouse and wellhead will be such that any release of liquids will be contained within the building or in a bermed containment area surrounding the facilities. Liquid inside the building will be contained and managed as appropriate.

Transportation Vehicles

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve either vehicles transporting IX resin to and from the satellite facility to the CPF or transporting radioactive contaminated waste from the satellite facility to an approved disposal site.

All chemicals and products delivered to or transported from the satellite facility will be carried in DOT-approved packaging. In the event of an accident, procedures are currently in place in the SHEQMS Volume VIII, *Emergency Manual*, to insure a rapid response to the situation.

The uranium-loaded resin will be transported from the satellite facility to the CPF processing building in a specially designed, low profile, 4,000-gallon capacity tanker trailer. The primary access route is approximately 13.3 miles in length with the majority of the route following lightly traveled secondary roads (**Figure 4.2-1**). Only 4.2 miles are on US Hwy 2/71, with the remainder on county and private roads. In the event of an accident, each resin transport vehicle will be equipped with an emergency contingency package whereby the driver could begin the containment of any spilled material. Because the uranium adheres to the resin and the resin is wet when transferred, the radiological and environmental impacts of a spill due to an accident will be minimal. Finally, each resin transfer vehicle will be equipped with a radio for communications with the CPF. This allows quick response and implementation of the emergency response plan for transportation accidents.

Spills

Spills can take two forms within an in-situ facility. These are surface spills (such as pond leaks, piping ruptures etc.) and subsurface releases such as a well casing failure, or a pond liner leak resulting in a release of waste solutions. Spill contingency plans are discussed in Section 5.7.1.3.

Engineering and administrative controls are in place at the CPF and will be implemented at the satellite facility to prevent both surface and subsurface releases to the environment, and to mitigate the effects should an accident occur. The most common form of surface release from in-situ mining operations occurs from breaks, leaks, or separations within the piping that transfers mining fluids from the satellite processing building to the wellfield and back. With the current CBR monitoring system, these are generally small releases and are quickly discovered and mitigated.

In general, piping from the satellite facility to and within the wellfield, will be constructed of HDPE with butt welded joints or the equivalent. All pipelines will be pressure tested before final 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 a major cause of potential failure, which is vehicles driving over the lines causing breaks. Typically, the only exposed pipes will be at the satellite facility, at the wellheads, and in the wellhouses in the wellfield. Trunkline flows and manifold pressures will be monitored for spill detection and process control.

4.2.2 Solid Waste

Any facility or process with the potential to generate industrial waste should practice good housekeeping. This activity generally consists of keeping facilities, equipment, and process areas clean and free of industrial waste or other debris. Good housekeeping includes promptly cleaning any spillage or process residues that are on floors or other areas that could be spread and collecting solid wastes in designated containers or area until proper disposal.

Solid waste generated at the satellite facility is expected to include spent resin, resin fines, empty reagent containers, miscellaneous pipe and fittings, and domestic trash. Solid wastes will be classified as contaminated or non-contaminated waste according to survey results. The solid waste will be segregated based on whether it is clean or has the potential for contamination with 11(e).2 byproduct materials.

The largest volume of solid wastes requiring disposal at the TCEA site will be during facility decommissioning. Soils would be included in decommissioning surveys and any soils exceeding NRC release limits at 10 CFR Part 40, Appendix A, Criterion 6 would be removed and disposed of as 11e.(2) byproduct waste. Proposed decommissioning and reclamation activities are discussed in Section 6.0.

4.2.2.1 Non-contaminated Solid Waste

Non-contaminated solid waste is waste which is not contaminated with 11(e).2 byproduct material or which can be decontaminated and re-classified as non-contaminated waste. This type of waste may include trash, piping, valves, instrumentation, equipment and any other items which are not contaminated or which may be successfully decontaminated. Release of contaminated equipment and materials is discussed in further detail in Section 5.

CBR has recently estimated that the CPF produces approximately 1,055 cubic yards (yd^3) of non-contaminated solid waste per year. This estimate is based on the number of collection containers on site and the experience of the contract waste hauler. CBR estimates that the proposed satellite facility would produce approximately 700 yd^3 of non-contaminated solid waste per year. Non-contaminated solid waste will be collected on the site in designated areas and disposed of in the nearest permitted sanitary landfill.

4.2.2.2 11(e).2 Byproduct Material

Solid 11e.(2) byproduct wastes consists of solid waste contaminated with 11e.(2) byproduct material that cannot be decontaminated.

11(e).2 byproduct material generated at ISL facilities consists of filters, Personal Protective Equipment (PPE), spent resin, piping, etc. CBR has recently estimated that the CPF produces approximately 60 to 90 cubic yards (yd^3) of 11(e).2 byproduct material waste per year. This estimate is based on the number of historical number of shipments to the licensed disposal facilities. CBR estimates that the proposed satellite facility would produce approximately 60 yd^3 of 11(e).2 byproduct materials per year. These materials will be stored on site until such time that a full shipment can be shipped to a licensed waste disposal site or licensed mill tailings facility. CBR currently maintains an agreement for waste disposal at a properly licensed facility as a License Condition for SUA-1534. CBR is required to notify NRC in writing within 7 days if the disposal agreement expires or is terminated, and to submit a new agreement for NRC approval within 90 days of the expiration or termination.

If decontamination is possible, records of the surveys for residual surface contamination will be made prior to releasing the material. Decontaminated materials have activity levels lower than those specified in NRC guidance (NRC 1987). An area will be maintained inside the restricted area boundary for storage of contaminated materials prior to their disposal.

4.2.2.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Nebraska. Disposal of solid materials collected in septic systems must be performed by companies or individuals licensed by the State of Nebraska. NDEQ regulations for control of these systems are contained in Title 124 (NRC 2010c).

4.2.2.4 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Nebraska, hazardous waste is governed by the regulations contained in Title 128 (NDEQ 2010d). Based on waste determinations conducted by CBR as required in Title 128, CBR is a Conditionally Exempt Small Quantity Generator. To date CBR only generates universal hazardous wastes such as fluorescent light tubes, used waste oil and batteries. CBR recently estimated that the current operation generates approximately 1,325 liters of waste oil per year. CBR estimates that the proposed satellite facility would produce approximately 800 liters of waste oil per year. Waste oil is disposed of by a licensed waste oil recycler. CBR has management procedures in place in the SHEQMS Volume VI, *Environmental Manual,* to control and manage these types of wastes.

4.3 References

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Table 4.1-1 Monthly Summary of Radon Daughter Surveys (2009) at Crow Butte Central Processing Facility

Sample Point #	Sample Point Locations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
		Working Level*											
1R	Between IX Columns & Precipitation Cells	0.034	0.051	0.014	.027	0.020	0.014	0.022	0.025	0.013	0.012	0.016	0.059
2R	Between Precipitation Cells & Eluent Tanks	0.032	0.044	0.012	.024	0.016	0.015	0.029	0.030	0.012	0.013	0.011	0.050
3R	Between IX Columns & Injection Tanks	0.035	0.059	0.013	.019	0.015	0.008	0.015	0.023	0.014	0.009	0.008	0.051
4R	Between IX Columns & Resin Transfer Tank	0.034	0.056	0.013	.018	0.016	0.010	0.014	0.017	0.011	0.012	0.014	0.030
5R	Between IX Columns & Column Drain Tank	0.030	0.047	0.011	.015	0.013	0.009	0.012	0.019	0.012	0.010	0.013	0.026
6R	Between IX Column Trains	0.033	0.047	0.015	.015	0.011	0.009	0.015	0.018	0.015	0.011	0.020	0.031
7R	Between Precipitation Cells & Raw Water Tk.	0.019	0.029	0.010	.021	0.017	0.013	0.013	0.018	0.010	0.009	0.012	0.037
8R	Motor Control Room	0.009	0.003	0.003	.004	0.002	0.003	0.002	0.002	0.007	0.008	0.002	0.003
9R	Lab	0.005	0.007	0.011	.007	0.006	0.003	0.007	0.006	0.004	0.022	0.005	0.007
10R	Lunch Room	0.009	0.001	0.002	.004	0.001	0.002	0.004	0.006	0.002	0.003	0.002	0.002
11R	Reverse Osmosis Building	0.003	0.025	0.007	.005	0.002	0.003	0.007	0.003	0.003	0.003	0.003	0.002
12R	Restoration Room	0.026	0.031	0.011	.008	0.014	0.010	0.007	0.012	0.012	0.004	0.007	0.024
	Facility Average (1R-8R & 12R)	0.028	0.041	0.011	.017	0.014	0.010	0.014	0.018	0.012	0.010	0.011	0.034
	Annual Facility Average	0.018											
	1R-8R & 12R												

***Working level** (WL) is any combination of short-lived radon daughters (for Radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.

Table 4.1-2 Monthly Airborne Uranium Sampling at Crow Butte Central Processing Facility for 2009

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	uCI/ml											
Between IX Trains	2.73E-13	4.69E-13	2.18E-13	10.2E-13	4.02E-13	3.29E-13	2.31E-13	5.73E-14	1.02E-12	1.43E-13	2.26E-13	2.75E-13
Under Thickener (yellowcake Storage)	3.75E-13	1.82E-13	9.02E-13	1.16E-13	1.73E-13	4.54E-13	1.62E-13	1.60E-13	5.76E-14	2.50E-13	8.10E-13	5.38E-13
Belt Filter Room	9.62E-12	1.27E-11	9.29E-12	9.63E-12	5.58E-12	4.75E-12	3.68E-12	2.96E-12	5.30E-12	5.51E-12	6.87E-12	4.40E-12
Precipitation Area-Catwalk by Precipitation B	6.51E-13	9.49E-13	3.18E-12	5.84E-13	4.69E-13	8.07E-13	1.86E-13	2.56E-13	2.68E-13	2.63E-13	2.42E-13	3.49E-13
Dryer Room	3.80E-12	2.88E-12	2.11E-12	4.40E-12	2.84E-12	3.06E-12	8.38E-12	1.53E-11	7.81E-12	7.35E-12	2.61E-12	7.03E-12
Outside of the Dryer Room (Change Room)	2.17E-12	2.48E-12	1.83E-11	1.91E-12	1.01E-12	2.89E-12	1.76E-12	1.86E-12	1.96E-12	8.21E-13	1.04E-12	2.40E-12
Laboratory	1.23E-13	2.16E-13	9.42E-15	4.26E-15	3.54E-13	4.75E-13	2.43E-13	6.07E-14	3.66E-13	5.98E-14	3.11E-13	1.37E-13
Facility Average*	2.81E-12	3.28E-12	6.76E-12	2.79E-12	1.75E-12	2.05E-12	2.40E-12	3.43E-12	3.23E-12	2.39E-12	1.97E-12	2.50E-12

* Does not include Laboratory

Table 4.2-1 Deep Disposal Well Injection Radiological Data for Crow Butte Central Processing Facility (2008 and 2009)

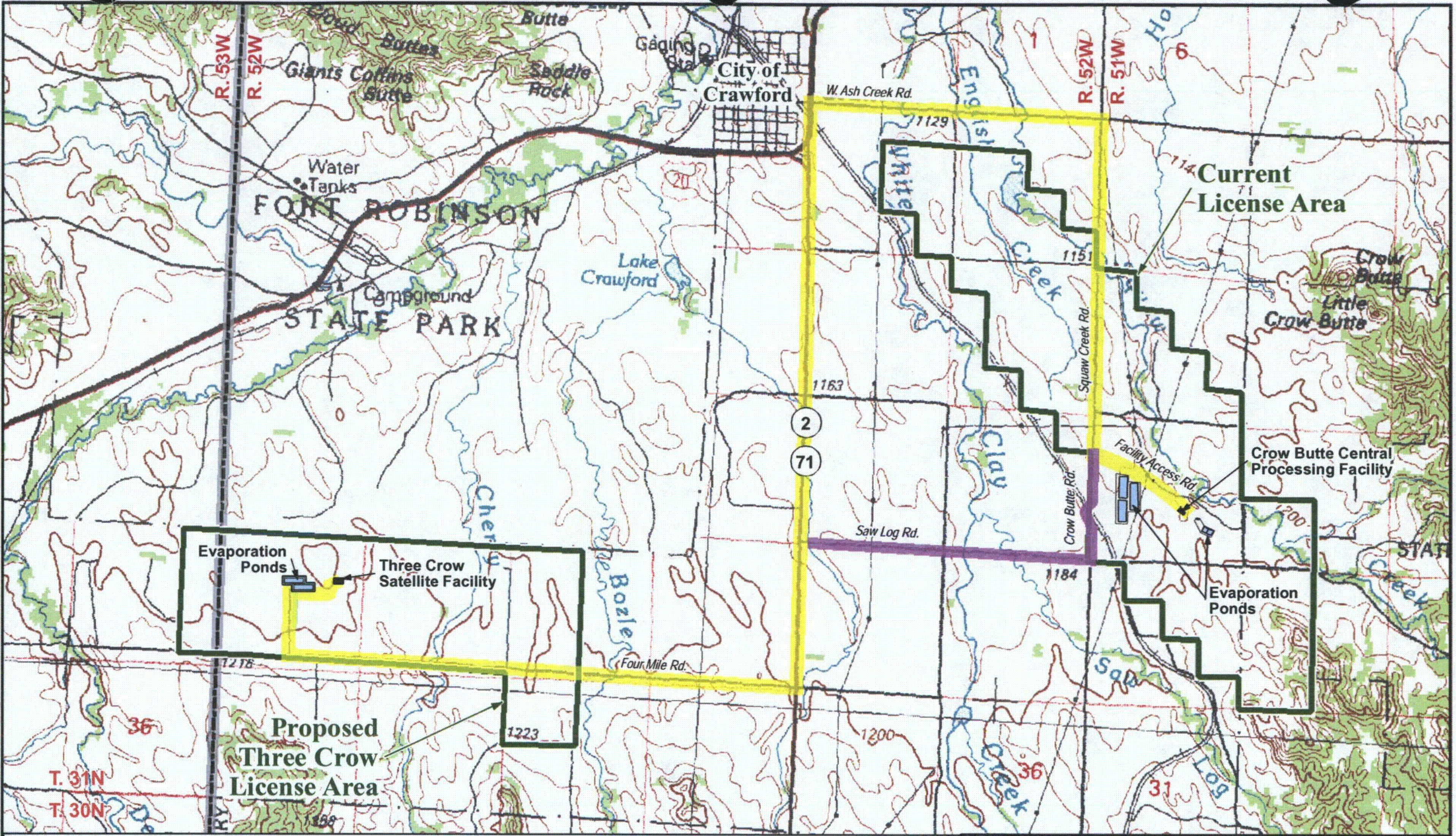
Month	Total Gallons Injected	Average Natural Uranium (mg/l)[a]	Total Natural Uranium Injected (mg)	Total Natural Uranium Injected (uCi)	Average Radium-226 (uCi/l)[a]	Total Radium-226 Injected (uCi/l)
January 2009	4,656,906	5	8.81E+07	5.97E+04	707	1.25E+04
February 2009	4,208,406	3	4.78E+07	3.24E+04	752	1.20E+04
March 2009	3,849,464	3	4.37E+07	2.96E+04	656	9.56E+03
April 2009	3,761,898	5	7.12E+07	4.82E+04	686	9.77E+03
May 2009	4,821,589	4	7.30E+07	4.94E+04	892	1.63E+04
June 2009	5,634,712	4	8.53E+07	5.78E+04	1,000	2.13E+04
Semi-Annual Totals	**26,932,975**	--	**4.09E+08**	**2.77E+05**	--	**8.14E+04**
July 2009	5,467,407	3	6.21E+07	4.20E+04	1,120	2.32E+04
August 2009	5,519,131	6	1.25E+08	8.49E+04	991	2.07E+04
September 2009	5,418,568	5	1.03E+08	6.94E+04	652	1.34E+04
October 2009	5,791,232	4	8.77E+07	5.94E+04	866	1.90E+04
November 2009	6,060,190	6	1.38E+08	9.32E+04	1,090	2.50E+04
December 2009	6,730,245	7	1.78E+08	1.21E+05	1,250	3.18E+04
Semi-Annual Totals	**34,986,773**	--	**6.94E+08**	**4.70E+05**	--	**1.33E+05**
January 2008	5,132,667	3	5.83E+07	3.95E+04	669	1.30E+04
February 2008	3,388,598	4	5.13E+07	3.47E+04	751	9.63E+03
March 2008	2,565,135	5	4.85E+07	3.29E+04	795	7.72E+03
April 2008	3,724,924	3	4.23E+07	2.86E+04	818	1.15E+04
May 2008	3,650,359	4	5.53E+07	3.74E+04	818	1.13E+04
June 2008	3,946,776	3	4.48E+07	3.03E+04	739	1.10E+04
Semi-Annual Totals	**22,408,459**	--	**3.01E+08**	**2.03E+05**	--	**6.42 E+04**
July 2008	4,051,240	4	6.13E+07	4.15E+04	698	1.07E+04
August 2008	4,664,934	5	8.83E+07	5.98E+04	775	1.37E+04
September 2008	4,823,374	6	1.10E+08	7.42E+04	753	1.37E+04
October 2008	5,202,468	5	9,85E+07	6.67E+04	693	1.36E+04
November 2008	4,823,009	4	7.30E+07	4.94E+04	763	1.39E+04
December 2008	4,553,541	6	1.03E+08	7.00E+04	741	1.28E+04
Semi-Annual Totals	**28,118,566**	--	**5.34E+08**	**3.62E+05**	--	**7.85E+04**

[a] Maximum deep well injection limits: ra-226 – 5,000 uCi/l; U-Natural – 25 mg/l

Table 4.2-2 Deep Disposal Well Injection Non-radiological Data for Crow Butte Operations 2009

Parameter	Annual Composite Results		Maximum Injection Level	Laboratory
	mg/l[a]			
	Annual Average	Range		
Sodium	1794	11422 - 3382	40,000	Crow Butte Lab
Calcium	104	76 – 137	Report Only	Crow Butte Lab
Sulfate	1092	661 – 1530	10,000	Crow Butte Lab
Chloride	3232[c]	505 – 30,490[c]	40,000	Crow Butte Lab
Vanadium	2.83	1.0 - 13.0	50	Crow Butte Lab
Alkalinity	1598	1150 – 1875	4,100	Crow Butte Lab
pH (std. units)	8.18	8.02 – 8.33	5.0-9.5	Crow Butte Lab
Arsenic	[b]	<0.1 – 0.037	5	Energy Lab
Barium	<0.01	<0.1 - <0.1	100	Energy Lab
Cadmium	<0.01	<0.1 - <0.1	1	Energy Lab
Chromium	<0.5	<0.5 - <0.05	5	Energy Lab
Lead	<0.5	<0.5 - <0.5	5	Energy Lab
Mercury	<0.0001	<0.0001 - <0.0001	0.2	Energy Lab
Selenium	[b]	<0.1 – 0.037	1	Energy Lab
Silver	<0.5	<0.5 - <0.5	5	Energy Lab

[a] mg/l unless noted otherwise.
[b] Eleven results at <0.1 with one at 0.037.
[c] Maximum result for 11 samples was 1702, with the one highest at 30,490 (without latter reading average is 754)
Note: Reporting data based on 12 monthly samples (January – December, 2009)



LEGEND

- Evaporation Pond
- Facility Building
- Primary Access Route
- Alternate Access Route

N

W — E

0 3,000 6,000

Scale in Feet

PROJECTION:
NAD_1927_STATE_PLANE_
NEBRASKA_NORTH_FIPS_2601

CROW BUTTE RESOURCES, INC.

FIGURE 4.2-1
PROPOSED ACCESS ROUTE BETWEEN THREE CROW SATELLITE FACILITY AND CROW BUTTE CENTRAL PROCESSING FACILITY

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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\CO001396_ThreeCrow\2_GIS\ArcMaps\0001_TRITR Fig_4_2-1 Proposed Access Route between TCEA to CBCPF .mxd - 7/21/2010 @ 1:11:35 PM

5 OPERATIONS

CBR operates a commercial scale in-situ leach uranium mine 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 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 CBR policy of providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures 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 SHEQMS 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 SHEQMS 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 CPF and associated operations and represents the management levels that play a key part in the SHEQMS that will also apply to the satellite facility. 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:

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 and Director of Safety, Health, Environment and Quality (SHEQ). 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 Director of SHEQ. The President has overall responsibility for approving the Three Crow 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 Safety, Health, Environment and Quality Management System (SHEQMS). 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 SHEQ or the RSO. The Vice President of Operations directly supervises the General Manager.

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 of SHEQ, the Manager of SHEQ or the RSO. The General Manager reports directly to the Vice President of Operations.

5.1.5 Director of Safety, Health, Environment, and Quality

The Director of SHEQ 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 SHEQMS. The Director of SHEQ is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The Director of SHEQ 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 SHEQ or the site RSO. The Director of SHEQ may also serve as Corporate Radiation Safety Officer and if doing so, shall meet the qualifications described in Reg. Guide 8.31.

5.1.6 Manager of Safety, Health, Environment, and Quality

The Manager of SHEQ is responsible for all radiation protection, health and safety, and environmental programs as stated in the SHEQMS and for ensuring that CBR complies with all applicable regulatory requirements. The manager is located at the offices of site operations. This manager is responsible for the drafting, approving and updating SHEQMS procedures on an annual basis. The Manager of SHEQ reports directly to the Director of SHEQ and supervises the site RSO to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. 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 SHEQ 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 Manager of SHEQ has a secondary reporting requirement to the President. The Manager of SHEQ 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 Technicians (HPT) 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 eliminate or mitigate 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 Manager of SHEQ. The RSO, as a direct report to the Manager of SHEQ, 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 regulations or license conditions, including the ALARA program. The RSO has no production-related responsibilities, maintaining independence from operations personnel.

5.1.8 Health Physics Technician

The 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. 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 5.7.6 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 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 SHEQ.

5.1.10 ALARA Program Responsibilities

The purpose of the ALARA program is to keep exposures to all radioactive materials and other hazardous material as low as possible, and to expose 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 program 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 Reg. Guide 8.31 (NRC 2002a), 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 SHEQMS;

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 SHEQMS;
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 SHEQMS, 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 SHEQMS;
2. Making 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

The SHEQMS formalizes the approach to environmental, health, and safety management to ensure a consistency across its operations. The SHEQMS 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 Cameco SHEQ Policy and regulatory requirements. The Manager of SHEQ with assistance from the RSO and Safety Supervisor, is responsible for drafting, approving, and updating (as needed) the SHEQMS site-specific procedures on an annual basis. More frequent updates may be made if site activities and/or conditions warrant such actions.

The SHEQMS:

- Assures that sound management practices and processes are in place to ensure that strong SHEQ 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 objectives; and
- Ensures continued improvement of programs and performance.

The SHEQMS 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 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 SHEQ objectives while satisfying CBR government requirements.

The SHEQMS 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 Reg. Guide 8.2 (NRC 1973).

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 SHEQMS 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. 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 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 (SRWPs) for periodic tasks that require similar radiological protection measures (e.g., maintenance work on a specified facility 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 SHEQMS 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 (SER) 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

A 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 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 SERP will implement the following review procedures for the evaluation of all appropriate changes to the facility operations as outlined in the SHEQMS 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:

<u>Current NRC License Requirements</u>

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.

<u>Ability to Meet NRC Regulations</u>

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 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 Project operations. Similar activities will be performed for the TCEA.

5.3.1 Radiation Safety Inspections

5.3.1.1 Daily and Weekly Inspections

The RSO and the facility foreman, or designees, should conduct a weekly inspection of all facility areas to observe general radiation control practices and review required changes in procedures and equipment. The RSO, HPT, or qualified designee, should conduct 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. Problems observed during all inspections should be noted in writing in an inspection logbook or other retrievable record format. The entries should be dated, signed, and maintained on file for at least 1 year. The RSO should review all violations of radiation safety procedures or other potentially hazardous problems with the resident manager or other mine employees who have authority to correct the problem. Also, the RSO should review the daily work-order and shift logs on a regular basis 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 staff, or the RSO designee prior to initiation of work.

5.3.1.2 Monthly Reviews

At least monthly, the RSO should review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month. The RSO should provide to the resident manager and all department heads for their review a written summary of the month's significant worker protection activities that contains (1) a summary of the most recent personnel exposure data, including bioassays and time-weighted calculations, and (2) a summary of all pertinent radiation survey records.

In addition, the monthly summary report should specifically address any trends or deviations from the radiation protection and ALARA program, including an evaluation of the adequacy of the implementation of license conditions regarding radiation protection and ALARA. The summary should provide a description of unresolved problems and the proposed corrective measures. Monthly summary reports should be maintained on file and readily accessible for at least 5 years.

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 the SHEQMS Volume VI, *Environmental Manual,* and is based on the guidance in Reg. Guide 3.11.1 (NRC 1980a). The existing pond inspection program will be used as applicable as the basis for inspections on the TCEA evaporation ponds. 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 SHEQ 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 Reg. 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 audit report should summarize the following data:

- Employee exposure records (external and time-weighted calculations).
- Bioassay results.
- Inspection log entries and summary reports of daily, weekly, and monthly inspections.
- Documented training program activities.
- Radiation safety meeting reports.
- Radiological survey and sampling data.
- Reports on overexposure of workers submitted to the NRC.
- Operating procedures that were reviewed during this time period.

The report on the annual radiation protection and ALARA audit will specifically discuss the following:

- Trends in personal exposures for identifiable categories of workers and types of operational activities.
- Whether equipment for exposure control is being properly used, maintained, and inspected.
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report specifically discusses the following:

- Trends in personnel exposures.
- Proper use, maintenance and inspection of equipment used for exposure control.
- 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. 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 radiological standards are being met at the Three Crow site. The Lead Operator at the satellite facility or wellfield operations would have the responsibility for responding to any spill requiring cleanup. Facility operators and wellfield operators, who have received spill response training, would conduct the cleanup operations.

The proposed management audit and inspection programs for the the satellite facility would be sufficient for the type of operations and number and type of employees. CBR has projected that the staffing level for the the satellite facility would be twelve full-time CBR staff members to staff 3 employees per 12-hour shift (One lead Operator and two facility operators). These new employees will be needed for the satellite facility, wellfield operations and maintenance positions. Other staff members working out of the CPF that would occasionally visit the satellite facility and associated wellfields would include the RSO, HPT, Safety Supervisor, Manager of SHEQ, 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 RSO are as follows:

- Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in Uranium Recovery (UR) facility radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.
- Health Physics Experience: At least 1 year of work experience relevant to UR operations in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actual work with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training - At least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery. In addition, the RSO should attend refresher training on UR facility health physics every 2 years.
- Specialized Knowledge - A thorough knowledge of the proper application and use of all health physics equipment used in the UR facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the UR process and equipment used in the facility and how hazards are generated and controlled during the UR process.

5.4.2 Health Physics Technician Qualifications

In addition to the RSO, there should be a minimum of one full-time health physics technician at any full-scale operating UR facility. The health physics technician should have **one** of the following combinations of education, training and experience:

- Education: An associate degree or 2 or more years 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 UR facilities;
- 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 UR facility; **OR**
- Education: 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 UR facilities; and

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

The health physics technician should demonstrate a working knowledge of the proper operation of health physics instrument used in the UR facility, surveying and sampling techniques, and personnel dosimetry requirements.

5.5 Radiation Safety Training

All site employees and contractor personnel at the CPF are administered a training program based upon the SHEQMS covering radiation safety, radioactive material handling, and radiological emergency procedures. The CBR Training Program in the SHEQMS 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 Reg. Guide 8.29, Reg. Guide 8.31, and Reg.Guide 8.13 (NRC 1996, 2002a, and 1999a). 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 TCEA.

5.5.1 Training Program Content

5.5.1.1 Visitors

Visitors to the site 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 employees as discussed in Section 5.4.3.3.

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 Reg. Guide 8.31:

1. Fundamentals of Health Protection
   - The radiologic and toxic hazards of exposure to uranium and its daughters,
   - How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration),
   - Why exposures to uranium and its daughters should be kept ALARA.
2. Personal Hygiene at UR Facilities
   - Wearing protective clothing,

- Using respiratory protective equipment correctly,
- Eating, drinking, and smoking only in designated area,
- Using proper methods for decontamination (i.e., showers).

3. Facility-Provided Protection
   - Ventilation systems and effluent controls,
   - Cleanliness of the work place,
   - Features designed for radiation safety for process equipment,
   - Standard operating procedures,
   - Security and access control to designated areas,
   - Electronic data gathering and storage,
   - Automated processes.
4. Health Protection Measurements
   - Measurement of airborne radioactive materials,
   - Bioassays to detect uranium (urinalysis and in vivo counting),
   - Surveys to detect contamination of personnel and equipment,
   - Personnel dosimetry.
5. 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.
6. 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 understands the correct answer. 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 HPTs in radiation exposure monitoring and exposure determination programs, instrument calibration, facility inspections, posting requirements, respirator programs and Health Physics Procedures contained in the SHEQMS 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 the SHEQMS Volume VIII, *Emergency Manual.* 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 CPF 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 IX resin removed from the restricted area for transfer to other areas.

At the satellite facility, licensed stored material would typically include loaded IX resin and byproduct waste awaiting disposal. Lixiviant would be found in production piping in the wellfield and wellhouses, production trunkline to the satellite facility, and within piping located in the satellite building. Loaded IX 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 CPF.

5.6.1 License Area and Facility Security

5.6.1.1 Current Central Processing Facility Area

The active mining areas are controlled with fences and appropriate signs. All CPF 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 CPF. A 24-hour per day 7-day per week staff is on duty in the CPF.

CPF 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 (**Figures 3.2-1 and 3.2-2**) or, if in controlled or unrestricted areas, is properly secured. In particular, operators ensure that loaded IX 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 CPF 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 General Manager or the Manager of Safety, Health, Environment, and Quality.

5.6.2 Three Crow Security

Entrance to the TCEA site will be via the gravel Four Mile 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 facility 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 satellite facility serves as a control for industrial/property protection purposes (**Figure 3.2-2**), with the restricted area noted in red on **Figure 3.2-1**. The entire area within the security fencing surrounding the evaporation ponds will be a designated restricted area (**Figure 3.2-2**). 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 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 satellite facility are shown in **Figures 3.2-1 and 3.2-2**. 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, or inspectors, entering the satellite facility site will be required to register at the facility office and will not be permitted inside the facility 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 RSO or designee. Training requirements associated with visitors and contractors are discussed in Section 5.5.

The satellite facility will routinely operate 24 hours per day and 7 days per week, so that CBR employees will normally be on-site except for occasional shutdowns. The satellite facility structure will be equipped with locks to prevent unauthorized access. All facility 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 IX resin and byproduct 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 IX resin and parked within or near the satellite facility building.

Wellhouses where pregnant lixiviant solutions would be present in the production piping would be kept locked. Only authorized personnel would have keys to the wellhouses. The production trunk line conveying pregnant lixivant from the wellhouses 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 SHEQMS, Volume IV *Health Physics Manual,* 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 TCEA is 32.3 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 7.4 mrem per year. It is unlikely that even frequent visitors to the TCEA 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 in 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 IX resin from a satellite facility to the CPF 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 in a 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 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; and
- 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 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 satellite facility will be the release of radon-222 gas from the production solutions. Elution and processing of uranium product will be performed at the CPF, where a vacuum dryer is used for drying the yellowcake product. Therefore, there will be no airborne particulate effluent from the satellite facility.

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

Venting to the atmosphere outside of the facility building minimizes personnel exposure. Small amounts of radon-222 may be released in the satellite facility building during solution spills, filter changes, IX resin transfer operations and maintenance activities. The satellite facility 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 Reg. Guide 3.56 (NRC 1986). 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 satellite facility 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 TCEA will be treated using IX (IX) and 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 RO unit is typically used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. 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 CPF by three methods:

- Evaporation from the evaporation ponds;

- Deep well injection; and
- Land application.

CBR proposes to handle liquid effluents from the satellite facility 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 Reg. Guide 3.11 (NRC 1977). 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 satellite facility.

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 SHEQ, 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, the evaporation pond or deep disposal well.

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 CPF and the wellfield. These are generally small, short duration releases because engineering controls detect pressure changes in the piping systems and alert the facility operators through system alarms.

In general, piping from the satellite facility to and within the wellfield will be constructed of PVC or 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 facility, 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 SHEQMS Volume VIII, *Emergency Manual.*

CBR 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 the SHEQMS 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 IX resin enroute to or from the CPF. Tanker trailers used for transportation of IX resin between the satellite facility and the CPF 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 CPF. 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 CPF 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 satellite facility, 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 CPF 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 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 CPF and should not be a problem at the satellite facility 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 satellite facility construction may also produce the same effect. Vegetation 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 facility 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 facility 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 satellite facility, 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.

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 satellite facility. The required frequency is quarterly in designated Radiation Areas and semiannually in all other areas of the facility. 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:

- 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
- 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 the SHEQMS Volume IV, *Health Physics Manual.* Proposed survey locations for the satellite facility are shown on **Figure 2.9-9**. Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions. Surveys are performed in accordance with Reg. Guide 8.30 (NRC 2002b).

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake are recommended in Reg. Guide 8.30, Section 1.4 and are performed in accordance with the instructions currently contained in SHEQMS 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 CPF, beta surveys should not be necessary at the satellite facility.

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 Reg. Guide 8.34 (NRC 1992a). CBR believes that it is not likely that any employee working at the satellite facility 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 Three Crow process facility 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 the SHEQMS 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 satellite facility will not have aged sources of yellowcake since it is frequently transferring the IX resin to the CPF for further processing.

Cumulative Exposures

Based on the proposed type of operations (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 Three Crow site and the current main operating CPF. The satellite facility will 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 facility personnel at the satellite facility will 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 Facility Airborne Radiation Monitoring Program

The proposed airborne sampling location for the satellite facility is shown on **Figure 5.7-2**. 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 exposure (**Figure 5.7-2**). Proposed satellite facility survey and sampling Locations address potential 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.

The satellite facility would be subject to requirements of the SHEQMS Volume III *Operating Manual*, 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 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 Reg. 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 ALARA and is in conformance with regulatory requirement identified in 10 CFR Part 20.

5.7.2.3 Airborne Uranium Particulate Monitoring

Airborne particulate levels at solution mines that ship loaded IX resin are normally very low since the product is wet. No precipitation, drying, or packaging of source material will be performed at the 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 SHEQMS Volume IV, *Health Physics Manual.* The Air Monitoring Chapter implements the guidance contained in Reg. Guide 8.25 (NRC 1992b). 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 SHEQMS 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, and occurs 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 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 5×10^{-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 3×10^{-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 satellite facility. 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 the SHEQMS Volume III *Health Physics Manual*.

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).

5.7.2.4 Radon Daughter Concentration Monitoring

Surveys for radon daughter concentrations will be conducted in the operating areas of the satellite facility on a monthly basis. Sampling locations will be determined in accordance with the guidance contained in Reg. Guide 8.25. Section 3.1 of Reg. 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 the SHEQMS Volume IV, *Health Physics Manual.* Samplers will be calibrated at the manufacturer's suggested interval or daily before use with a digital mass flowmeter or other primary calibration standard. Air sampler calibration will be performed in accordance with the instructions currently contained in the SHEQMS 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.

5.7.2.5 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 SHEQMS Volume IV, *Health Physics Manual.* The respirator program is designed to implement the guidance contained in Reg. Guide 8.15 (NRC 1999b) and Reg. Guide 8.31 (NRC 2002a). The respirator program is administered by the RSO as the Respiratory Protection Program Administrator (RPPA).

Since airborne uranium concentrations at the 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 Three Crow would be determined by SOPs and Radiation Work Permits for specific tasks. The CBR respirator policy and requirements of respirator use are discussed in detail in the SHEQMS.

5.7.3 Exposure Calculations

Employee internal exposure to airborne radioactive materials at the satellite facility will be determined based upon the requirements of 10 CFR § 20.1204 and the guidance contained in Reg. Guides 8.30 and 8.7 (NRC 2002b and 1992c). Following is a discussion of the exposure calculation methods and results.

5.7.3.1 Natural Uranium Exposure

Exposure calculations for airborne natural uranium are carried out using the intake method from Reg. 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, µg/m^3, µCi/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 the satellite facility, the occupancy time for "routine" operations would be an exposure period based on actual hours worked (12-hours shift period for facility 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 RWPs 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 satellite facility that have been used to date at the CPF and which are currently contained in the SHEQMS 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 Reg. Guide 8.30 to estimate internal doses. As an example, the Committed Effective Dose Equivalent (CEDE) can be calculated using Equation 2 in Reg. 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.

5.7.3.2 Radon Daughter Exposure

Exposure calculations for airborne radon daughters are carried out using the intake method from Reg. 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 satellite facility that have been used to date and which are currently contained in the SHEQMS 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 Reg. Guide 8.30 where:

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

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

5.7.3.3 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 Reg. Guide 8.36 (NRC 1992d).

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.

5.7.4 Bioassay Program

CBR has implemented a urinalysis bioassay program at the Crow Butte Uranium Project facilities that meets the guidelines contained in Reg. Guide 8.22 (NRC 1988). 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 Reg. Guide 8.22.

Elements of the quality assurance requirements for the Bioassay Program are based upon the guidelines contained in Reg. 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 satellite facility. The facility 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 Reg. Guide 8.22 and with the instructions currently contained in SHEQMS Volume IV, *Health Physics Manual.*

5.7.5 Contamination Control Program

CBR will perform surveys for surface contamination in operating and clean areas of the satellite facility in accordance with the guidelines contained in Reg. 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.

The RSO, the radiation safety staff, or properly trained employees perform surveys of all items removed from the restricted areas with the exception of small, hand-carried items described above. Due to the distance separating the satellite facility and the CPF where the RSO and radiation staff is officed, it would be more efficient to have properly trained full-time personnel at the Three Crow site available to perform surveys for releasing items from the restricted area. Such a person would be the Lead Operator or a facility/wellfield operator trained by the RSO or radiation staff in the use of applicable radiation survey instruments and procedures. These staff members would have received training as operators and received radiation safety training 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 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"*, NRC, 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 Reg. 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 satellite facility will be conducted, concentrating on facility 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 satellite facility will be implemented in accordance with the SHEQMS Volume IV, *Health Physics Manual.*

5.7.6 Airborne Effluent and Environmental Monitoring Programs

CBR collected baseline monitoring data from 2007 to 2009. However, following discussions with the NRC, the preoperational baseline monitoring plan was revised to more fully meet the requirements of Reg. Guide 4.14. The key to this requirement is that the NRC considers the proposed satellite facility a "mill" as defined in Reg. Guide 4.14. This was not the previous interpretation by CBR and other uranium in situ operators. As a result, the revised program was initiated in January 2010 and will continue until 12-months of data (as applicable) have been collected and analyzed. The monitoring program is discussed in Section 2.9. The operations sampling locations will follow this preoperational monitoring program,

The operational baseline monitoring program is presented in **Table 5.7-1**.

Radon

The radon gas effluent released to the environment from satellite facility will be monitored at the same air monitoring locations (TCA-1 through TCA-5) that were used for baseline determination of radon concentrations as described in Section 2.9.2. Sampling locations are shown on **Figure 2.9-1**. Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged on a semiannual basis to achieve the required lower limit of detection (LLD). SHEQMS 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 Reg. 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 satellite facility would use pressurized downflow IX 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 IX 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. MILDOS-AREA outputs are presented in Appendix M and are discussed in Section 7.3.3. In determining the source term for MILDOS-AREA for the satellite facility, radon gas release was estimated at 25% of the radon-222 in the production fluid from the wellfields and an additional 10% in the IX circuit in the satellite building. The release of radon-222 at this concentration did not result in significant public dose.

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.

Surface Soil

Surface soil has been sampled as described in Section 2.9. Surface soil samples will be taken at the monitoring locations (TCA-1 through TCA-5 during operations. Following conclusion of operations, samples will be collected and will be compared to the results of the preoperational monitoring program. Samples shall be analyzed for natural uranium, ra-226, and pb-210.

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 facility 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 TCEA will be collected at the established sampling points described in Section 2.9 and shown in **Figure 2.9-8.**Vegetation samples will be collected at the sample areas during operations (3 samples during grazing season and analyzed for radium-226 and lead-210). Post operational vegetation samples will be collected following conclusion of operations and will be compared to the results of the preoperational monitoring program

Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (TCA-1 through TCA-5) during operations. 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

Upstream and downstream sediment samples from the White River will be collected annually at the sample locations described in Section 2.9 and shown in **Figure 2.9-7**. Samples will be collected as described in Section 2.9.7 and analyzed for natural uranium, radium-226, thorium-230 and lead-210.

5.7.7 Groundwater/Surface Water Monitoring Program

5.7.7.1 Program Description

During operations at the satellite facility, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. The CBR 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.

5.7.7.2 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

Private water supply wells W-269, W-274, W-275, W-312 and W-314 located within 0.5 mile of the TCEA license boundary will be sampled on a quarterly basis with continued landowner consent. Groundwater samples are taken in accordance with the instructions contained in SHEQMS Volume VI, *Environmental Manual.* Samples are analyzed for natural uranium and radium-226. Water well samples will be collected and analyzed as described in Section 2.9.3.1.

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 or as required by the NDEQ. 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 SHEQMS 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 (UCLs) 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 IX process (uranium is exchanged for chloride on the IX 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 NRC Project Manager is notified by telephone or email within 48 hours and notified in writing within thirty (30) 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.

5.7.7.3 Surface Water Monitoring

Surface water samples will be collected as described in Section 2.9. Samples will be collected on a quarterly basis and analyzed for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210, and Po-210. Sample locations are shown in **Figure 2.9-7.**

Surface water samples will be taken in accordance with the instructions contained in SHEQMS 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. Surface monitoring results are submitted in the semi-annual environmental and effluent reports submitted to NRC.

5.7.7.4 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 satellite facility and will meet the guidance contained in Reg. Guide 3.11 and Reg. 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 NRC 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 NRC 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.

5.7.8 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 SHEQMS 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

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Table 5.7-1 Three Crow Expansion Area Operational Monitoring Program

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
Air Particulates	3	On TCEA northern boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Nearest Resident	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Control background location east of TCEA License Boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon Gas	3	On TCEA northern boundary	Continuous using RadTrak Type DRNF	Monthly	Monthly	Rn-222
	1	Nearest Resident	Continuous using RadTrak Type DRNF	Monthly	Monthly	Rn-222
	1	Control background location east of TCEA License Boundary	Continuous using RadTrak Type DRNF	Monthly	Monthly	Rn-222
Groundwater	1	Wells within 0.5 Mile of site boundary (W-269, W-274, W-275, W-312, W-314	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Th-230 Pb-210 & Po-210
Surface Water	2[1]	White River (W-4 and W-5) Cherry Creek, Unnamed Creek, Bozle Creek	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Pb-210 & Po-210
	1	Cherry Creek Pond, Ice House Pond, Sulzbach Pond, & Grabel Pond(s)	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Pb-210 & Po-210
Vegetation	3	Established 3 sampling points at boundary downwind of satellite facility in predominent wind	Grab	3 times during grazing season	Each sample	Ra-226 & Pb-210

Table 5.7-1 Three Crow Expansion Area Operational Monitoring Program

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
		direction				
Food	3	Crops	Grab	Time of Harvest or Slaughter	1	Ra-226 & Pb-210
	3	Livestock			1	
	3	Private Garden Vegetables			1	
Fish	Each Body of Water	Collection of fish from White River (W-4 & W-5); Cherry Creek & Bozle Creek	Grab	Semiannually	2	Ra-226 & Pb-210
Surface Soil [2]	5	Same location used for collection of air particulates	Grab	Annually	Annually	Natural Uranium, Ra-226 & Pb-210
Sediment	2 from each stream	Up and down gradient samples from Cherry Creek, Unnamed Drainage, Bozle Creek & White River (W-4 & W-5)	Grab (Composite samples)	Annually	Annually	Natural Uranium, Ra-226, Th-230 & Pb-210
	1 from each pond	Cherry Creek Pond, Ice House Pond, Sulzbach Pond & Grable Pond(s)	Grab (Composite samples)	Annually	Annually	Natural Uranium, Ra-226, Th-230 & Pb-210
Direct Radiation (Continuous)	5	Same location used for collection of air particulates	Grab	Quarterly Change of Passive Dosimeters	Quarterly	Gamma exposure rate using a continuous integrating device

[1] Two from surface water that could be impacted by project operations.
[2] Surface soil samples collected to a depth of 5 cm using a consistent technique.

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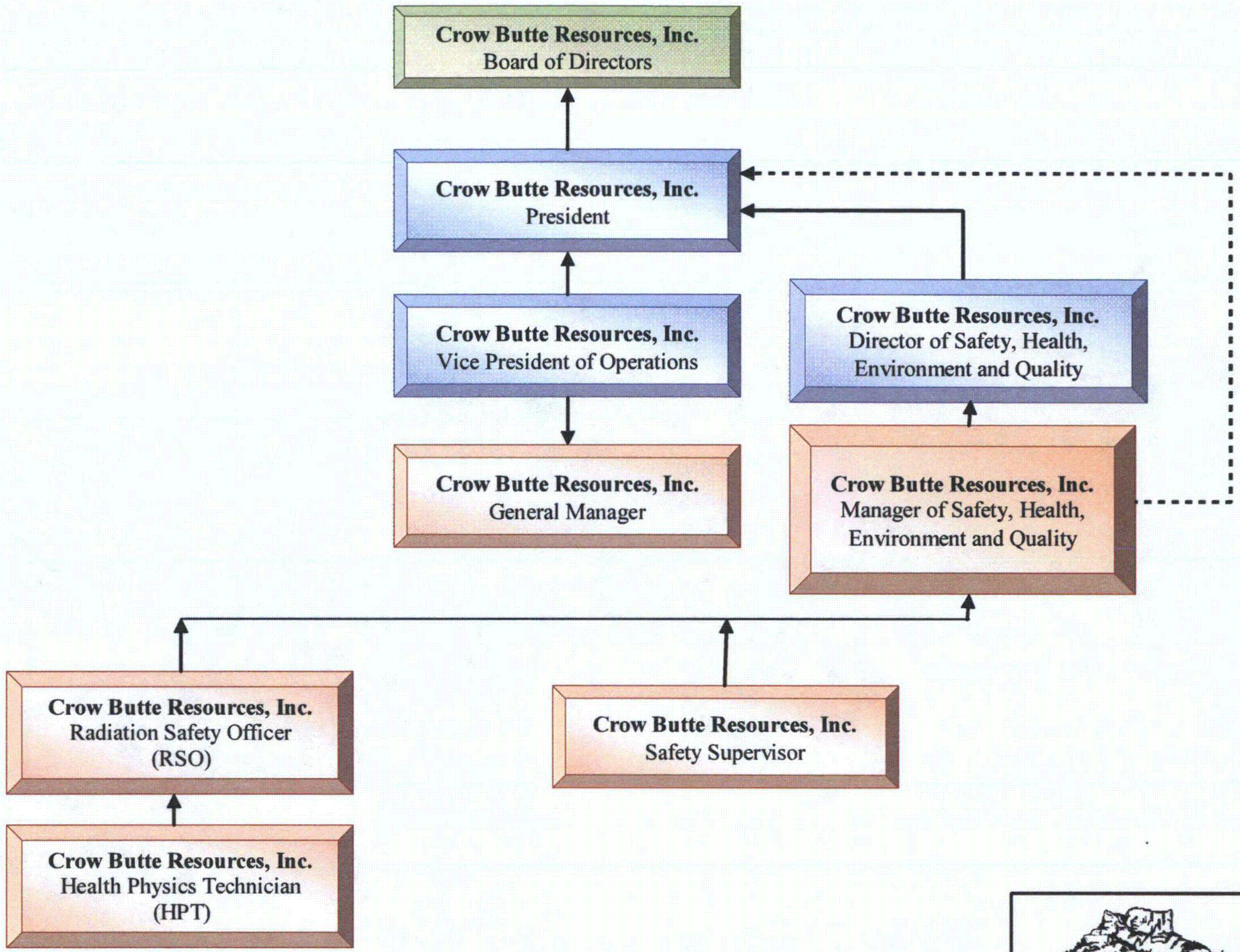

CROW BUTTE RESOURCES, INC.

FIGURE 5.1-1
CROW BUTTE RESOURCES ORGANIZATIONAL CHART

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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

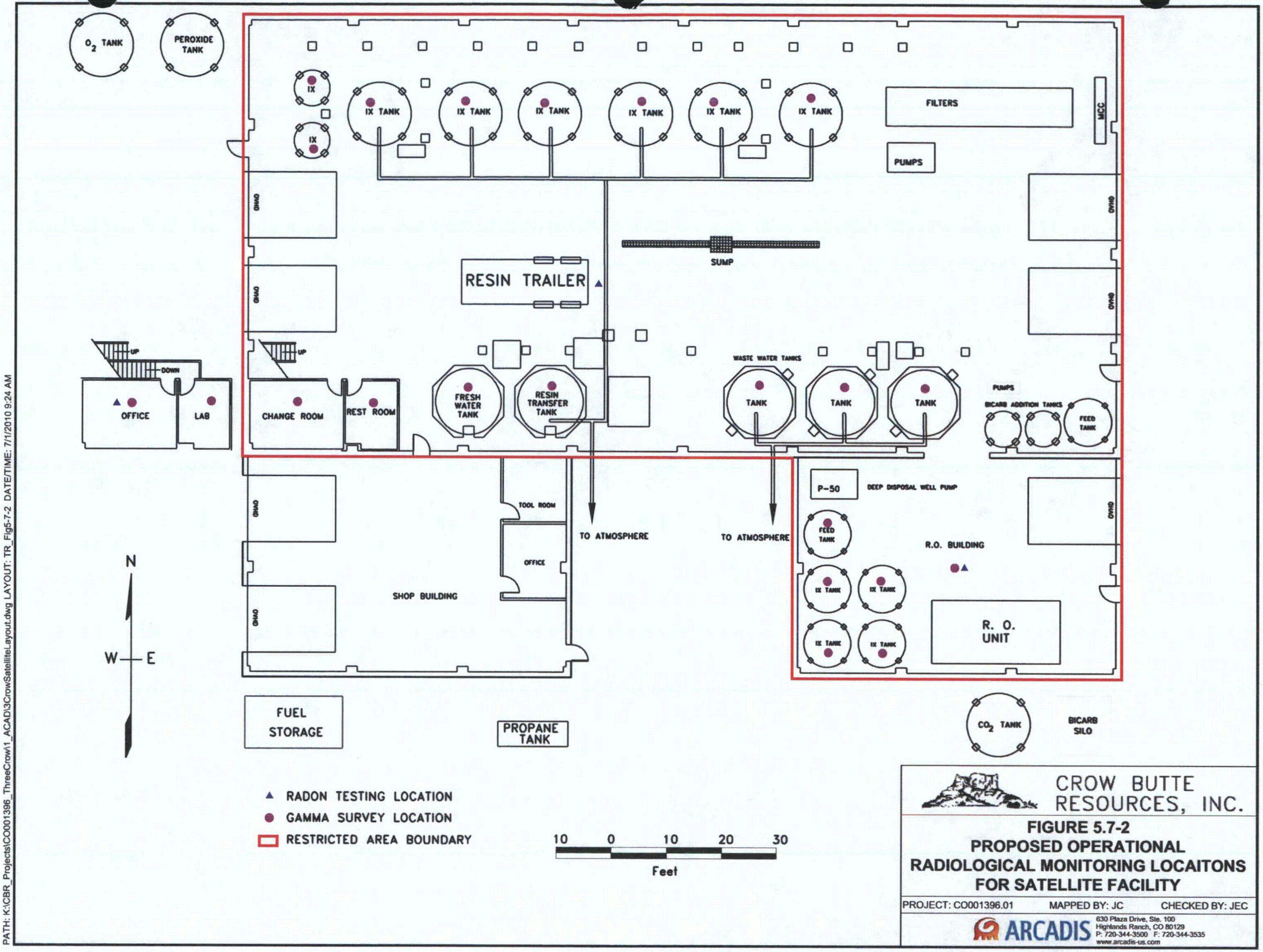

FIGURE 5.7-2
PROPOSED OPERATIONAL RADIOLOGICAL MONITORING LOCAITONS FOR SATELLITE FACILITY

PATH: K:\CBR_Projects\CO001396_ThreeCrow\1_ACAD\3CrowSatelliteLayout.dwg LAYOUT: TR_Fig5-7-2 DATE/TIME: 7/1/2010 9:24 AM

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 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 TCEA is similar to that found in the CPF license area. It is a roll front deposit in fluvial sandstone and is similar to those in the Wyoming 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.

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 TCEA 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 TCEA, 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 facility 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 facility 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 IX resins. In in-situ operations with chemistries similar to the TCEA, 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 TCEA 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 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.

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 six wells for each four acres is 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**.

Appendix L contains the restoration tables for Mine Units 1 through 10 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 Notice of Intent.

6.1.3.2 Establishment of Restoration Goals

Groundwater restoration standards are established by the NDEQ, with concurrence of the NRC and EPA. 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:

- The restoration parameters that have numerical groundwater standards established in NDEQ Title 118 (NDEQ 2006) or other established agency approved documents must be restored to the standard (maximum contaminant level [MCL]) unless the standard is exceeded by the mean of the preoperational sampling values (baseline mean).
- If the baseline concentration exceeds the applicable MCL as noted above, 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 on a wellfield average of the preoperational sampling data. These values (based on 3 samples from injection and production wells) would be averaged to obtain the assigned restoration value.
- 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**. All of the parameters listed in this table as parameters with numerical water standards (Title 118 or other sources) are subject to change by the NDEQ based on these procedures. NDEQ establishes the final groundwater restoration standards.

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, the groundwater is suitable for any use for which it was suitable before mining. NRC considers these NDEQ restoration goals as the secondary goals.

Prior to any mining in a mine unit, the groundwater restoration values that have been established based on the above procedures, are submitted to the NDEQ for approval. The restoration values for each mine unit would be based on current NDEQ Title 118 numerical standards and wellfield averages at the time the notice of intent is submitted to the NDEQ. All data to verify the selection of these wells would be submitted.

The primary goal of restoration is to, on a parameter-by-parameter basis, return the average wellfield unit concentration to baseline conditions. The secondary goal of groundwater restoration is to, on a parameter-by-parameter basis, return the average wellfield unit concentration to the numerical class-of-use standards established by the NDEQ. Groundwater restorations activities are in accordance with a groundwater water restoration plan approved by the NDEQ and NRC.

It is anticipated that the Class III UIC Permit issued for the TCEA will have similar requirements as described above. **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.

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 5 are currently undergoing restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the NRC. 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 CPF. 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.

The approved CBR restoration plan consists of four steps:

1. Groundwater transfer.
2. Groundwater sweep.
3. Groundwater treatment.
4. 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 (Process Related Chemicals). Instructions and safety precautions on the use of sodium sulfide are included in the SHEQMS Volume III *Operating Manual* (Restoration Reductant [Sodium Sulfide]).

The CBR 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 for a minimum of four quarters. 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 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 2.7-8** column "Typical Water Quality During Mining at CPF" 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 2.7.4 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 conducting a pilot study using bioremediation to complete restoration of Mine Unit 4 at the existing CPF. This bioremediation test was initiated on December 17, 2008. The injection of emulsified oil substrate (EOS, a registered product of EOS Remediation), was completed on April 08, 2009. The wells in the study area were shut down for 30 days. The wells are being sampled periodically to determine the effects of the EOS on the formation. Based on the results of this study, bioremediation may or may not be used at the TCEA. If the tests are successful, and use at the TCEA 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 Three Crow Wellfield would be 1,011,663,888 gallons. This is based on a calculated square footage of 15,544,844 ft^2 of the potential wellfield area, an average under-ream interval of 30 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 IX 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. IX, RO, and/or Electro Dialysis Reversal 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 RO unit. The use of an 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 water may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

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. 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 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 per month for a period of four quarters months, and if the 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.

The current 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. The NDEQ approves the stabilization period.

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 NRC. This information will also be included in the final report on restoration.

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 NRC 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.

6.2 Plans for Reclaiming Disturbed Lands

The following section addresses the final decommissioning methods of disturbed lands including wellfields, satellite facility areas, evaporation ponds, and diversion ditches that will be used on the Crow Butte Project sites. The section discusses general procedures to be used during final decommissioning as well as the decommissioning of a particular phase or production unit area.

Decommissioning of wellfields and process facilities, will be scheduled after agency approval of groundwater restoration and stability. Decommissioning will be accomplished in accordance with an approved decommissioning plan and the most current applicable NDEQ and NRC rules and regulations, permit and license stipulations and amendments in effect at the time of decommissioning.

The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 6.2.4.
- Determination of appropriate cleanup criteria for structures (Section 6.3) and soils (Section 6.4).
- Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 6.3.
- Decontamination of items to be released for unrestricted use to levels consistent with NRC requirements.
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.
- Perform final site soil radiation surveys.
- Backfill and recontour all disturbed areas.
- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the Crow Butte facilities. These activities and procedures will apply to the TCEA facilities as well as the current facilities. CBR will, prior to final decommissioning of an area, submit to the NRC and NDEQ a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning. As required by 10 CFR 40.36 (f), records of information important to TCEA decommissioning will be maintained in the office of the onsite RSO. Such information shall meet the criteria of 10 CFR 40.42 (g) (4) and (5).

6.2.1 General Surface Reclamation Procedures

The primary surface disturbances will be the satellite facilities (uranium recovery building, fuel and chemical storage, shop, office, rest rooms and laboratory), evaporation ponds, and wellfield production areas. Surface disturbances also occur during the well drilling program, pipeline installation, and road construction. These more superficial disturbances, however, involve relatively small areas or have short-term impacts.

The objective of the surface reclamation plan is to return disturbed lands to production compatible with the post mining land use of equal or better quality than the premining condition. For the Crow Butte area, the reclaimed lands should be capable of supporting livestock grazing and providing habitat for wildlife species. Soils, vegetation, wildlife and radiological baseline data will be used as guidelines for the design, completion and evaluation of surface reclamation. Final surface reclamation will blend affected areas with adjacent undisturbed lands so as to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind and water, sedimentation and re-establish natural trough drainage patterns.

The following sections provide reclamation procedures for the facility sites, wellfield production units, evaporation ponds, and access and haul roads. Reclamation schedules for wellfield production units will be discussed separately because they are dependent upon the progress of mining and the successful completion of groundwater restoration. Cost estimates for bonding calculations are discussed in Section 6.6 and include all activities that are anticipated to complete groundwater restoration, decontamination, decommissioning, and surface reclamation of wellfield and satellite facilities installed. These cost estimates are updated annually to cover work projected for the next year of mining activity.

6.2.1.1 Topsoil Handling and Replacement

In accordance with NDEQ requirements, topsoil is salvaged from building sites (including the satellite buildings) and pond areas. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which are determined during final wellfield construction activities.

As described in Section 2.6, topsoil thickness varies within the TCEA. Topsoil thickness is usually greatest in and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil stripping depths may vary in depth, depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, field mapping and Soil Conservation Service Soil Surveys will be utilized to determine approximate topsoil depths.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles are generally located on the leeward side of hills to minimize wind erosion. Stockpiles are not located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles are seeded as soon as possible after construction with the permanent seed mix.

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil is separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil is replaced and topsoil is applied. Mud pits generally remain open a short time. The success of revegetation efforts at the current site show that these procedures adequately protect topsoil and result in vigorous vegetation growth.

6.2.1.2 Contouring of Affected Areas

Due to the relatively minor nature of disturbances created by in-situ mining, there are only a few where subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. Generally speaking, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials, which requires replacement and contour blending during reclamation. The existing contours will only be interrupted in small, localized areas. Because approximate original contours will be achieved during final surface reclamation, no post mining contour maps have been included in this application.

Changes in the surface configuration caused by construction and installation of operating facilities will be temporary during the operating period. These changes will mitigated by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes. Restoration of the original land surface, which is consistent with the pre- and post-mining land use, the blending of affected areas with adjacent topography to approximate original contours and the reestablishment of drainage patterns will be accomplished by returning the earthen materials moved during construction to their approximate original locations.

Drainage channels that have been modified by the mine plan for operational purposes such as road crossings will be reestablished by removing fill materials, culverts and reshaping to as close to pre-operational conditions as practical. Surface drainage of disturbed areas that have been located on terrain with varying degrees of slope will be accomplished by final grading and contouring appropriate to each location so as to allow for controlled surface run off and eliminate depressions where water could accumulate.

6.2.1.3 Revegetation Practices

Revegetation practices are conducted in accordance with NDEQ requirements. During mining operations the topsoil stockpiles, and as much as practical of the disturbed wellfield and pond areas, will be seeded with vegetation to minimize wind and water erosion. After placement of topsoil and contouring for final reclamation, an area will normally be seeded with a seed mixture developed in consultation with the Natural Resource Conservation Service as required by the NDEQ.

6.2.2 Process Facility Site Reclamation

Following removal of structures as discussed in Section 6.3, subsoil and stockpiled topsoil will be replaced on the disturbances from which they were removed during construction, as practicable.

Areas to be backfilled will be scarified or ripped prior to backfilling to create an uneven surface for application of backfill. This will provide a more cohesive surface to eliminate slipping and slumping. The less suitable subsoil and unsuitable topsoil, if any, will be backfilled first so as to place them in the deepest part of the excavation to be covered with more suitable reclamation materials. Subsoils will be replaced using paddle wheel scrapers, bulldozers or other appropriate equipment to transfer the earth from stockpile locations or areas of use and to spread it evenly on the ripped disturbances. Motorgraders may be used to even the spread of backfill materials. Topsoil replacement will commence as soon as practical after a given disturbed surface has been prepared. Topsoil will be picked up from storage locations by paddle wheel scrapers or other appropriate equipment and distributed evenly over the disturbed areas. The final grading of topsoil materials will be done so as to establish adequate drainage and the final prepared surface will be left in a roughened condition.

6.2.3 Evaporation Pond Decommissioning

6.2.3.1 Disposal of Pond Water

The volume of water remaining in the lined evaporation ponds after restoration as well as its chemical and radiological characteristics will be considered to determine the most practical disposal program. Disposal options for the pond liquid include evaporation (e.g., sprinklers), treatment and disposal in the deep well, or transportation to another licensed facility or disposal site. There are currently no plans for treating and discharging the pond water to public waters under an NPDES permit.

6.2.3.2 Pond Sludge and Sediments

Pond sludges and sediments will contain mining process chemicals and radionuclides. Wind blown sand grains and dust blown into the ponds during their active life also add to the bulk of sludges. This material will be contained within the pond bottom and kept in a dampened condition at all times, especially during handling and removal operation to prevent the spread of airborne contamination and potential worker exposure through inhalation. Dust abatement techniques will be used as necessary. The sludge will be removed from the ponds and loaded into roll off containers, dump trucks or drums and transported to an NRC licensed disposal facility.

6.2.3.3 Disposal of Pond Liners and Leak Detection Systems

Pond liners will be kept washed down and intact as much as practical during sludge removal so as to confine sludges and sediments to the pond bottom. Pond liners will be cut into strips and transported to a NRC licensed disposal facility or will be decontaminated for release to an unrestricted area. After removal of the pond liners, the pond leak detection system piping will be removed. Materials involved in the leak detection system will be surveyed and released for unrestricted use if not contaminated or transported to a NRC licensed facility for disposal. The earthen material in the pond bottom and leak detection system trenches will be surveyed for soil contamination. Any contaminated soil in excess of the cleanup criteria discussed in Section 6.4 will be removed and disposed at a NRC licensed disposal facility.

Following the removal of all pond materials and the disposal of any contaminated soils, surface preparation will take place prior to reclamation.

6.2.3.4 On Site Burial

At the present time, on site burial of contaminants is not anticipated. However, depending upon the availability of a NRC licensed disposal site at the time of decommissioning, on site burial may become a potential alternative. Should this occur, pond locations would be considered initially as the on site disposal locations for contaminated materials. Appropriate licensing with the regulatory agencies would be obtained prior to any on site disposal of contaminated wastes.

6.2.4 Wellfield Decommissioning

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities discussed below. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged.
- Removal of buried well field piping.
- Wells will be plugged and abandoned according to the procedures described below.
- The wellfield area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.
- Final revegetation of the wellfield areas will be conducted according to the revegetation plan.
- All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.

It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted area landfill. Other materials that are contaminated will be acid washed or decontaminated with other methods until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a NRC licensed disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence at the CPF and at the TCEA. Once a production unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the wellfield will be scheduled for decommissioning and surface reclamation.

6.2.4.1 Well Plugging and Abandonment

All wells no longer useful to continue mining or restoration operations will be abandoned. These include all injection and production wells, monitor wells, and any other wells within the production unit used for the collection of hydrologic or water quality data or incidental monitoring purposes. The only known exception at this time may be a shallow well that could be transferred to the landowner for domestic or livestock use.

The objective of the Crow Butte well abandonment program is to seal and abandon all wells in such a manner as to assure the groundwater supply is protected and to eliminate any potential physical hazard.

Prior to abandoning a well, data will be gathered (static water level, under-ream interval, casing depth) for use in a well abandonment spreadsheet that accounts for formation pressures, mining injection pressures, static water level, casing depth, materials used and weight of material used. Based on that information, adjustments can be made to the amount of bentonite chips to be used to plug the well screens, and also to calculate the minimum weight (lbs/gallon) of abandonment mud to be used to fill the hole to the surface and keep formation and mining pressures from allowing water to rise in the borehole. A prepackaged bentonite filled tube is currently used for plugging of the well screens. These tubes are placed into the screens by filling the well to the surface with water from a water truck, and then dropping the bentonite tubes down the well. The water is allowed to run while the tubes make their descent into the screens. The drill rig then trips drill pipe into the well and tags the bentonite to make sure it has reached the targeted depths. The drill stem is raised approximately 10 feet and a Plug-gel abandonment mud is mixed. If the weight of the abandonment mud needs to be increased, an amount of barite may be added to increase the weight. Likewise, a drilling additive (Dris-pac) to improve the ability of the abandonment mud to carry the barite may be added. In situations where it appears that the operating pressure and formation pressure are great enough to make it difficult to mix heavy mud, cement slurry may be substituted to fill the casing to the surface. All abandoned wells will remain above the surface until the wellfield is reclaimed. This will allow for the continuation of monitoring and observation of the integrity of the abandonment fluid. If needed, additional abandonment fluids will be added.

The plugging method is approved by the NDEQ and is generally as summarized below:

- A mechanical plug may be placed above the screened interval.
- Thirty to fifty feet of coarse bentonite chips will be added to provide a grout seal.
- A plug gel or cement grout will be placed by tremie pipe from the chips to the top of the casing. The weight of the gel or grout plus the weight of the bentonite chips will be enough to exceed the local Chadron formation pressure plus the maximum injection pressure allowed (100 psi).
- The tremie pipe will be removed (when possible) and the casing will be filled to the surface.
- An approved hole plug will be installed.
- The well casing will be cut off below ground level, capped with cement, and the surface disturbance will be smoothed and contoured.

- The hole will be backfilled and the area revegetated.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning. CBR must submit a notarized affidavit to the NDEQ detailing the significant data and the procedure used in connection with each well plugged. The DNR also requires filing a well abandonment notice for all registered wells.

6.2.4.2 Buried Trunklines, Pipes and Equipment

Buried process related piping such as injection and production lines will be removed from the mine unit undergoing decommissioning. Salvageable lines will be held for use in ongoing mining operations. Lines that are not reusable may either be assumed to be contaminated and disposed of at a licensed disposal site or may be surveyed and, if suitable for release to an unrestricted area, may be sent to a sanitary landfill.

6.3 Removal and Disposal of Structures, Waste Materials, and Equipment

CBR would submit a final and detailed decommissioning plan for structures and equipment to the NRC for review and approval at least 12 months before the planned commencement of decommissioning of such structures and equipment. This final decommissioning plan would include a description of structures and equipment to be decommissioned, a description of planned decommissioning activities, a description of methods to be used to ensure protection of workers and the environment against radiation hazards, a description of the planned final radiation survey, and an updated detailed cost estimate.

The procedures to be used for removing and disposing of structures, waste materials and equipment would meet the following criteria:

- A written program is in place to control residual contamination on structures and equipment.
- Measurements of radioactivity on the interior surface of pipes, drain lines, and duct work would be determined by conducting measurements at all traps and other appropriate access points, provided that such contamination is likely to be representative of contamination on the interior of the pipes, drain lines and ductwork.
- Any surfaces of premises, equipment or scrap that would likely be contaminated, but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement, would be presumed to be contaminated in excess of the limits.
- Prior to the release of structures for unrestricted use, a comprehensive radiation survey would be made to establish that contamination is within the limits specified in NRC *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material* (NRC 1993) and NRC approval would be obtained.
- A contract between CBR and a waste disposal operator would be in place to dispose of 11e.(2) byproduct material.

6.3.1 Preliminary Radiological Surveys and Contamination Control

Prior to satellite building decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations (as discussed in Section 5.7) will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

6.3.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new location within the Crow Butte site for further use or storage;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other non-restricted use by others.

It is most likely that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts were unsuccessful, the material would be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a licensed disposal site or properly licensed facility if contaminated.

6.3.2.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with license conditions contained in SUA-1534 and NRC guidance.

The CBR release limits for alpha radiation are as follows:

- Removable of 1,000 dpm/100cm^2
- Average total of 5,000 dpm/100 cm^2 over an area no greater than one square meter
- Maximum total of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2

Monitoring for beta contamination is a current license requirement. This requirement has been eliminated in subsequent ANSI standards, including ANSI/HPS N13.12 (ANSI 1999). In addition, CBR has routinely made these measurements but has never found them limiting.

Decontamination of surfaces will comply with the CBR ALARA policy, to reduce surface contamination as far below the limits as practical.

Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an NRC-licensed facility for disposal. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427.

6.3.2.2 Disposal at a Licensed Facility

If facilities or equipment are to be moved to a facility licensed for disposal of 11e.(2) byproduct material, the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling.
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the satellite building.
- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.
- All other miscellaneous contaminated material will be transported to a licensed disposal facility.

6.3.2.3 Release for Unrestricted Use

If a piece of equipment or structure is to be released for unrestricted use, it will be appropriately surveyed before leaving the licensed area. Both interior and exterior surfaces will be surveyed to detect potential contamination. Radioactivity levels would be determined on the interior surfaces of pipes, drain lines, or duct work by making measurements in all traps and other appropriate access points, provided that contamination at these locations would be expected to be representative of contamination on the interior of the pipes, drain lines or duct work. If the shape, size, or presence of inaccessible surfaces prevents an accurate and representative survey, the material will be assumed contaminated and properly disposed of. Appropriate decontamination procedures will be used to clean any contaminated areas and the equipment resurveyed and documentation of the final survey retained to show that unrestricted use criteria were met prior to releasing the equipment or materials from the site. The current release criteria are based on NRC guidelines. The criteria to be used for release to unrestricted use will be the appropriate NRC guidelines at that time. Release surveys will be based on the release methods discussed in Section 5.7.

If a process building is left on site for unrestricted use by a landowner, the following basic decontamination procedures will be used. Actual corrective procedures will be determined by field requirements as defined by radiological surveys.

After the building has been emptied, the interior floors, ceiling and walls of the building and exterior surfaces at vent and stack locations will be checked for contamination. Any remaining removable contamination will be removed by washing. Areas where contamination was noted will be resurveyed to ensure removal of all contamination to appropriate levels.

Process floor sumps and drains will be washed out and decontaminated using water and, if necessary, acid solutions. If the appropriate decontamination levels cannot be achieved, it may be necessary to remove portions of the sump and floor to disposal.

Excavations necessary to remove trunklines or drains will be surveyed for contaminated earthen material. Earthen material that is found to be contaminated will be removed to a licensed disposal facility prior to backfilling the excavated areas.

The parking and storage areas around the building will be surveyed for surface contamination after all equipment has been removed.

Decontamination of these areas will be conducted as necessary to meet the standards for unrestricted use.

6.3.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed of at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. CBR currently maintains agreements with two such facilities located in the states of Utah and Wyoming for disposal of 11e.(2) byproduct materials generated by mining operations. A contract for disposal at a minimum of one facility will be maintained current as required in NRC License SUA-1534.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

6.4 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

6.4.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA goals and the chemical toxicity of uranium.

The proposed limits and ALARA goals for cleanup of soils are summarized in **Table 6.4-1** and described below.

The existing radium-226 criterion in 10 CFR Part 40, Appendix A, was used to derive a dose criterion (Benchmark Approach) for the cleanup of byproduct materials. The Benchmark Dose was modeled using the RESRAD code (Version 6.22). The RESRAD runs are shown as Appendix A of the *Wellfield Decommissioning Plan for Crow Butte Uranium Project* presented in **Appendix N.** The results show that a concentration of 537 pCi/g for natural uranium in the top 15 cm layer of soil for the resident farmer scenario is equivalent to the Benchmark Dose derived from a concentration of 5 pCi/g of radium-226.

ALARA considerations require that an effort be made to reduce contaminants to as low as reasonably achievable levels. The ALARA goals are normally based on a cost-benefit analysis. For the cleanup of gamma-emitting radionuclides, the cost of cleanup becomes excessively high as soil concentrations and/or gamma emission rates become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels along with appropriate field survey and sampling procedures result in near background radium-226 concentrations for the site. In addition, the presence of a mixture of radium-226 and uranium will tend to drive the cleanup to even lower radium-226 concentrations. It is therefore believed that no specific ALARA goal is required for surface radium-226.

CBR proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. According to the RESRAD runs presented in **Appendix N**, the ratio of radium-226 dose rate per pCi/g to the uranium dose rate per pCi/g is 120. It is also shown by calculation that the ratio of radium-226 to uranium emission rates is 30. Therefore, if the action level for pure radium-226 results in cleanup of the site to less than 5 pCi/g, the action level should result in the cleanup of pure uranium to 30 times 5 or 150 pCi/g.

The uranium concentration should be limited to – at most – 230 pCi/g for all soil depths because of chemical toxicity concerns. Using the most conservative daily limit corresponding to the National Primary Drinking Water Standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day.

CBR desires to reduce subsurface concentrations to a maximum of two-thirds of the proposed limit of 15 pCi/g radium-226. The subsurface uranium goal has not been reduced since it has not been demonstrated that these levels can be detected with readily available field instruments.

Section 2.5 of **Appendix N** demonstrates that spills of process solutions at the CPF are not likely to contain substantial amounts of thorium-230. CBR believes that development of soil cleanup criteria for thorium-230 is not appropriate at this time. In the unlikely event that a situation exists where thorium-230 is present in significant quantities, cleanup criteria will be developed using the radium-226 Benchmark approach and submitted to the NRC for approval prior to final site decommissioning.

6.4.2 Excavation Control Monitoring

CBR will use 17,900 cpm as its gamma action level, as determined with a Ludlum Model 44-10/2221 NaI detection system or equivalent held at 18 inches above ground surface. The gamma action level, defined as the gamma count rate corresponding to the soil cleanup criterion, will be used in the interpretation of the data. This action level will be used with caution, or until a new action level is developed.

Hand-held and GPS-based gamma surveys will be used to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

The 17,900 cpm action level was based on an evaluation of the correlation between gamma count rates and ra-226 concentration in soil using data from the few spill-related contaminated areas that existed at the CPF area. CBR believes that 17,900 cpm is a conservative value since the contaminated areas were small in size. The measured gamma emission rate per unit ra-226 concentration from small areas is normally lower than that which would be measured using large areas, such as 100- m^2 area. Therefore cleanup to 17,900 cpm should ensure that each 100- m^2 area meets the radium-226 soil cleanup standard.

Section 6.3 of **Appendix N** discusses the development of the 17,900 counts per minute (cpm) action level. It does however allow for a revision of the number should it later be determined not appropriate.

6.4.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas, including 10 m buffer zones.

CBR will divide the area systematically into 100 m^2 grid blocks and sample all grid blocks containing gamma count rates exceeding the gamma action level. The samples will be five-point composites, and analyzed at an offsite laboratory for radium-226 and natural uranium.

CBR will sample the remaining grid blocks with average gamma count rates ranking in the top 10 percent.

If any grid blocks within the top 10 percent fail the cleanup criteria, CBR will sample the second ten percent of grid blocks. This will continue until all grid blocks pass within a 10 percent grouping. To meet the cleanup criterion, each of the sampled grid blocks must satisfy the following inequality,

$$\sum \frac{C_i}{Cc} < 1$$

where C_i is the concentration of the constituent and C_c is the concentration of the constituent that is equivalent to the Benchmark Dose.

CBR will remediate the grid blocks failing this inequality or propose alternatives consistent with Appendix A of 10 CFR 40.

After all sampled grids have met the inequality, an EPA-recommended statistical test will be done to determine whether the mean of the equality defined above for all grid blocks is 1 or less at the 95 percent confidence level, using Equation 8-13 of draft NUREG/CR-5849 (NRC 1992). If the mean of the sample concentrations is less than the criterion but the data fail the statistical test, CBR will follow procedures similar to those recommended in Section 8.6 of draft NUREG/CR-5849 (NRC 1992).

6.4.4 Subsurface Soil Cleanup Verification and Sampling Plan

For subsurfaces, CBR will adopt different survey and sample protocols, depending on the type and size of excavation. CBR will rely more on sampling and radium-226 and natural uranium analysis over surveying, to verify cleanup of subsurface excavations. The protocols are summarized in site procedures.

6.4.5 Temporary Ditches and Impoundments Cleanup Verification and Sampling Plan

CBR will adopt survey and sample protocols for temporary ditches and surface impoundments on a case-by-case basis. Ditches and impoundments can extend from the surface to the subsurface. For the purpose of decommissioning, the surfaces will be considered as part of adjacent soil surfaces. The subsurfaces will be surveyed and sampled systematically, based on their size and geometry. As with other subsurfaces, CBR will rely more on sampling and radium-226 and uranium analysis over surveying to verify cleanup of ditches and impoundments. Surveying is applicable in larger impoundments, however, wherein the effects of geometry are not as pronounced, particularly in areas not influenced by adjacent walls.

6.4.6 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The criteria that CBR will use to select the commercial laboratory will follow the guidance published in the Multi-Agency Radiological Laboratory Analytical Protocols Manual (NRC 2004). The commercial laboratory will adhere to a well-defined quality assurance program that addresses the laboratory organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, SOPs, sample receipt, handing, storage, records, and appropriate licenses.

The analytical work performed by the commercial laboratory will adhere to CBR-defined Data Quality Objectives (DQOs). Part of the DQO process is specific analytical sensitivities required by CBR. The minimum sensitivity required for each sample will be 0.5 pCi/g dry weight for each analyte, with an estimated overall error of $\pm$ 0.5 pCi/g.

CBR will expect the reporting equivalent of an EPA Contract Laboratory Program Level 3 data package from the commercial laboratory.

CBR will maintain a laboratory QA file that will include, at a minimum, the laboratory Quality Assurance Manual (QAM) and audit reports.

6.5 Decommissioning Health Physics and Radiation Safety

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels are kept ALARA during decommissioning. This program will ensure that contamination and any use of the premises, equipment or scrap will not result in an unacceptable risk to the health and safety of the public or the environment. The RSO, HPT or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Reg. Guide 8.30 (NRC 2002) or other standards applicable at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC and NDEQ. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning.

6.6 Financial Assurance

6.6.1 Bond Calculations

Cost estimates for the purpose of bond calculations are made annually for the CPF site. The cost assessment includes groundwater restoration, decontamination and decommissioning and surface reclamation costs for all areas to be affected by the installation and operation of the proposed mine plan. The detailed calculations utilized in determining the bonding requirements for the CPF are submitted annually.

6.6.2 Financial Surety Arrangements

CBR maintains an NRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation activities. CBR maintains an Irrevocable Standby Letter of Credit issued by the Royal Bank of Canada (New York Branch) in favor of the State of Nebraska in the present (2010) amount of $28,902,051. This amount has been approved by the NDEQ and is under review by the NRC. The surety amount is revised annually in accordance with the requirements of SUA-1534. The surety amount will be revised to reflect the estimated costs of reclamation activities for the TCEA as development activities proceed.

6.7 References

Nebraska Department of Environmental Quality. (NDEQ). 2006. *Title 118 – Ground Water Quality Standards and Use Classification*, March 27, 2006.

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U.S. Nuclear Regulatory Commission. (NRC). 2002. Regulatory Guide No. 8.30, *Health Physics Surveys in Uranium Recovery Facilities*, May 2002.

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	--
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)	Reserved	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)	500	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

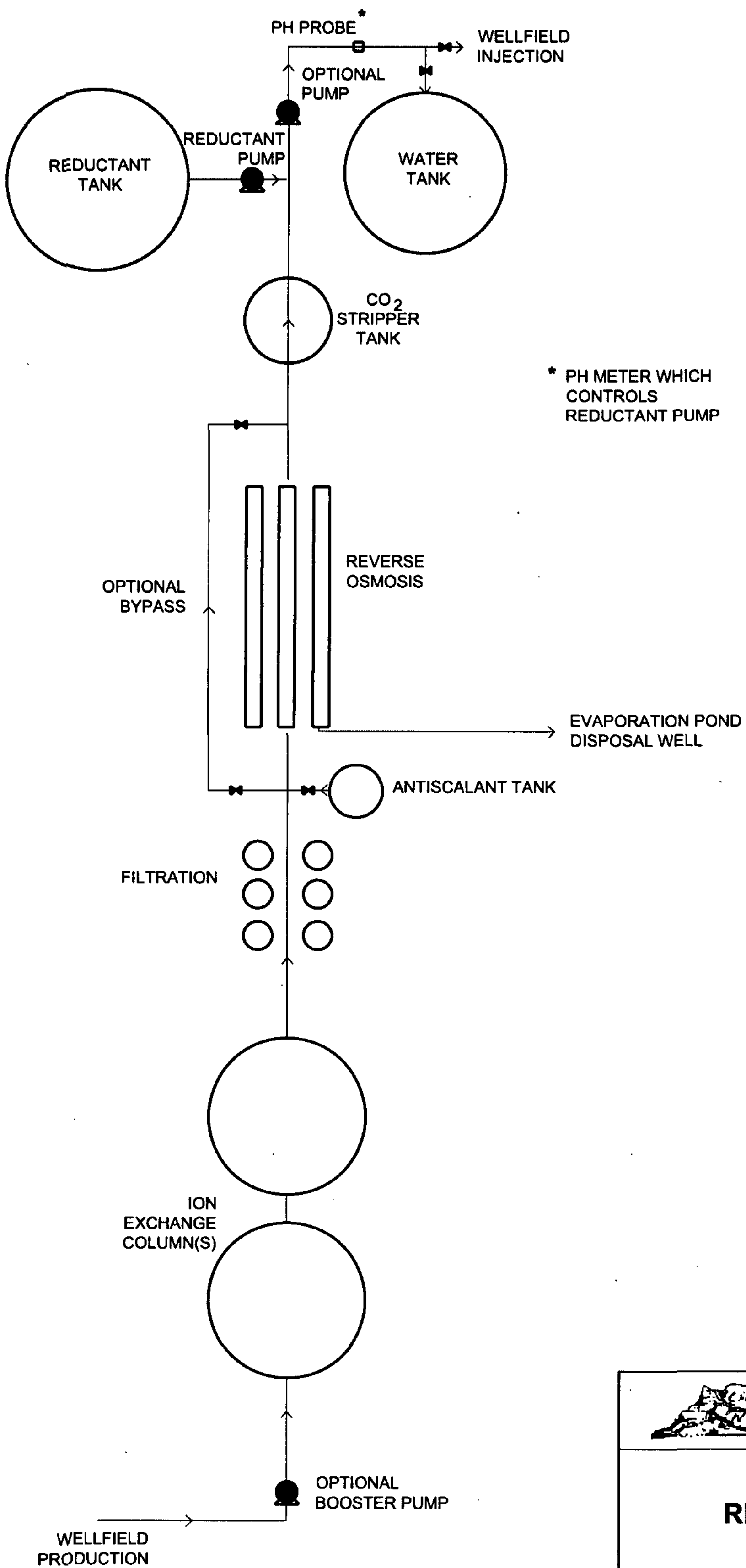
Table 6.1-2 Typical Reverse Osmosis Membrane Rejection

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.

Table 6.4-1 Soil Cleanup Criteria and Goals

	Radium-226 (pCi/gm)		Natural Uranium (pCi/gm)	
Layer Depth	*Limit*	*Goal*	*Limit*	*Goal*
Surface (0-15 cm)	5	5	230	150
Subsurface (15 cm layers)	15	10	230	230



CROW BUTTE RESOURCES, INC.

FIGURE 6.1-1
RESTORATION PROCESS FLOW DIAGRAM

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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

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.

This section discusses and describes the short and long term impacts associated with operations and the consequences of possible accidents at the CPF and the TCEA. Environmental impacts of the proposed satellite facility on scenic resources are discussed in Section 2.4.2.5.

7.1 Environmental Effects of Site Preparation and Construction

The initial site preparation and construction associated with the satellite facilityA will include the following:

- Construction of a satellite process facility located approximately 5.7 miles west of the current process facility. This satellite facility will be housed in a building approximately 130 feet long by 100 feet wide and will contain IX and associated equipment capable of processing 6,000 gpm of production flow and 1,500 gpm of restoration flow..
- Construction of solar evaporation ponds located in conjunction with the satellite facility and a deep well for disposal of wastewater.
- A deep well injection building and associated facilities.
- Access roads, as required.
- Expansion of the CPF to accomodate the increase in the IX resin handling, elution, precipitation, thickening and drying circuits to handle the additional production.

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 of the satellite facility are estimated based on the studies conducted by CBR which are 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.

Construction of the satellite facility will require disturbance of an estimated 671 acres for the satellite facility, wellfields, evaporation ponds and road improvements. Of this total, approximately 14 acres will be associated with the satellite facility, deep disposal well, and evaporation ponds. Surface disturbances will include construction of access roads, facility site grading, construction of evaporation ponds, and contouring for control of surface runoff. All areas disturbed will be reclaimed during final decommissioning activities. The planned schedule for construction, production, restoration, and decommissioning was presented in Section 1.

The primary surface disturbances associated with solution mining are the sites containing the processing facilities, associated facilities, facilities and evaporation ponds. Surface disturbances also occur during the well drilling program, pipeline installation, and road construction. These more superficial disturbances, however, involve relatively small areas or have short-term impacts.

Due to the relatively minor nature of disturbances created by in-situ mining, there are only a few areas disturbed to the extent to which subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. Generally speaking, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials, which requires replacement and contour blending during reclamation. The existing contours will only be interrupted in small, localized areas. Because approximate original contours will be achieved during final surface reclamation, no post-mining contour maps have been included in this application.

Changes in the surface configuration caused by construction and installation of operating facilities will be only temporary, during the operating period. These changes will be caused by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes.

These surface impacts are unavoidable and will last for the duration of the project until final decommissioning. Mitigation measures for land surface impacts are discussed in Section 6.2.

7.1.1 Air Quality Effects of Construction

Construction activities at the satellite facility 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. Estimated fugitive dust emissions during construction of in situ leach operations are less than two percent of the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and less than one percent for PM_{10} (NRC 2009).

There will be an increase in the total suspended particulates (TSP) in the region as a result of construction of the satellite facility. 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 facility pad areas, roads, and areas covered by the pond liners. Of these, the only significant source of TSP is dust emissions from unpaved roads.

A discussion as to specific regulatory issues associated with air quality impacts of operation is presented in Section 7.2.1.2.

7.1.2 Land Use Impacts of Construction

The principal land use for the 14 acre site associated with the proposed satellite facility, evaporation ponds, and disposal well is rangeland, primarily for livestock forage. Livestock and livestock products had a value of $28.61 per acre. Based on this average yield, construction activities in a 14 acre area would result in the lost livestock production of approximately $400 per year. Considering the relatively small size of the area impacted by construction, the exclusion of agricultural activities from this area over the life of the operation,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 can carry sediment and other pollutants that can potentially harm lakes, streams and wetlands. The 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 the NDEQ 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 (NDEQ 2005). 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 the SHEQMS 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.

Administrative and engineering controls implemented by CBR during initial site preparation and construction of the satellite facility and related facilities are expected to ensure that surface water impacts are minimal.

7.1.4 Population Impacts of Construction

The effects of construction of the proposed 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 City 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 satellite facility will be even smaller in scope. CBR estimates that four to seven temporary construction workers will be involved in constructing the 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

The project area is surrounded by agricultural lands and rural residences. The existing ambient noise in the vicinity of the Project area is dominated by intermittent, low levels of traffic noise from Four Mile Road, which is used primarily to access local residences and agricultural lands, and by intermittent noise from agricultural equipment. Nebraska SH 2/71 is located about 1.5 miles east of the TCEA boundary. U.S. Highway 20 (Hwy 20) is located less than one mile from the northwest corner of the TCEA. A Burlington Northern Santa Fe (BNSF) rail line is located east of SH 2/71 and is approximately 2.9 miles from the TCEA boundary at the closest point. Traffic noise from the highways and trains on the BNSF rail line would be intermittently audible to receptors within and in close proximity to the TCEA.

Increased vehicle travel and the operation of construction equipment at the satellite facility during the construction phase of the project would result in a slight increase in noise impacts to residents. Noise from construction equipment could raise noise levels as much as 9 dBA during the construction phase of the project. Noise from construction would not be generated during nighttime hours. Construction activities would typically occur over an 8-hour work day, 5 days per week. Increased noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction and construction traffic, (including movement of heavy equipment, which would be much less dense and slower than typical highway traffic) would be barely perceptible over the existing ambient noise that is intermittently dominated by vehicle noise from Four Mile Road. Noise from construction and construction traffic would be temporary and would briefly add to existing highway noise.

7.2 Environmental Effects of Operations

The major environmental concerns during the operation of the 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 nonradiological 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 at the satellite facility. 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.

The operations of the satellite facility will not result in major emissions of these nonradiological emissions and would therefore not be considered a major source of emissions under state permitting regulations, especially since the project will be located in an National Ambient Air Quality Standards (NAAQS) attainment area for all criteria pollutants and there are no Prevention of Significant of Deterioration (PSD) issues (see discussions below). This statement also would apply to the construction activities, which pose higher impact risks than the operations phase (see discussions in Section 7.1.1). Other nonradiological emissions occurring during operations would be fugitive dust emissions generated by activities such as onsite traffic related to operations and maintenance, employee traffic to and from the site, resin transfers from the satellite facility to the main CPF, and heavy truck traffic delivering supplies to the site and product from the site. Dust emissions associated with the operational phase will be less than the construction phase.

7.2.1.1 Particulate Emissions During Operations

The amount of dust generated during operations can be estimated from the following equation taken from "Supplement No. 8 for Compilation of Air Pollutant Emission Factors" (EPA 1978).

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

Where:

- E = emission factor, lb TSP per vehicle-mile
- s = silt content of road surface material, 40%
- S = average vehicle speed, 30 miles per hour
- 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 0.25 lb TSP per vehicle-mile. The distance from the City of Crawford to the satellite facility is approximately 8.3 miles. Approximately 4.0 miles of this distance is on improved roads and 4.3 miles is on dirt or trail roads. CBR expects that most employees at the satellite facility will travel from the City of Crawford. Assuming ten employees and a 7 day workweek, there would be 70 round trips per week and the weekly mileage on dirt or trail roads would be 602 miles. Deliveries and other travel may require up to 50 round trips per week which would be an additional 430 miles per week on dirt or trail roads.

The distance from the satellite facility to the Crow Butte Main Facility is 13.3 miles (via primary access route) of which 9.3 miles are on dirt or trail roads. Assuming 2 round trips per day for resin transfer and an additional 10 round trips per day for facility personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1,562 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 2,595 miles per week. With an emission factor of 0.25 lb TSP per vehicle-mile, there will be a total dust emission of approximately 16.9 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 TCEA would be minimal. Mitigation measures such as the application of water or dust control chemicals to unpaved roads will be implemented as necessary.

7.2.1.2 Criteria Pollutant Regulatory Compliance Issues

The statements in this section apply to both construction and operations phase of the proposed satellite facility.

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). The NAAQS standards for other pollutants are presented in **Table 2.5-15**. All counties within the 80 km radius of the project are in attainment of NAAQS. Concentrations of the criteria pollutants from the operations will not be expected to exceed the regulated or "threshold" level for one or more of the NAAQS pollutants within the 80 km radius.

In addition to the NAAQS ambient air quality standards, there are national standards for the Prevention of Significant Deterioration (PSD) of air quality (see discussions in Section 2.5.6). The PSD program is administered by the State of Nebraska and South Dakota, with their programs designed to protect the air quality in area that are in attainment with the NAAQS and to prevent degradation of air quality in areas below the standard (designed as clean air areas). The PSD requirements establish allowable pollution "increments" that may be added to the air in each area while still protecting air quality. The increment is the maximum allowable deterioration of air quality. The maximum allowable increments applicable to Nebraska and South Dakota are shown in **Table 2.5-24.**

The allowable increments vary by location across the states. Those areas characterized as Class I (i.e., National Parks and Wilderness Areas) and allow less incremental pollution increase. Class III areas are planning areas set aside for industrial growth. The areas classified as Class II are essentially all other areas of the state not designated as Class or Class III. There are no Class I National Park and Wilderness Areas in Nebraska. The State of South Dakota has two Class I Areas: Badlands and Wind Cave National Parks. The Wind Caves National Park is the closer of the two to the TCEA, being a distance of approximately 63 miles. Therefore, no impacts associated with PSD requirements would be expected based on the estimated amount of emissions from the TCEA operations.

7.2.2 Land Use Impacts of Operations

The principal land use for the TCEA and the 2.25-mile review area is grazing livestock. Rangeland accounted for 42.8 percent of the land use in the TCEA and surrounding 2.25-mile area of review (AOR) as discussed in Section 2.2. The secondary land use within the TCEA license boundary is cropland. This cropland is primarily wheat, although a small proportion is used for alfalfa hay. Cropland accounted for 18.7 percent of the land use in the TCEA and the AOR. Land use was discussed in detail in Section 2.2.

For the proposed disturbance of 671 acres for the proposed satellite facilities, wellfields, evaporation pond areas and roadways, cropland accounts for 384.0 acres or 57.2 percent of the total area. Rangeland accounts for 265.9 acres or 39.6 percent of the total area. Rangeland rehabilitation (4.53 acres) and structural biotope (16.63 acres) are the only other impacted land uses. **Figure 7.2-1** depicts the proposed wellfield areas and the current types of land use.

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 671 acres associated with the satellite facility, wellfields, evaporation ponds, and roads. As discussed in Section 2.2, livestock and livestock products had a value of $28.61 per acre, indicating that livestock production on impacted rangeland within the TCEA has a potential value of approximately $7,610

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 384.1 acres associated with the satellite facility, wellfields, evaporation ponds, and roads. In 2007 Dawes County had 44,100 acres harvested for 70,170 tons of alfalfa hay and 43,445 acres harvested for 1,337,320 bushels of winter wheat (NASS 2009). These harvests resulted in yields of 1.6 tons of alfalfa hay and 30.8 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the TCEA would be as much as 615 tons of hay and up to 11,833 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 operation project will not significantly impact local or regional agricultural production. The limited 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 Pine Ridge 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 satellite facilities will affect soils. With proper implementation of best management practices (BMPs), effects to soils are not expected to be significant within the TCEA.

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 TCEA 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 satellite facility would continue until the area is revegetated..

Wind erosion is also possible at the TCEA, particularly in the eastern half of the project area. Various soils meet the criteria for high 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 locally obtained gravel, and timely reclamation.

Water erosion is also possible at the TCEA, especially in areas disturbed by road and wellfield construction. 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 soil 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 with gravel, installing drainage controls, and reseeding and installing water bars across reclaimed areas will also aid in rèducing soil loss.

Sedimentation in streams and rivers at the TCEA could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of area drainages. Installation of appropriate erosion control measures as required by the CBR 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. Soils sensitive to compaction do exist on the site. Compaction of the soils could decrease infiltration and promote higher runoff. Construction and traffic will be minimized where possible, and soils will be loosened prior to 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.

Satilite 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 satellite facility 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 satellite facility. If not remediated quickly, these materials have the potential to adversely impact soil resources. 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.

Soil Impact Mitigation Measures

BMPs have been included in the project description and will be followed to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the TCEA. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document. Fundamentally, efforts will be made to preserve existing vegetation where practical.

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 BMPs do not result in compliance with applicable standards, modify or improve such BMPs to meet the controlling standard of surface water quality.

Topsoil

- Topsoil 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

- Restricting the length and grade of roadbeds.
- Surfacing roads with durable material (i.e., locally obtained native gravel).
- Creating cut and fill slopes that are stable.
- Revegetating the entire road prism including cut and fill slopes.
- 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.

Implementation of the above BMPs, SPCCs, and SWPPPs will minimize effects to soils associated with the construction of the satellite facility.

7.2.4 Archeological Resources Impacts of Operations

Field investigations were conducted in January 2006 on a 2,100-acre area of anticipated potential development encompassing the TCEA. The proposed 1,643 acres that make up the TCEA are totally included within this acreage. 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 important prehistorical or historical information and are not considered eligible for the National Register of Historic Places.

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 satellite facility 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 Three Crow Pumping 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 operation is expected to be on the order of 0.5% to 1.5% of the total mining flow (6,000 gpm). Additional consumptive volume (1,500 gpm) 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 into the monitor well ring 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 7.2-1** provides a summary of excursions reported for the current license area.

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 evaporation 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 evaporation ponds will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all evaporation ponds will be inspected on a regular basis. In the event that a problem is detected, the contents of any given evaporation pond can be transferred to another evaporation pond while repairs are made. The proposed evaporation 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 evaporation 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 evaporation 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 evaporation pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ (NDEQ 2002).

With respect to potential overflow of an evaporation pond, current standard operating procedures require that evaporation pond levels be closely monitored as part of the daily inspection. Process flow to the evaporation ponds will be minimal in comparison to the pond capacity, thus it can easily be diverted to another evaporation pond if necessary. In addition, sufficient freeboard will be maintained on all evaporation ponds to allow for a significant addition of rainwater with no threat of overflow. Finally, the dikes and berms around the evaporation 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. 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 to prevent spilled process solutions from entering surface water features. 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 National Environmental Policy Act (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 nine well fields, satellite facility, evaporation ponds and access roads will be constructed in 2014 with an expected mine life of operation of approximately seven years. As shown in **Figure 7.2-1**, wellfield development will be constructed in areas dominated by cultivated areas and mixed grass prairie vegetation. Areas within Sections 28, 29, 30 and 33 T31N 52W will be developed and contain wellfields and a significant amount of project-related infrastructure.

Vegetation removal and soil handling associated with the construction and installation of well fields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, since 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, the impacts would include those described below.

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) due to soil disturbance and grading activities. 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 and/or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

The total number of acres currently identified as having the potential for disturbance within the 1,643-acre permit area over the long-term operation of the project will be approximately 671 acres (**Table 7.2-2**). Initially, the construction of the satellite building(s)/associated facilities, evaporation ponds, Mine Unit No. 1 and needed roadways would have short-term surface disturbances of approximately 100 acres (approximately 6 percent of the total permit boundary acreage). The production building and associated facilities would disturb an area of 1.8 acres (area within fence-line of production facilities) and the evaporation ponds an area of 11.6 acres (area within fence-line of ponds). These structures, except for approximately 2.23 acres of the evaporation ponds, are located within Mine Units 1, 2 and 3. **Table 7.2-2** provides a breakdown of the area of disturbance by the type of habitat cover acreage.

Over the life of the project, it is currently estimated that 41 percent of total permit area acreage would be disturbed due to site development and operation. The likelihood of impact is greatest for the primary vegetation cover types of cultivated fields (384 acres) and mixed grass prairie (266 aces), which occupy approximately 97 percent of the total acreage with the potential for disturbance (671 acres). Cultivated and mixed grass prairie habitat cover (946 and 579 acres, respectively) account for 58 percent and 35 percent, respectively, of the total permit acreage of 1643 acres. There are no plans to disturb riverine and deciduous streambank forest habitat cover types within the permit boundary.

The majority of new roads are located within proposed wellfields. An existing road will serve as the entrance roadway to the satellite production facility and offices. This road will be upgraded. Estimated acreage disturbances was based on a 40-foot wide entrance road and 20-foot wide mine unit roads. Road locations and distances can be seen in **Figure 2.1-3.**

The proposed deep disposal well will be located to the east of the fenced-in area of the satellite facilities (**Figure 3.2-2**). located within mixed grass prairie habitat consisting of an area of approximately 50 x 50 feet. Potential impacts are considered minimal, which is based on the operating history of the deep disposal well located at the current CBR operating facilities.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of invasive, non-native species within the TCEA. Non-native species invasion and establishment as a result of previous and current disturbance has become an increasingly concern 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 TCEA has a relatively high level of noxious weeds and other unwanted invasive, non-native species in the areas adjacent to roads, particularly Four Mile Road (**Figure 2.8-1**), but to a lesser degree in areas located farther from roads.

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 pre-disturbance conditions of diversity (both species and structural). Reestablishment of mixed-grass prairie to pre-disturbance conditions would be influenced by factors that are both climatic (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 pre-contours and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts are disturbed by surface activities, these areas would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) complete 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 surface waters in the TCEA. Cherry Creek, an ephemeral stream, is the only potential available surface waters within the TCEA, with the creek being desiccated by man-made activities (i.e., mixed grass prairie surrounded by croplands) and without defined banks and streambed. 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 members 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 poaching, 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 TCEA 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 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 the 1,643 acre project area would have a low effect on common wildlife species. The primary 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 use suitable habitats to the extent that they are available. The primary small mammals in the TCEA include, but are not limited to, eastern cottontail, deer mouse, 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 proposed project include: (1) a direct loss of certain big game habitat, most likely deer and pronghorn; (2) the displacement of these big game species; (3) an increase in the potential for collisions between wildlife and motor vehicles; and (4) an increase in the potential for poaching and harassment of wildlife.

In general, direct habitat removal used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Since 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 various big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat due to the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect wildlife use 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 intensive activities such as drilling and road building diminishes and the well fields are put into production. By the time the well fields are under full production, construction activities 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 well field 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, due to the proximity to the City of 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 on 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 use of leks and/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 activities within the 0.25-mile lek buffer areas are be 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 activities should be limited within a one-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

As noted in Section 2.8.8.3, few raptors and no nests were observed during the 2008 field survey. The potential impacts to raptors within the TCEA include: (1) temporary reductions in prey populations; and (2) mortality associated with roads.

The development of proposed well fields pads, evaporation ponds and satellite facilities would disturb an estimated 266 acres of mixed grass prairie, a potential habitat for several species of small mammals that serve as prey items for raptors. This impact would affect approximately 16 percent of the total project area, although this is not likely to be a limiting factor of raptor use within this area. The small amount of short-term change in prey base populations created by the construction activities is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations 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 TCEA.

There will be no new public roads constructed. However, there will be increased traffic due to site operations on current county roads such as Four Mile Road. 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 to public vehicle use for roads located near active raptor nests 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 the White River and its tributaries. However, the construction, operation, and maintenance of the project are not expected to affect these habitats. There are no surface impoundments located within the permit boundary.

7.2.7.11 Threatened and Endangered Species

For Dawes County, the Nebraska Game and Parks Commission lists four threatened or endangered species (NGPC 2008). The list is based upon documented occurrences of listed species and expert knowledge about the distribution of listed species and suitable habitat compiled on a county by county basis. Three of the species are fish and the fourth is the Swift Fox. Given the absence of surface water at the TCEA, the fish are not addressed further.

Eskimo Curlew

The Eskimo Curlew (*Numenius borealis*) is a relatively short, slender curlew with a slightly down curved bill. The bird's northward migrations route encompasses the eastern portion of Nebraska, but it has been reported that the curlew has migrated through all regions of the state during the months of Marsh, April, May and June. Newly plowed fields, burned prairies and marshes are particularly attractive to migrating curlews. It feeds in the plowed fields by 8 or 9 am, and can be observed consuming grasshopper egg pods, earthworms and locusts.

In the project area, there is potential feeding habitat for the bird, but there have not been any possible or confirmed sightings within the area (AGC Nebraska Chapter 2007). It is unlikely that the bird uses the area for anything but a migratory access way. Upon review of the bird's absence in the area, it is concluded that the negotiated alternative would have no effect on the Eskimo Curlew. The Eskimo Curlew is not included on the county by county list noted above.

Mountain Plover

The Mountain Plover is currently being considered for listing under its federal status, and it is listed as threatened in the state of Nebraska. Nebraska law provides additional protection by requiring state agencies to ensure that their actions, or actions authorized or funded by them, do not jeopardize the mountain plover (NPGC 2008d). The plover prefers nesting in arid flats in very short grass with a lot of bare ground, often times near prairie dog colonies.

There is potential habitat for the plover in southern Dawes and Sioux counties, and there been recent scattered observations in the neighboring Box Butte County (NPGC 2008). It is possible that they may occur in isolated instances in the project area, but because prairie dogs are likely controlled and there is not a lot of bare ground space in the area, strong plover nesting habitats are limited. Further, no nests were observed during field studies.

Because there is plover potential in the project area, measures can be taken to reduce effects to the bird. (1) Disallow construction activities during the critical nesting season: the last two weeks of April through the second week of July. (2) If construction activities cannot be avoided during these periods, a presence–absence survey of suitable Mountain Plover habitat in which ground disturbing activities are proposed would be conducted.

After review of the bird's status and potential occurrence within the TCEA, it is concluded that the proposed project with the above-referenced mitigation measures will not have adverse effects on the Mountain Plover. The Mountain Plover is not included on the county by county list noted above.

Swift Fox

The swift fox is widely distributed throughout the Great Plains, and small, disjunct populations exist in the western third of Nebraska and Kansas (USFWS 1995). High-quality swift fox habitat is present within the Oglala National Grassland, immediately northwest of the TCEA. The TCEA contains mixed-grass prairie, which is considered suitable habitat for the swift fox; however, the this area is a mosaic of grassland and cropland, which does not favor swift fox use, though this species can use areas with mixed land uses (USFWS 2001). Mixed grass prairie makes up approximately 35 percent (579 acres) of the project permit area.

Since swift fox are known to occur within the region, and suitable mixed-grass prairie habitat occurs throughout the TCEA, potential impacts may result from project implementation. Construction activities within these mixed-grass prairie habitats could affect potential swift fox denning and foraging habitats. If swift fox are denning in the immediate vicinity of a planned project facility, it is likely that construction activities would displace adults away from the den, at least during daytime periods of construction. Displacement could prevent the adults from securing adequate food for pups or prevent adults for adequately caring for their young. In addition, vehicular traffic associated with the construction and operation of project facilities could result in vehicle collisions resulting in direct mortality.

Because the potential for the displacement of swift fox from construction and operational activities exists within mixed-grass prairie, mitigation measures will be made to avoid and/or reduce such incidents.

CBR will avoid impacting the swift fox species by selecting planned areas of disturbance (including wellfields and drills sites) that are not in suitable habitat and by avoiding certain locations during specific times of the year. Surveys shall be conducted that are consistent with the Nebraska Game and Parks Commission (NG&PC) standard protocol included in the CBR Mineral Exploration Permit Number NE0210824 as Attachment 1, issued by the NDEQ on August 19, 2009. The procedures in Attachment 1 are specific to drilling of boreholes, therefore these procedures have been expanded to include Three Crow project development activities, including construction, operational activities (e.g., wellfield development, satellite facility facilities, and access roadways) and decommissioning. The modified survey protocol to be used for the swift fox at the TCEA is presented in **Appendix K** of Volume II of this application.

Based upon the analysis of the effects of project implementation, the current and potential status of this species in the TCEA, and more suitable habitats in the region, it is concluded that the proposed project and planned mitigation measures will result in no adverse effect on the swift fox.

Whooping Crane

The whooping crane (*Grus americana*) is listed as endangered by the USFWS and NGPC, with the potential to occur in Dawes County. The whooping crane is an occasional spring and fall migrant along the Platte Valley in Nebraska, which accounts for approximately 90 percent of the observations in Nebraska. The Platte Valley is located in central Nebraska, a considerable distance from the project area. Additionally, suitable habitat is lacking within the project area (e.g., rivers and streams with associated sandbars and islands, marshlands, wet meadows and croplands). Conclusively, no impacts to the Whooping Crane are anticipated to occur on the TCEA Site. The Whooping Crane is not included on the county by county list noted above.

Reptiles, Amphibians, and Fish

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

7.2.7.12 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated to occur as no substantive impairment of ecological stability or diminishment of biological diversity within the TCEA. Of the total 1,643 acres within the permit boundary, 384 acres (approximately 23 percent of the total acreage) consist of cultivated habitat (**Table 7.2-2**). The mine units are comprised of approximately 380 acres of this cultivated habitat. Mixed grass prairie comprises 266 acres of the TCEA, which is 16 percent of the total permit area acreage. The majority of this acreage (approximately 254 acres) is located within the proposed mine unit boundaries.

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 the City of Crawford for work and from resin transfer to the CPF. 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

An assessment of the radiological effects of the satellite facility must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The satellite facility will have a production flow capacity of approximately 6000 gpm and will use fixed bed downflow IX columns to separate uranium from the pregnant production fluid. The facility will also have a capacity to treat 1500 gpm of restoration solution. The restoration process will use fixed bed downflow IX 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 with a two cell evaporation pond to provide surge capacity. The satellite facility will not have any precipitation equipment. The loaded IX resin will be transferred from the columns to a resin trailer for transport to the CPF, for regeneration and stripping. The reclaimed resin will be transported back to the satellite facility and reused in IX columns.

The uranium bearing regenerant at the CPF is treated in the uranium precipitation circuit. The precipitated uranium is vacuum dried.

The only airborne radiological emission from the 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 Reg. Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (March 1987). The details of this calculation are found in Appendix N-4.

MILDOS-AREA (December 1998) 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 satellite facility coupled with the CPF is discussed briefly. A detailed presentation of the source term and other MILDOS-AREA parameters is included in **Appendix M**. 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 satellite is an in-situ uranium recovery facility. The only source of planned radioactive emissions from the facility 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 satellite facility will have pressurized downflow IX columns capable of processing 6000 gpm of production solution. The satellite facility will also have IX and reverse osmosis equipment with a capacity of 1500 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 during the air blow down prior to resin transfer to the resin trailer. The air blow down 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, Cameco estimates that 10 percent of the contained radon found in the 6000 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 CPF for additional processing. The stripped and regenerated resin will be transferred to the trailer and returned to the satellite facility 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 produced in the production fluids will be released in the wellfield.

Atmospheric emissions of radon will lend its presence to all quadrants of the area surrounding the TCEA and the CPF. 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 satellite facility will have evaporation ponds used to store waste solutions, prior to deep well injection. The surge ponds will be double-lined with impermeable synthetic liners. There is a leak detection system installed to provide a warning if the liner develops a leak. The ponds, therefore, are not considered a source of liquid radioactive effluents.

The primary method of waste disposal at the satellite facility will be by deep well injection. The deep well will be completed at a depth of 3500 to 4000 ft, isolated from any underground source of drinking water by approximately 1800 ft of Pierre Shale. The well will be constructed under a permit from the NDEQ and meet all requirements of the Underground Injection Control program.

The satellite facility processing building 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, 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 Appendix N, the modeled emission rate of radon from the facility is 5446 Ci/yr which includes releases from IX, production and restoration activities.

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the TCEA, NTEA and CBR CPF was also estimated using MILDOS-AREA. 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 collective site operations of the Three Crow Satellite Facility, North Trend Satellite Facility and the CPF 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 Appendix M along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown in **Figure 7.3-2. Table 7.3-1** shows the estimated TEDE from operation of the TCEA, CPF and the NTEA.

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

1. The maximum TEDE is 32.3 mrem/yr.
2. Receptor Three Crow 1 is the closest resident in the downwind direction for the satellite facility. The estimated TEDE at this location is 32.3 mrem/yr.
3. 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.

7.3.4 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Crow Butte Project (TCEA, NTEA and CBR CPF) 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 TCEA, NTEA and the CPF would be to increase the dose to the bronchial epithelium of the continental population by 0.00057 percent.

7.3.5 Exposure to Flora and Fauna

There are two primary potential pathways for radiological exposures to flora and fauna: radon emissions and accidental spills of radiological containing fluids (e.g., lixiviant).

7.3.5.1 Radon Releases

Radon emissions at satellite uranium in situ facilities such as the proposed satellite facility (i.e., no yellowcake dryer and associated facilities) are considered the primary air contaminant during operations. Radon emissions during normal operations are considered the most important pathway for exposure to flora and fauna due to deposition of Ra-222 decay products on surface water, surface soils and vegetation. The MILDOS-AREA model provides an estimate of surface deposition rate as a function of distance from the source for the Ra-222 decay products and calculates surface concentrations.

The exposure to flora and fauna was evaluated in the Environmental Report submitted in September of 1987 (Ferret Exploration Company of Nebraska 1987) and the doses were found to be negligible. The proposed Three Crow and and North Trend Satellite Facilities will have no measurable impact on dose to flora and fauna.

The potential exists for individual fauna (e.g., small mammals and birds) that are mobile to have contact with higher, but short-term, contact with concentrations of Ra-222 than the public due to the potential proximity to releases. However, due to the typical mobility of such animals, it is likely that individuals would receive an intermittent exposure, as opposed to a constant concentration for the entire year.

There are currently no regulatory dosimetric standards for the protection of flora and fauna, with radiological protection frameworks being traditionally focused on the protection of man. Historically, the International Commission on Radiological Protection has maintained a position towards human health versus non-human species with the position that protection of humans from radiation exposure implicity ensures an adequate protection of other living organisms, therefore the environment (Brechignac 2009 [ICRP 1977 and 1991]). However, the development of a system capable of ensuring adequate protection of the environment against the harmful effects of ionizing radiation is currently being debated (Brechignac 2002).

7.3.5.2 Fluid Discharges

There are currently no planned discharges from the satellite facility, with waste waters being discharged to evaporation ponds or a Class I deep disposal well. Therefore, any fluid discharges would be associated with spills, e.g., pipeline break or leak. Spills of this type would be expected to occur within the restricted wellfield areas and between the wellfields and satellite process facility. Since the satellite processing building, fuel tanks, and chemical tanks are constructed on pads that are engineered to contain any spill from a pipe rupture, leaking vessel or inadvertent spill. Therefore, it is unlikely that any spills in the processing area would reach soils and vegetation. CBR operating procedures provide for ongoing monitoring of operational activities and for a rapid corrective action response to any spill, which would result in cleanup of the spilled material and, if applicable, removal of any contaminated soil and vegetation.

Long-term experience at CBR has shown that single-event spills typically do not cause significant contamination of soil and vegetation.

There is limited potential for wildlife or domestic animals to consume contaminated vegetation or seeds. Other than the potential for accidental spills discussed above which would be immediately assessed and cleaned up, the satellite facility would not be expected to significantly impact food source such as vegetation and seeds that local animals depend upon.

The MILDOS-AREA model was used to assess the potential radiological impact on human health.

7.4 Non-Radiological Effects

Nonradiological effects of site preparation and construction activities are discussed in Section 7.1, including impacts on air quality, land use, surface water, population, social and economic, and noise impacts. Impacts on operational activities are discussed in Section 7.2, including air quality, land use, soil, groundwater, surface water, ecology and noise impacts.

As discussed in Sections 7.1 and 7.2, overall emissions associated with equipment and facility operations during site preparation, construction and operations would be expected to be minimal and should not affect the local ambient air quality. Nonradiological emissions include NO_x, CO, SO_2, VOC and particulate matter (operating equipment and fugitive dust due to traffic on unpaved areas). During operations, a gaseous and airborne effluent will consist of air ventilated from the process building ventilation system and vented from process vessels and tanks. This gaseous effluent would primarily contain radon gas as previously discussed in Sections 4 and 7.3. The gaseous and airborne effluent will not contain any significant non-radiological emissions.

In addition to gaseous and airborne effluents, there would be three types of wastes generated at the proposed satellite facility: liquid, solid and sanitary. The operational-generated liquid wastes would be disposed of through a deep disposal well and evaporation ponds. Such liquid wastes would consist of: wellfield bleed streams; facility washdown water; groundwater restoration water; laboratory wastewaters; liquids resulting from rainwater/snow fall and spills within the curbed process areas. Accumulations of rainfall/snowmelt and any spills within the curbed bulk chemical, lubricant storage facility and the fuel diked area will be removed and disposed of as per the site Spill Prevention, Containment and Countermeasure Plan. Well development water in the wellfields will be collected in dedicated tanker trucks and transported to the main satellite processing facility for disposal in the deep disposal well or evaporation ponds.

There would be 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 CPF 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 satellite facility.

Solid wastes generated would consist of waste such as spent resin, resin fines, filters, miscellaneous pipe and fittings, and domestic waste. These wastes are classified as contaminated or noncontaminated waste according to radiological survey results. Contaminated byproduct waste that cannot be decontaminated is packaged and stored until it can be shipped to a licensed waste disposal site or licensed mill tailings facility. Non-contaminated solid waste is collected on the site on a regular basis and disposed of in a sanitary landfill permitted by the NDEQ. The CBR estimate of annual quantities of non-contaminated generated solid waste for Three Crow is presented in Section 4.2.2.1. No significant non-radiological impacts associated with management of relative small quantities of solid wastes would be expected.

The TCEA is expected to only generate a small amount of hazardous waste and is expected to be classified as a Conditionally Exempt Small Quantity Generator. The potential for any adverse impacts due to the handling and disposal of hazardous waste would be minimal due to the small quantities handled and operational procedures in the SHEQMS Volume VI, *Environmental Manual.* The SHEQMS is reviewed annually and the sections updated as required.

Sanitary liquid waste will be disposed of in an on-site wastewater treatment system (i.e., septic) permitted by the NDEQ under the Class V Underground Injection Control (UIC) Regulations. Periodic removal of septic tank solids will be performed by companies or individuals licensed for such activities by the State of Nebraska. There have been no problems associated with operating a similar sanitary system at the CPF and no problems would be expected for the the satellite facility.

For any spill, the free liquids would be recovered and any contaminated soils would be removed and placed in an offsite disposal site approved for the type of waste generated. Spills are also discussed in Section 4.2.1.3.4.

In summary, the design and construction of the satellite facility will concentrate on minimizing the potential for releases of nonradiological waste materials. For example, CBR would use diking or flow cut-off and flow isolation procedures for radiological and nonradiological spill control. A quality assurance and quality control system will be used, which would involve pre-operational testing of equipment, periodic testing and regular inspection of equipment (e.g., pipelines, manifolds), and associated monitoring on line flows and pressures with automatic shutdowns in response to flow or pressure changes. Consequently, any spills should be small with little impacts on the environment. For any spill, the free liquids would be recovered and disposed of in the deep disposal well or evaporation ponds and any contaminated soils would be removed and placed in an offsite disposal site approved for the type of waste generated.

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 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 be 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 and specifically at in situ leach facilities in NUREG/CR-6733 (NRC 1980a, CNWRA 2001). 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 the CBR SHEQMS Volume VIII, *Emergency Manual,* have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in the CBR SHEQMS Volume VII, *Training Manual,* have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. The CBR SHEQMS 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 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 satellite facility. The satellite facility will use oxygen, carbon dioxide, and sodium bicarbonate 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 CPF.

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 CPF, CBR will install wellfield oxygen distribution systems at the Three Crow site. 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 (CGA 1996). Construction of oxygen systems in the wellfield are covered by procedures contained in the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a spill or fire involving oxygen systems are contained in the SHEQMS 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 CPF to protect workers from undetected leaks of carbon dioxide. Operation of carbon dioxide systems is currently covered by procedures contained in the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a leak involving carbon dioxide are contained in the SHEQMS Volume VIII, *Emergency Manual.*

7.5.1.3 Sodium Bicarbonate

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 the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a spill involving sodium carbonate or soda ash are contained in the SHEQMS 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 satellite facility will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the processing building. Oxygen, hydrogen peroxide, carbon dioxide, propane and fuel will be stored in outside storage tanks. The tanks at the satellite facility will contain injection and production solutions and IX resin. Elution, precipitation, and drying will be performed at the CPF. The satellite facility will be designed to control and confine liquid spills from tanks should they occur. The facility 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 facility 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 Facility Pipe Failure

The rupture of a pipeline within the satellite processing area 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 the SHEQMS 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 processing facility 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 satellite facility or as otherwise provided in the final permit.. Monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the satellite facility. 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 (NRC 2000).

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 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 the SHEQMS 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 four acres. Shallow monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the satellite facility, subject to NRC/NDEQ approval. 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 the SHEQMS 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 Reg. Guides 3.11 and 3.11.1 (NRC 1977 and 1980b). 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 satellite facility 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 satellite facility, to and within the wellfield will be buried for frost protection. Pipelines are constructed of PVC, 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 CPF, 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 satellite facility 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 facility to the CPF and return shipments of barren, eluted resin from the CPF back to the satellite facility.

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 the proposed satellite facility is planned to replace declining production at the current facility. The shipment of loaded IX resin from the satellite 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 (CNWRA 2001). For Three Crow, uranium-loaded and barren resin will be routinely transported by tank truck from the satellite facility to the CPF. For the Crown Point site, NRC determined that the probability of an accident involving such a truck was 0.009 in any year (NRC 1997).

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 satellite facility. 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, bicarbonate, hydrogen peroxide 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 an approved licensed disposal site. Because of the low levels of radioactive concentration involved, these infrequent 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 facility is the transfer of the IX resin to and from the satellite facility.

Resin will be transported to and from the satellite facility in a 4,000 gallon capacity tanker trailer. It is currently anticipated that one load of uranium-laden resin will be transported to the CPF for elution and one load of barren eluted resin will be returned to the satellite facility on a daily basis.

The transfer of resin between the satellite facility and the CPF will occur on U.S. Hwy 2/71 and county and private roads. CBR has established a primary access route and an alternate access route. The primary access route will entail 4.0 miles of travel on U.S. Hwy 2/71, 7.8 miles on county roads and 1.5 miles on CBR private roads (Figure 4.2-1). The alternate route will consist of 1.0 mile on U.S. Hwy 2/71, 6.2 miles on county raods and 1.5 miles on CBR private roads. The planned access routes are discussed in more detail in Section 4.2.1.9.

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and NRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren eluted resin. Pertinent procedures include:

- 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.
- Licensed and trained CBR drivers will transport the resin between the satellite facility and the CPF.
- Crow Butte's current emergency response plan for yellowcake and other transportation accidents to or from the Crow Butte site is contained in the SHEQMS Volume VIII, *Emergency Manual*. This plan will be expanded to include an emergency resin transfer accident procedure. Personnel at both the satellite facility and the CPF will receive training for responding to a resin transfer transportation accident.

Currently, CBR 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 NRC 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 the entire 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 CPF or the satellite facility. 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 the SHEQMS 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, positive 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 nine years as of January 2010. 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 City of Crawford or in Dawes County. As discussed in further detail below, the mine currently employs a workforce of approximately 67 employees and 2 contractors employing 14 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 satellite facility.

7.6.1 Tax Revenues

Table 7.6-1 summarizes the recent tax revenues from the Crow Butte project in U.S. Dollars.

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. Spot market values for U_3O_8 peaked at about $125 per pound in 2007 have since fallen to around $40.75 per pound as of June 21,, 2010 (UxC 2010). It is likely that market values will not return to the 2007 high in the near future and that future tax revenues will more likely be representative of 2008 and 2009 levels.

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

It is anticipated that the transition from operations at the current permitted CBR facilities to the proposed Three Crow and North Trend Satellite operations would allow the uninterrupted continuation of these contributions towards the funding of Dawes County government subdivisions. Beneficiaries of CBR contributions to the General Fund, and therefore to Dawes County government subdivisions, include school districts, fire districts, county and municipal government agencies, and the White River Natural Resource District. Assuming uranium prices remain consistent with recent 2008-2009 prices, CBR tax revenue contributions from the proposed project are likely to account for a proportion of annual contributions of tax revenues to state funds similar to the levels from current operations.

7.6.2 Temporary and Permanent Jobs

7.6.2.1 Current Staffing Levels

CBR currently employs approximately 67 employees and 2 contractors employing 14 people 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. Total employment in Dawes County in November 2008 was 4,747 out of a total labor force of 4,833 (BLS 2010). Based on these statistics, CBR currently provides approximately 1.5 percent of all employment in Dawes County. In 2008, the CBR total payroll was over $3,941,000. Of the total Dawes County wage and salary payments of $86,633,000 in 2008, the CBR payroll represented about 5 percent.

Total CBR payroll for the past five years was:

2005	$2,382,000
2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,216,870*

*Estimate

The average annual wage for all workers in Dawes County was $49,167 for 2008. By way of comparison, the average wage for CBR was about $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including overtime, bonus or benefits.

7.6.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects to supplement the existing workforce for the proposed Three Crow operation with an additional 10 to 12 full time employees, 4 to 7 full time contractor employees, and 10 to 15 part time employees and short-term contractors for construction activities. The full- and part-time employees will be needed for the satellite facility 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. It is anticipated that the majority of the proposed Three Crow full time and part time workforce and contractors would be available from the current labor force in Dawes County. As of January 2009, total unemployment in Dawes County was 216 individuals or 4.5 percent of the total work force of 4,799 (BLS 2010). CBR expects that any new positions will be filled from this pool of available labor. These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

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.

Because skills and services required for the proposed Three Crow project would be available in the existing local labor force, it is not anticipated that the proposed project would require the migration of additional workers into the nearby City of Crawford and City of Chadron, or unincorporated Dawes County. In the event that proposed project requirements for specialized skills could not be met with the current workforce or local labor force, a small number of workers could be hired from outside of Dawes County. However, any such labor needs would be a negligible change in the population of Dawes County. It is not anticipated that there would be any change in the local population from implementation of the proposed project.

Because no changes in employment or population are anticipated as a direct result of implementation of the Proposed Action, no impacts to housing availability, including public housing, are expected. There would be no short- or long-term employees that would require temporary housing; therefore the proposed project would not affect the lodging capacities of nearby communities.

There would be no noticeable increase in the local population from the construction, operation, and maintenance of the proposed project; consequently, there would be no increase in the need for law enforcement and fire safety, medical facilities, public schools, grocery stores, or other community resources in Dawes County.

No increases in existing levels of domestic water usage in Dawes County are expected, nor are effects to existing domestic water facilities anticipated from an increase in population. In addition, the water requirements of the Three Crow construction and operations would not affect municipal water systems.

Electricity, water, propane and other fuel, sanitary water, wastewater treatment required for construction and operations will be provided by the utilities that currently provide these services to existing CBR operations. The proposed project may increase the quantities of electricity, water, propane and other fuel consumed by CBR activities for a limited period of time during because operations at satellite facility, would commence as operations in the Crow Butte Permit Area ise winding down. However, the scope of production at would be similar to current operations in the Crow Butte Permit Area. It is anticipated that fuel and utility requirements would also be similar. No substantial increases are likely for new operations at the satellite facility over existing operational uses.

It is not anticipated that construction activities would increase costs to other customers supplied by the affected utilities, or increase the requirement for utility services beyond the capacities of the providers. There would be no substantial uses of electricity for construction activities. Fuel would continue to be provided by local suppliers. There would be no interruption of fuel deliveries to other customers from increased propane, diesel and gasoline usage at Three Crow construction sites.

The Solid Waste Agency of Northwest Nebraska currently has the capacity for approximately 99 years of service, and would not be affected by the receipt of construction wastes or trash from the satellite facility. Other wastes are managed on site by CBR. Provision of waste services by local waste disposal providers would not be affected, as wastes are managed on-site by CBR.

7.6.3 Impact on the Local Economy

It is anticipated than the monetary benefits and costs from the the satellite facility would be similar to current CBR operations. In addition to providing a significant number of well-paid jobs in the local communities of the Cities 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 five years were:

2005	$4,570,000
2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$7,838,700

The vast majority of these purchases were made in the City of 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 facility, although not in strict proportion to production. While there are some savings due to some fixed costs (current CPF utilities for instance), there are additional expenses that are expected to be higher (i.e., wellfield development for the proposed satellite facilities). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds produced. Local purchases that will be made annually for the satellite facility are estimated to be $3.7 to $4.4 million. Most of these purchases will continue to be made in the City of Crawford and Dawes County. In addition, mineral royalty payments accrue to local landowners. Production royalties of $325,000 were paid to land owners in 2009. Additional royalty payments would be made to TCEA land owners. Most of the landowners are residents of the Dawes County; therefore beneficial impacts to county revenues and local businesses were accrued through the spending and circulation of these dollars in the local economy.

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 7.6-2**. Approval of the proposed TCEA License Amendment would continue the current economic impact through the anticipated end of production (2020). The Proposed Action requires no in-migrating workforce from outside of the local area that currently provides the CBR labor force (primarily communities in Dawes County). Consequently, no increases in housing or community service demands would occur, and existing and planned facilities would not be adversely affected.

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Table 7.2-1 Crow Butte Resources Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
SM4-5	January 25, 1995	March 9, 1995	Poor Well Development
SM4-2	April 2, 1995	March 13, 1996	Poor Well Development
SM4-7	December 27, 1995	March 13, 1996	Poor Well Development
I-196	March 29, 1996	August 19, 1999	Casing Leak
I-752	November 8, 1996	May 7, 1997	Casing Leak
SM6-26	March 19, 1998	No record available	High Water Table
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
I-567	September 20, 1999	October 12, 1999	Casing Leak
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	July 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 2, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM7-23	December 4, 2001	January 9, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	June 3, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003	Ongoing	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
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 27, 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 4, 2006	Excursion of mining solutions
PR-15	September 26, 2006	Ongoing	See IJ-13 and PR-8
CM9-5	May 15, 2008	June 24, 2008	Excursion of mining solutions

Table 7.2-1 Crow Butte Resources Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM9-3	May 30, 2008	July 15, 2008	Excursion of mining solutions
SM6-20	April 27, 2009	August 25, 2009	Excursion of mining solutions
CM9-4	June 11, 2009	July 21, 2009	Excursion of mining solutions
SM6-20	March 16, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-6	April 13, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-23	June 3, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	June 3, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-28	June 3, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-21	June 22, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-5	June 22, 2010	Ongoing	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)

Table 7.2-2 Acres Disturbed by Three Crow Satellite Facility, Evaporation Ponds, Wellfields and Roads

Disturbed Area	Type of Habitat Cover				Total
	Cultivated	Mixed Grass Prairie	Range Rehabilitation	Structure Biotype	
	Acres				
Mine Units (9)	379.87	253.94	3.52	8.86	646.12
Satellite Facilities (Inside Mine Unit (MU) boundary)	--	1.8	--	--	1.8
Evaporation Ponds (Inside MU Boundary)	0.03	5.52	--	6.0	11.6
Evaporation Ponds (Outside MU boundary)	--	0.46	--	1.77	2.23
Roadways (inside MU boundary)	4.14	3.10	--	--	7.24
Roadways (outside MU boundary)	0.1	1.17	1.01	--	2.28
Total Disturbed Acres	**384.14**	**265.99**	**4.53**	**16.63**	**671.3**

Note: The Satellite Facilities, roadways and a major part of the evaporation ponds are located within mine units. Therefore, the disturbance acreages associated with these assets are subtracted from the mine unit acreages and listed separately. Disturbances outside of the mine units are listed separately.

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

Receptor #	Description	Distance from Main Facility (km)	TEDE* (mrem/y)
1	R1	1.3	5.6
2	R2	2.8	4.1
3	R3	3.3	5.2
4	R4	4.4	2.7
5	R5	5.4	2.8
6	Crawford	6.3	2.6
7	R7	4.4	4.6
8	R8	4.1	4.7
9	R9	3.6	6.5
10	R10	3.0	11.2
11	R11	3.3	6.0
12	R12	2.4	13.6
13	R13	1.5	22.1
14	R14	1.1	23.0
15	R15	0.6	26.3
16	R16	1.3	7.6
17	R17	1.4	4.8
18	Ehlers	0.7	11.1
19	Gibbons	1.0	21.3
20	Stetson	1.3	15.6
21	Knode	3.3	5.2
22	Brott	1.9	10.6
23	SP1	0.8	13.9
24	SP2	0.9	22.2
25	SP3	1.1	20.8
26	McDowell	4.9	4.2
27	Taggart	4.8	4.6
28	Franey	4.9	5.8
29	Bunch	4.4	6.5
30	Dyer	2.5	2.9
31	NT-1	12.0	6.3
32	NT-2	9.8	3.9
33	NT-3	9.2	3.7
34	NT-4	8.9	3.0
35	NT-5	8.2	3.1
36	NT-6	13.7	2.0
37	NT-7	12.9	1.67
38	NT-8	2.8	12.0
1	Three Crow-1	8.3	32.3
2	Three Crow-2	11.3	1.1
3	Three Crow-3	6.8	2.3
4	Three Crow-4	5.3	3.2
5	Three Crow-5	12.4	1.4
6	Three Crow-6	9.9	2.3
7	Three Crow-7	3.5	2.4
8	Three Crow-8	9.6	2.1

*No differences in TEDE between age classes were observed.

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

Criteria	Dose (person rem/yr)
Dose received by population within 80 km of the facility	201
Natural background by population within 80 km of the facility	21439
Dose received by population beyond 80 km of the facility	783
Total continental dose	985
Natural background for the continental population	1.73×10^{8}
Fraction increase in continental dose	5.7×10^{-6}

Table 7.6-1 Tax Revenues from the Current Crow Butte Project

Type of Taxes	2009	2008	2007	2006	2005
Property Taxes	914,000	1,120,000	1,102,000	627,000	351,000
Sales and Use Taxes	136,000	140,000	90,000	238,000	185,000
Severance Taxes	403,000	512,000	1,066,000	545,000	338,000
Total	**1,453,000**	**1,772,000**	**2,258,000**	**1,410,000**	**874,000**

Table 7.6-2 Current Economic Impact of Crow Butte Uranium Project and Projected Impact from TCEA

Activity	Current Crow Butte Operation	Estimated Economic Impact due to Three Crow Expansion Area
Employment		
Full Time Employees	67	+ 10 to 12
Full Time Contractor employees	2	+ 4 to 7
Part Time Employees and Short Term Contractors	3	+ 4 to 7**
CBR Payroll, 2009	$4,216,870*	+ $400,000 to $480,000
Taxes		
Property Taxes	$914,000	-
Sales and Use Taxes	$136,000	-
Severance Taxes	$403,000	-
Total Taxes	$1,453,000	+ $1,000,000 to $1,200,000
Production Royalties		
Royalty Payments, 2009	462,000	+ 325,000
Local Purchases		
Local Purchases, 2009	$7,838,700	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	**$13,970,570**	**+ $5,375,000 to $6,355,000**

*Estimated **All construction workers

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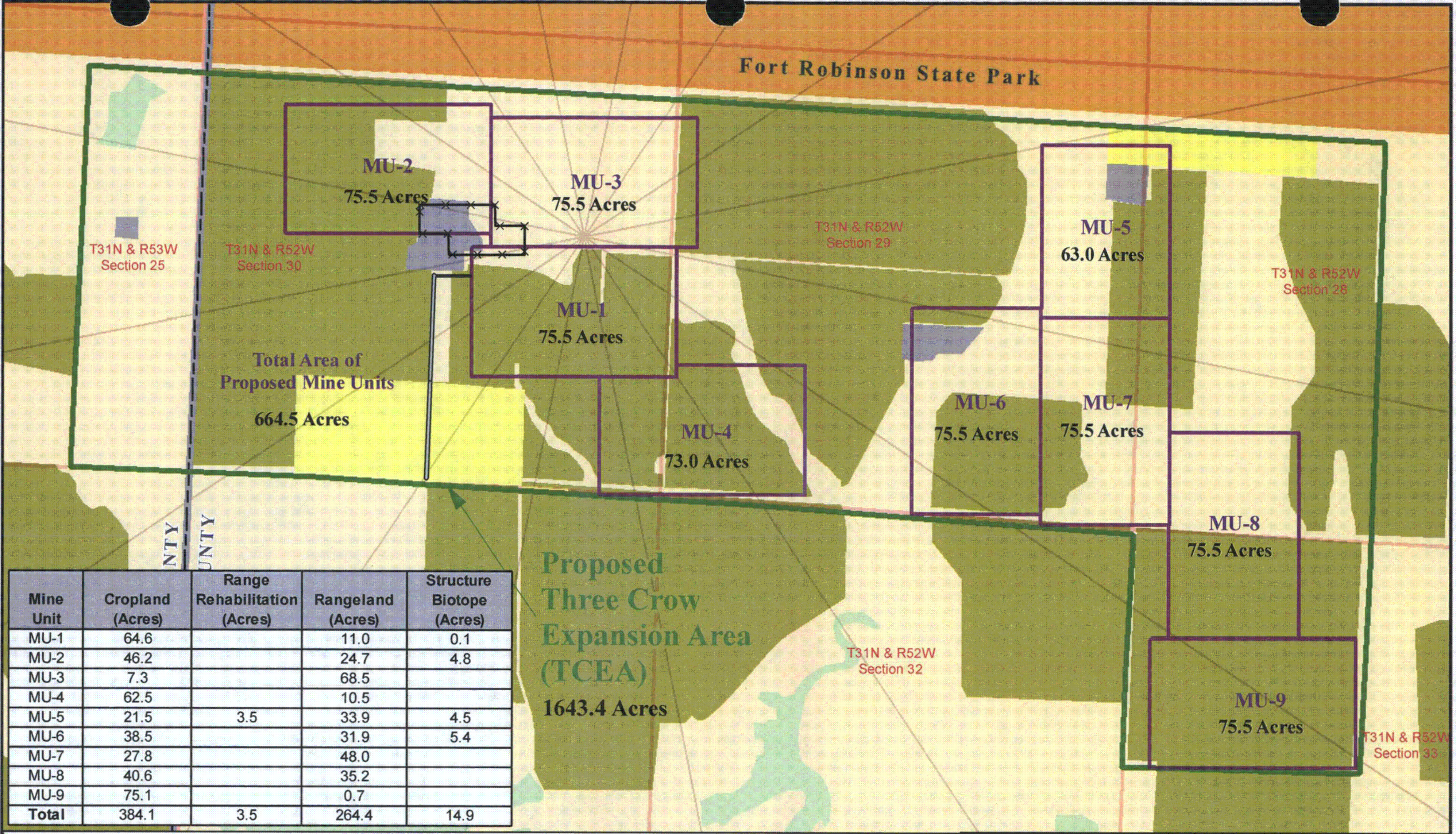

Mine Unit	Cropland (Acres)	Range Rehabilitation (Acres)	Rangeland (Acres)	Structure Biotope (Acres)
MU-1	64.6		11.0	0.1
MU-2	46.2		24.7	4.8
MU-3	7.3		68.5	
MU-4	62.5		10.5	
MU-5	21.5	3.5	33.9	4.5
MU-6	38.5		31.9	5.4
MU-7	27.8		48.0	
MU-8	40.6		35.2	
MU-9	75.1		0.7	
Total	384.1	3.5	264.4	14.9

Legend

Land Use

- Cropland
- Forested Land
- Rangeland
- Range Rehabilitation
- Structure Biotope
- Recreational Land

- Mine Unit Boundary
- Proposed Three Crow Expansion Area
- Grid Sector
- Fence

Acres of Disturbance
Outside of Mine Units--
4.51 Total
0.10 Cropland
1.63 Rangeland
1.01 Range Rehabilitation
1.77 Structure Biotope

0 1,000 2,000
Scale in Feet

PROJECTION:
*NAD_1927_STATEPLANE_*
NEBRASKA_NORTH_FIPS_2601

N
W E

CROW BUTTE
RESOURCES, INC.

FIGURE 7.2-1
THREE CROW
WELLFIELD LAND USE

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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Highlands Ranch, CO 80129
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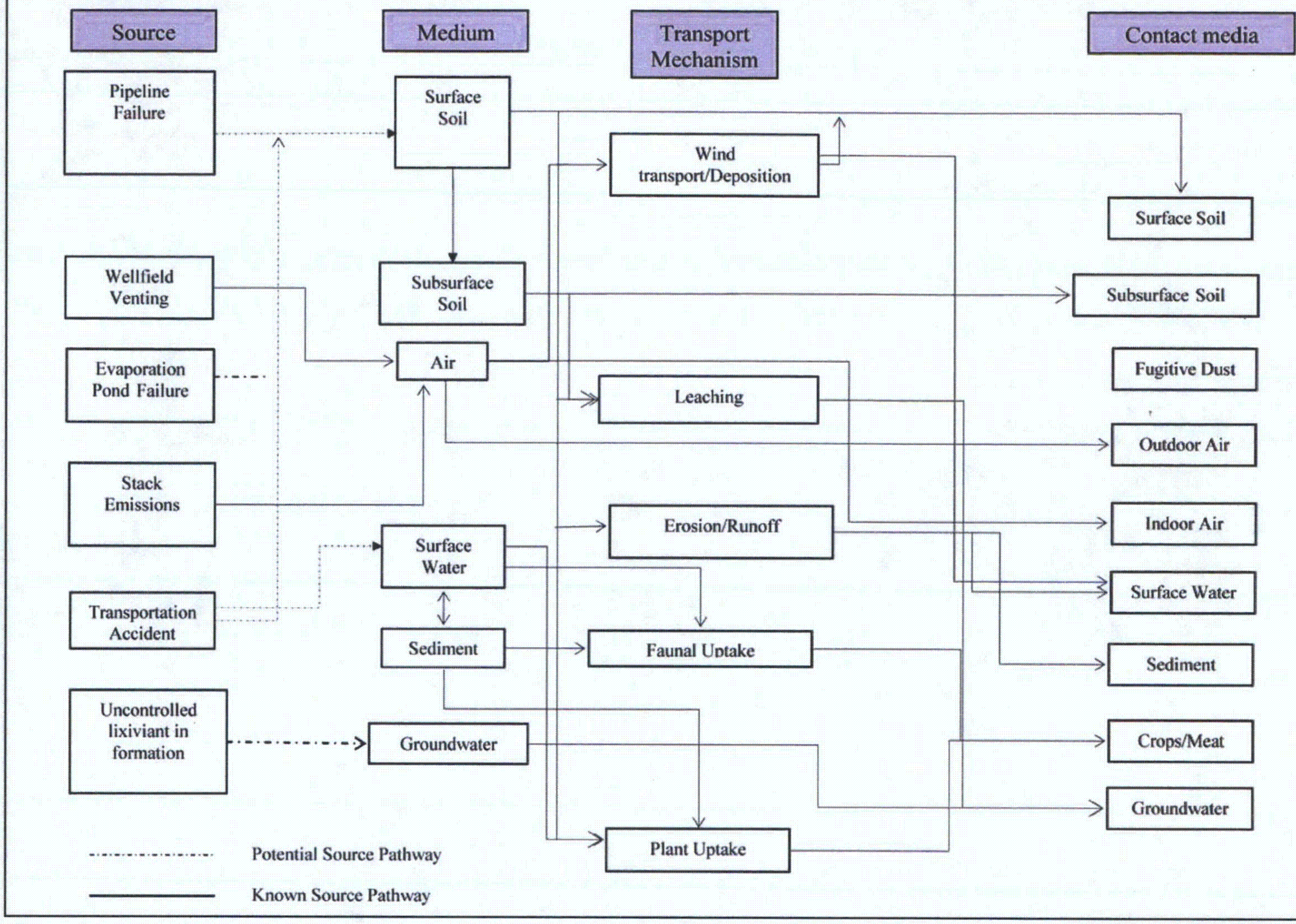
\\co3fp\gis-cadd\CBR_Projects\CO001396_ThreeCrow\2_GIS\ArcMaps\0001_TR\TR Fig_7_2-1 Three Crow WellField Land Use.mxd - 2/25/2010 @ 11:21:41 PM



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			

(Pathway)

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: CO001396.00001 MAPPED BY: JC CHECKED BY: LW

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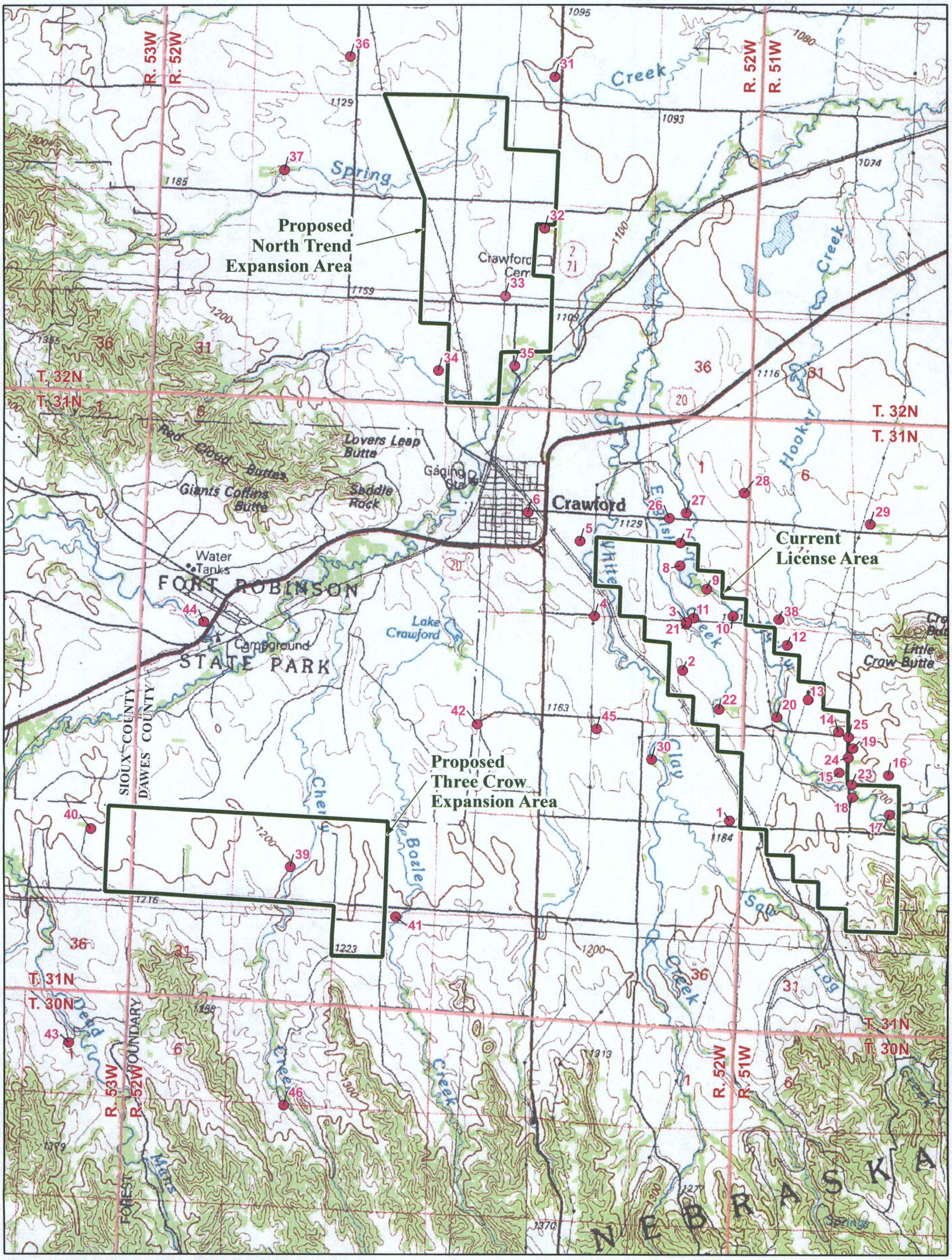
K:\CBR_Projects\CO001396_ThreeCrow\3_IMAGES\Illustrator\TR Fig_7_3-1 Human Exposure Pathways.ai @ 01/08/2010



Source: USGS 1:100,000 scale topographic map - Crawford (1984), NE

LEGEND

● Receptors

N
W E

0 4,000 8,000

Scale in Feet

CROW BUTTE RESOURCES, INC.

FIGURE 7.3-2
MILDOS RECEPTORS

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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8 ALTERNATIVES TO PROPOSED ACTION

8.1 No-Action Alternative

8.1.1 Summary of Current Activity

Crow Butte Resources, Inc. (CBR) currently operates the CPF, a commercial ISL uranium mining operation located approximately 4 miles southeast of the City of Crawford in Dawes County, Nebraska. Operation is allowed under Nuclear Regulatory Commission (NRC) Source Materials License SUA-1534.

A research and development (R&D) facility was operated in 1986 and 1987. Construction of the commercial process facility began in 1988, with production beginning in April of 1991. The total original license area is 3,300 acres and the surface area affected by the current commercial project is approximately 1,100 acres. Facilities include the R&D facility (which now houses the Restoration Circuit), the commercial process facility and office building, solar evaporation ponds, parking, access roads and wellfields.

In the current license area, uranium is recovered by in-situ leaching from the Chadron Sandstone at a depth that varies from 400 feet to 900 feet. The overall width of the mineralized area varies from 1000 feet to 5000 feet. The ore body ranges in grade from less than 0.05 percent to greater than 0.5 percent U_3O_8, with an average grade estimated at 0.27% U_3O_8. Production is currently in progress in Mine Units 6 through 10. Groundwater restoration has been completed and regulatory approval has been received in Mine Unit 1. Groundwater restoration is currently underway in Mine Units 2 through 5. Planning and construction is underway for Mine Unit 11 with production planned to begin in mid-year 2010.

The CPF is operating with a licensed flow rate of 9,000 gpm. Maximum allowable throughput from the facility under SUA-1534 is currently 2,000,000 pounds of U_3O_8 per year.

8.1.2 Impacts of the No-Action Alternative

The no-action alternative would allow CBR to continue mining operations in the CPF license area. Based on current plans and mining schedules discussed in Section 1 (**Table 1.7-1** and **Figure 1.7-1**), CBR could continue production at the current license area until 2014 when reserves are expected to be depleted.to the point where commercial production would no longer be economical and would be discontinued. Restoration and reclamation activities would become the primary activities, with final restoration and reclamation completed in 2025.

Assuming favorable regulatory action by the NRC and State of Nebraska, mining operations are estimated to begin at the proposed NTEA satellite facilities in 2013 and last for approximately 8 1/2 years (2021). As discussed in the NTEA Technical Report [Application for Amendment of NRC Source Materials License SUA-1534] (CBR 2007), NTEA reserves would be depleted in 2021.

At the time that commercially-recoverable resources are depleted in the CPF license area, all activities at the site that are not associated with groundwater restoration and decommissioning will be completed, resulting in the loss of a significant portion of the total employment at the site.

In actuality, many of these jobs would be lost well before 2014. For example, the well drilling, installation, and wellfield construction activities would be completed several years before the completion of mining activities and these positions would no longer be necessary. At the completion of decommissioning activities, all employment opportunities at the mine would be terminated. If approved, mining operations at the NTEA would extend current employment levels through 2021 before a portion of jobs are lost as the reserves decline. The impacts to the local economy from the approval of mining operations at NTEA, including employment opportunities, are evaluated in the NTEA Technical Report (CBR 2007).

In addition to the loss of significant employment opportunities in the City of Crawford and Dawes County, the premature closing of the CPF before commercially-viable resources are recovered would adversely affect the economic base of Dawes County. As discussed in further detail in Section 9, the CPF currently provides a significant economic impact to the local Dawes County economy as shown in **Table 7.6-1**.

If this amendment request is denied, the negative impact on the Dawes County economy would be felt as early as 2010 when employment levels for drilling and construction activities would be cut and purchases of services and materials would diminish.

A decision to not amend SUA-1534 to allow mining in the TCEA would leave a large resource unavailable for energy production supplies. The estimated recoverable resource at the TCEA is nearly 3,750,000 pounds U_3O_8, with an annual production rate of approximately 600,000 pounds. The current estimated recoverable resource at NTEA is also approximately 5,000,000 pounds U_3O_8, with an annual production rate of approximately 500,000 to 600,000 pounds.

In 2008, total domestic U.S. uranium production was approximately 3.9 million pounds U_3O_8, of which over 590,000 pounds (or approximately 15 percent) was produced at the CPF (EIA 2010a). During the same year, purchases of domestic U.S. uranium by U.S. civilian nuclear power reactors were approximately 53 million pounds U_3O_8e (equivalent) with approximately 14% supplied by domestic producers (EIA 2010b). Foreign-origin uranium accounted for the remaining 86 percent of deliveries. The CPF (including the TCEA and NTEA) represents an important source of new domestic uranium supplies that are essential to provide a continuing source of fuel to power generation facilities.

In addition to leaving a large deposit of valuable mineral resources untapped, a denial of this amendment request would result in the loss of a large investment in time and money made by CBR for the rights to and development of these valuable deposits.

Denial of the amendment request would have an adverse economic affect on the individuals that have surface leases with CBR and own the mineral rights in the TCEA.

8.2 Proposed Action

The proposed TCEA contains a licensed area of approximately 1,643 acres. Of this potential licensed area, the total surface area to be affected by mining operations will be approximately 671 acres for the satellite facility including the wellfields and evaporation ponds. The satellite facility will be located within a 1.8-acre fenced area in the SE1/4 NE1/4, Section 30, T31N, R52W. This area will also contain the chemical storage areas. The evaporation ponds will be located approximately 3,000 feet west of the satellite facilities (nearest fence to fence) in the SW1/4 NE1/4 and SE1/4 NW1/4 of Section 30, T31N R52W. The ponds will be enclosed within a fenced area consisting of approximately 11.6 acres.

The TCEA will be developed and operated by CBR. All land within the proposed license boundary of the TCEA is privately owned. CBR has obtained surface and mineral leases from the appropriate landowners.

Commercial production at the CPF including the proposed NTEA is expected to extend over the next ten years with the uranium reserves at both areas depleted by 2020. Commercial production at the proposed TCEA would occur over seven years between from late 2014 through 2021, extending production by seven years. Aquifer restoration and reclamation will be done concurrent with operations, plus an additional time period at the end of the project for final decommissioning activities and surface reclamation. All three projects would be completely restored and reclaimed by 2025. More detailed schedules are provided in Section 1.

The CPF recovers uranium from the Chadron Sandstone. In the TCEA, uranium will also be recovered from the Chadron Sandstone. The depth in the TCEA ranges from 580 to 940 feet. The width varies from 70 feet to 250 feet.

The satellite facility process structure will be a building approximately 130 feet long by 100 feet wide. The proposed satellite facility equipment will include the following systems:

- Ion exchange;
- Filtration;
- Resin transfer; and
- Chemical addition.

The in-situ process consists of an oxidation step and a dissolution step. The oxidants utilized in the facility are hydrogen peroxide and/or gaseous oxygen. A sodium bicarbonate lixiviant is used for the dissolution step.

The uranium-bearing solution resulting from the leaching of uranium underground is recovered from the wellfield and piped to the satellite facility for extraction. The satellite facility process utilizes the following steps:

- Loading of uranium complexes onto an IX resin;
- Reconstitution of the solution by the addition of sodium bicarbonate and oxygen;
- Shipment of loaded IX resin to the CPF; and,
- Restoration of groundwater following mining activities.

The satellite facility will be designed for a maximum flow rate, excluding restoration flow, of 6,000 gpm (restoration would account for another 1,500 gpm). Uranium-bearing resin will be transferred to the CPF for elution and packaging of yellowcake.

The operation of the satellite facility results in a number of effluent streams. Airborne effluents are limited to the release of radon-222 gas during the uranium recovery process. Liquid wastes are handled through evaporation and/or deep well injection.

Groundwater restoration activities consist of four steps:

- Groundwater transfer;
- Groundwater sweep;
- Groundwater treatment; and
- Aquifer recirculation.

Groundwater restoration will take place concurrently with development and production activities. The goal of the groundwater restoration is to return the water quality of the affected zone to a chemical quality consistent with baseline conditions or, as a secondary goal, to the quality level specified by the NDEQ.

Following groundwater restoration activities, all injection and recovery wells will be reclaimed using appropriate plugging and abandonment procedures. In addition, a sequential land reclamation and revegetation program will be implemented on the site. This reclamation will be performed on all disturbed areas, including the satellite facility, wellfields, ponds and roads.

CBR will maintain financial responsibility for groundwater restoration, facility decommissioning and surface reclamation. Currently, an irrevocable letter of credit is maintained based on the estimated costs of the aforementioned activities.

The environmental impacts of the requested action will be minimal as discussed in Section 7. The primary radiological air impacts will be from the release of radon gas during production. The release of radon will be minimized by the use of pressurized downflow IX columns. In addition, radon gas quickly dissipates in the atmosphere and results in a minimal additional exposure to the public as discussed in Section 4. All drying and packaging will be performed at the central process facility using a vacuum drying system, thereby minimizing the potential for radioactive air particulate releases at TCEA.

In situ leach mining of uranium alters the geochemistry and the water quality in the mining zone. CBR has proven in the current licensed area that impacts to groundwater can be controlled through stringent well construction techniques, wellfield operating methodologies that minimize excursions, and the use of best practicable technologies to restore the groundwater to premining baseline or class of use after mining activities are complete.

The impacts discussed in Section 7 include short-term and long-term impacts. However, it should be noted that in situ leach mining technique allows the entire mine site to be decommissioned and returned to unrestricted use within a relatively short time.

8.3 Reasonable Alternatives

8.3.1 Process Alternatives

8.3.1.1 Lixiviant Chemistry

CBR is utilizing a sodium bicarbonate lixiviant that is an alkaline solution. Where the groundwater contains carbonate, as it does at CBR, an alkaline lixiviant will mobilize fewer hazardous elements from the ore body and will require less chemical addition than an acidic lixiviant. Also, test results at other projects indicate only limited success with acidic lixiviants, while the sodium bicarbonate has proven highly successful on the Crow Butte R&D project and on commercial mining operations to date. Alternate leach solutions include ammonium carbonate solutions and acidic leach solutions. These solutions have been used in solution mining programs in other locations; however, operators have experienced difficulty in restoring and stabilizing the aquifer. Therefore these solutions were excluded from consideration.

8.3.1.2 Groundwater Restoration

The restoration of the R&D project, the successful completion of restoration in Mine Unit 1, and the current restoration activities in Mine Units 2 through 5 at the current licensed CPF exhibit the effectiveness of the restoration methods. These methods (groundwater sweep, permeate/reductant injection and aquifer recirculation) have been shown to restore groundwater to pre-mining quality. No feasible alternative groundwater restoration method is currently available for the CPF and proposed NTEA and TCEA. The NRC and NDEQ consider the method currently employed at the CPF as the BPT available.

8.3.1.3 Waste Management

Liquid wastes generated from production and restoration activities are handled by one of three methods: solar evaporation ponds, deep disposal well injection, or land application. All three methods are permitted at the CPF; however, only solar evaporation ponds and deep disposal have been used to date. The use of deep waste disposal wells in conjunction with storage/evaporation ponds to dispose of the high total dissolved solids (TDS) liquid wastes that primarily result from the yellowcake processing and drying facilities is considered the best alternative to dispose of these types of wastes. The Three Crow deep disposal well would 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). These discharges must be authorized by the State of Nebraska under a Class I UIC Permit to receive such wastes. CBR considered and rejected using land application as a disposal method at Three Crow due to required treatment and monitoring costs and potential environmental impacts from a surface discharge.

Alternative pond design and locations for the CPF have been considered. The design is such that any seepage of toxic materials into the subsurface soils or hydrologic system would be prevented.

All solid wastes are transported from the site for disposal. Non-contaminated waste is shipped to an approved sanitary landfill. Contaminated wastes are shipped to a NRC-approved facility for disposal. Should a NRC (or Agreement State)-licensed disposal facility not be available to CBR at the time of decommissioning, the alternative of on-site burial may be necessary. This alternative could incur long term monitoring requirements and more expensive reclamation costs.

At this time, CBR believes that off-site disposal of 11(e)2 byproduct material from Three Crow at a licensed disposal facility is the best alternative and there are no plans for onsite disposal.

8.4 Alternatives Considered but Eliminated

As a part of the alternatives analysis conducted by CBR, several mining alternatives were considered. Due to the significant environmental impacts and cost associated with these alternative mining methods in relation to the Three Crow ore body, they were eliminated from further consideration.

8.4.1 Mining Alternatives

Underground and open pit mining represent the two currently-available alternatives to solution mining for the uranium deposits in the project area. Neither of these methods is economically viable for producing the Three Crow reserves at this time. These alternative methods are not economically feasible for several reasons including the spatial characteristics of the mineral deposit and environmental factors. The depth of the deposit and subsequent overburden ratio makes surface mining impractical. Surface mining is commonly undertaken on large, shallow (less than 300 feet) ore deposits. At the TCEA, uranium is recovered from depths ranging from 580 to 940 feet.

In addition, the physical characteristics of the deposit and the overlying materials make underground mining infeasible for the TCEA or CPF. The costs of mine development, including surface facilities, shaft, subsurface stations, ventilation systems, and drifting would decrease the economic efficiency of the project.

From an environmental perspective, open pit mining or underground mining and the associated milling process involve higher risks to employees, the public, and the environment. Radiological exposure to the personnel in these processes is increased not only from the mining process but also from milling and the resultant mill tailings. Moreover, the personnel injury rate is traditionally much higher in open pit and underground mines than has been the experience at ISL solution mining operations.

Both open pit and underground mining methods would require substantial de-watering to depress the potentiometric surface of the local aquifers to provide access to the ore. The groundwater would contain naturally high levels of ra-226 that would have to be removed prior to discharge, resulting in additional radioactive solids that would have to be disposed. For conventional mining, a mill tailings pond containing 5 to 10 million tons of solid tailings waste from the uranium mill would also be required.

In a comparison of the overall impacts of in-situ leaching of uranium compared with conventional mining an NRC evaluation (NRC 1982) concluded that environmental and socioeconomic advantages of in-situ leaching include the following:

Significantly less surface area is disturbed than in surface mining, and the degree of disruption is much less.

1. No mill tailings are produced and the volume of solid wastes is reduced significantly. The gross quantity of solid wastes produced by in situ leaching is generally less than 1% of

that produced by conventional milling methods (more than 948 kg (2,090 lb) of tailings usually result from processing each metric ton (2,200 lb) of ore.

2. Because no ore and overburden stockpiles or tailings pile(s) are created and the crushing and grinding ore-processing operations are not needed, the air pollution problems caused by windblown dusts from these sources are eliminated.

3. The tailings produced by conventional mills contain essentially all of the radium-226 originally present in the ore. By comparison, less than 5% of the radium in an ore body is brought to the surface when in-situ leaching methods are used. Consequently, operating personnel are not exposed to the radionuclides present in and emanating from the ore and tailings and the potential for radiation exposure is significantly less than that associated with conventional mining and milling.

4. By removing the solid wastes from the site to a licensed waste disposal site and otherwise restricting them from contaminating the surface and subsurface environment, the entire mine site can be returned to unrestricted use within a relatively short time.

5. Solution mining results in significantly less water consumption than conventional mining and milling.

6. The socioeconomic advantages of in situ leaching include:
   - The ability to mine a lower grade ore;
   - A lower capital investment;
   - Less risk to the miner;
   - Shorter lead time before production begins; and,
   - Lower manpower requirements.

Finally, and perhaps most important, because Crow Butte is an established commercial solution mining site, there are no viable alternative mining methods at this time. The current market price of uranium makes an established solution mining operation the most economically viable method of mining uranium at Three Crow at this time.

8.5 Cumulative Effects

8.5.1 Cumulative Radiological Impacts

On October 17, 2006, CBR submitted a license amendment request to the NRC requesting an increase in the licensed flow at the CPF. License Condition 10.5 of SUA-1534 limited current operation to an annual facility throughput of 5,000 gpm exclusive of restoration flow. CBR requested an amendment to this license condition to increase the licensed flow to increase production and assist restoration efforts. The production increase was to be accomplished by expanding the existing facility and mining existing wellfields to lower levels of soluble uranium. CBR requested approval to increase the annual facility throughput to 9,000 gpm exclusive of restoration flow. The amendment request did not change the annual licensed production rate of 2,000,000 pounds of U_3O_8 per year. NRC issued the license amendment on Nov. 30, 2007.

The only environmental impact of the increased flow rate at the current operation is a corresponding increase in the emission of radon-222 from the current operation. The amendment estimated a 22 percent increase in the maximum public dose and that the maximum public dose would remain well below the limit found in 10 CFR § 20.1301.

8.5.2 Future Development

CBR has identified several additional resource areas in the region near the CPF that could conceivably be developed as satellite facilities. Development of these facilities is dependent upon further site investigations by CBR and the future of the uranium market. If conditions warrant, CBR may submit additional license amendment requests to permit development of these additional resources. However, CBR currently projects that development of these areas would be primarily intended to maintain production allowed under the current license as reserves in the current licensed area and at Three Crow are depleted.

8.6 Comparison of the Predicted Environmental Impacts

Table 8.6-1 provides a summary of the environmental impacts for the no-action alternative (Section 8.1), the preferred alternative (Section 8.2), and the process alternatives (Section 8.3). The predicted impacts for the mining alternatives discussed in Section 8.4 are not included for comparison because these alternatives were rejected due to significant environmental and economic impacts. Environmental impacts were discussed in greater detail in Section 7.

8.7 References

Crow Butte Resources, Inc. (CBR). 2007. *Application for Amendment of NRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report – Volume 1.*

Energy Information Administration (EIA). 2010a. [Web Page]. *Domestic Uranium Production Report* {for 2008). [Web page]. Located at: http://www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html. Accessed on: February 12, 2010.

Energy Information Administration (EIA). 2010b. [Web Page]. *Uranium Marketing Annual Report.* Located at: http://www.eia.doe.gov/cneaf/nuclear/umar/umar.html. Accessed on: February 12, 2010.

U.S. Nuclear Regulatory Commission. (NRC). 1982. *Draft Environmental Statement Related to the Operation of the Teton Project*, NUREG-0925, June 1982. Para. 2.3.5.

Table 8.6-1 Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Land Surface Impacts	None	Minimal temporary impacts in wellfield areas, significant surface and subsurface disturbance confined to a portion of the 14 acre satellite facility site.	Same as Preferred Alternative.	Same as Preferred Alternative. Potential additional impacts from land application of treated waste water.
Land Use Impacts	None	Loss of crop and cattle production in 671 acre area for duration of project.	Same as Preferred Alternative.	Same as Preferred Alternative plus a potential long term land use impact from on-site disposal of 11(e)2 byproduct material.
Transportation Impacts	None	Minimal impact on current traffic levels. Estimated additional heavy truck traffic of 500 trips per year; additional 6 – 8 VTPD light duty trucks.	Same as Preferred Alternative.	Same as Preferred Alternative.
Geology and Soil Impacts	None	None	None	None
Surface Water Impacts	None	None	None	None
Groundwater Impacts	None	Consumption of Chadron groundwater for control of mining solutions and restoration (estimated at 50 gpm average)	Same as Preferred Alternative. Increased difficulty with groundwater restoration and stabilization.	Same as Preferred Alternative.
Ecological Impacts	None	No substantive impairment of ecological stability or diminishing of biological diversity.	Same as Preferred Alternative.	Same as Preferred Alternative.

Table 8.6-1 Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Air Quality Impacts	None	Additional 15.7 tons per year total dust emissions due to vehicle traffic on gravel roads.	Same as Preferred Alternative.	Same as Preferred Alternative.
Noise Impacts	None	Barely perceptible increase over background noise levels in the area.	Same as Preferred Alternative.	Same as Preferred Alternative.
Historic and Cultural Impacts	None	None	None	None
Visual/Scenic Impacts	None	Moderate impact; noticeable minor industrial component in sensitive viewing areas.	Same as Preferred Alternative.	Same as Preferred Alternative plus possible long term visual and scenic impacts from on-site disposal cell for 11(e)2 byproduct material
Socioeconomic Impacts	Eventual loss over the next 5 to 10 years of positive economic impact of $13.6M to the local area as reserves deplete in the current licensed operation	Extension of the current annual direct economic impact of $13.6M plus the addition of between $5.05M and $6.03M annual direct economic impact to local area	Same as Preferred Alternative.	Same as Preferred Alternative.
Nonradiological Health Impacts	None	None	None	None
Radiological Health Impacts	None	22% increase in estimated maximum dose from additional radon gas released at Three Crow.	Same as Preferred Alternative.	Same as Preferred Alternative.

Table 8.6-1 Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Waste Management Impacts	None	Generation of additional liquid and solid waste for proper disposal.	Same as Preferred Alternative. Mobilization of additional hazardous elements in lixiviant requiring disposal.	Same as Preferred Alternative. Potential additional long term impact from on-site disposal of 11(e)2 byproduct material.
Mineral Resource Recovery Impacts	Loss of a valuable domestic energy resource. CBR estimated reserves are under development but the current estimated recoverable resource is 5.0 million pounds with a current spot market value of $225 million.	Recovery and use of a domestic energy resource.	Same as Preferred Alternative.	Same as Preferred Alternative.

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9 COST-BENEFIT ANALYSIS

9.1 General

The general need for production of uranium is assumed to be an integral part in the nuclear fuel cycle with the ultimate objective being the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against environmental costs including a prorated share of the environmental costs of the uranium fuel cycle. The incremental impacts of typical mining and milling operation required for the fuel cycle are justified in terms of the benefits of energy generation to the society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility such as the CPF and the proposed satellite facility must be reasonable as compared to that typical operation.

9.2 Economic Impacts

Monetary benefits have accrued to the community from the presence of the CPF, such as local expenditures of operating funds and the federal, state and local taxes paid by the 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 satellite facility.

9.2.1 Tax Revenues

Table 9.1-1 summarizes the tax revenues from the CPF.

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 $40.75 per pound U_3O_8 on June 21, 2010 [UxC 2010]), the increased production from the satellite facility should contribute to higher tax revenues.

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

9.2.2 Temporary and Permanent Jobs

9.2.2.1 Current Staffing Levels

CBR currently employs approximately 67 employees and 2 contractors employing 14 people 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 5 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2008 was 2,491 out of a total labor force of 3,065. Based on these statistics, CBR currently provides approximately 3.0 percent of the private employment in Dawes County. In 2006, the CBR total payroll was over $3,941,000. Of the total Dawes County wage and salary payments of $86,633,000 in 2008, the CBR payroll represented about 5 percent.

Total CBR payroll for the past four years was:

2005	$2,382,000
2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,216,870 (estimated)

The average annual wage for all workers in Dawes County was $49,167 for 2008. By way of comparison, the average wage for CBR was about $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including bonus or benefits.

9.2.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite facilities 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 2008, total unemployment in Dawes County was 933 individuals, or 4.3 percent of the total work force of 4,936. 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 facility. These new employees will be needed for satellite facility operators 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.

9.2.3 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:

2005	$4,570,000
2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$7,838,700

The vast majority of these purchases were made in the City of Crawford and Dawes county.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the proposed satellite facilities and from restoration activities, although not in strict proportion to production. While there are some savings due to some fixed costs (CPF utilities for instance), there are additional expenses that are expected to be higher (well-field development for the satellites is expected to be more expensive). Therefore, it can be assumed that the overall effect on local purchases will be relatively 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.

9.2.4 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 9.1-2**.

9.2.5 Estimated Value of Three Crow Resource

CBR is currently continuing to develop the reserve estimates for the TCEA. Based on the current recoverable resource estimate of 3,750,481 pounds U_3O_8 and the current market price of uranium ($40.75 per pound on June 21, 2010 [UxC 2010]), the total estimated value of the energy resources at Three Crow is approximately $150,000,000. This value will fluctuate as the market price and realized price varies.

9.2.6 Short-Term External Costs

9.2.6.1 Housing Impacts

The available housing resources should be adequate to support the short term needs during facility construction. According to the Nebraska Department of Economic Development (NDED), in 2000 (last US census) a total of 492 housing units were vacant in Dawes County out of a total housing base of 4,004 units (NDED 2010). Of the vacant units, 176 were available for rent. In addition to this availability of rental housing units, there are two small hotels in the City of Crawford that generally have vacancies and routinely provide units for itinerant workers such as railroad crews. Temporary housing resources have experienced little change in the past two decades.

More recent data indicate that in 2008 there were a total of 533 houses in the City of Crawford, with 468 occupied (345 owner occupied and 123 renter occupied) (City-Data 2010a). This indicated that 65 housing units were available for purchase or rent. The housing density was 467 houses/condos per square mile. The median rent being asked for vacant rental units in 2008 was $337/month. The median purchase price for a home was $51,856.

The City of Chadron, which is located within communicating distance to the City of Crawford and the TCEA project, was reported that in 2008 there were a total of 2,447 houses with 2,189 occupied (1,216 owner occupied and 973 renter occupied) (City-Data 2010b). This indicated a total of 973 housing units were available for purchase or rent. The housing density was 675 houses/condos per square mile. The median rent asked for vacant rental units in 2008 was $368/month. The median purchase price for a home was $127,963.

9.2.6.2 Noise and Congestion

CBR projects an increase in the noise and congestion in the immediate area of the satellite facility during initial construction of the facility. This will include heavy truck and equipment traffic and access to the jobsite by construction workers. These impacts will be most noticeable to residents in the immediate vicinity of the facility and will be temporary in nature. The increase in noise should be considered in light of the project location, which is bounded on the south by Four Mile Road.

A Burlington Northern Santa Fe (BNSF) rail line is located east of SH 2/71 and is approximately 2.9 miles from the TCEA boundary at the closest point. Noise from the trains on the BNSF rail line would be intermittently audible to receptors within and in close proximity to the TCEA. The rail line is used for combining local "pusher" engines with south bound trains to assist them in climbing the Pine Ridge south of the City of Crawford. As a result, there is a significant amount of noise generated by this activity including trains parked for extended periods. Dust from construction activities will be controlled using standard dust suppression techniques used in the construction industry.

9.2.6.3 Local Services

As previously noted, CBR actively recruits and trains local residents for positions at the mine. CBR expects that the majority of permanent positions at the new satellite facility will be filled with local hires. As a result of using the local workforce, the impact on local services should be minimal. In many cases these services (e.g., schools) are underutilized due to population trends in the area.

9.2.7 Long-Term External Costs

9.2.7.1 Housing and Services

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 long term positions that will be created by the expansion to the proposed Three Crow area 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 2008, total unemployment in Dawes County was 933 individuals, or 4.3 percent of the total work force of 4,936. CBR expects that the new positions at the satellite facility will be filled from this pool of available labor.

9.2.7.2 Noise and Congestion

CBR projects a minor increase in the long term noise and congestion in the immediate area of the satellite facility. Most of this will consist of increased traffic from employees commuting to and from the work site and performing work in the wellfields. Some increase in heavy truck traffic will occur due to deliveries of process chemicals such as oxygen and the shipment of IX resin from the satellite facility to the CPF. Delivery and IX shipments should average two per day. These impacts will be most noticeable to residents in the immediate vicinity of the facility. As noted in Section 9.2.6.2, there is significant existing noise in the immediate area generated by the adjacent rail line and highway.

In the area around the City of Crawford, the increased traffic will be unnoticeable due to the presence of U.S. Highway 20 and Nebraska Highway 2/71, which are both significant transport routes. The annual average 24 hour total and heavy vehicle count for U.S. Highway 20 at the eastern approach to the City of Crawford for 2008 was 1,650 and 215, respectively (NDOR 2010). The limited additional traffic related to the TCEA operation will not significantly affect these main routes.

9.2.7.3 Aesthetic Impacts

The primary visible surface structures proposed for the TCEA include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing building and evaporation ponds. The project will use existing and new roads to access each wellhouse, the deep disposal well building, evaporation ponds and the satellite processing building. Project development would alter the physical setting and visual quality of portions of the landscape, which would affect the overall landscape to some degree, as viewed from sensitive viewing areas. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture, which characterize the existing landscape. The project would primarily affect agricultural land.

In foreground-middleground views, the satellite processing building, evaporation ponds, wellhouses, and associated access road clearings would be the most obvious features of development. Clearings and access roads would be visible as light-tan exposed soils in geometrically-shaped areas with straight, linear edges that provide some textural and color contrasts with the surrounding cropland. The satellite facility processing building, wellhouses, and wellhead covers would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from Four Mile Road and residences within the Expansion Area, but would be subordinate in scale to the rural landscape.

The electric distribution line poles would be an estimated 20 feet tall, and would be located throughout the project area to connect wellhouses with existing lines. The distribution lines are similar in appearance to those typical of the rural landscape, but would occur at a higher density than on adjacent lands. The lines would be obvious to viewers at the viewing areas, but would not change the rural character of the existing landscape.

Wellhead covers would be difficult to discern in the landscape from any sensitive viewing area. The form and textural contrast would be very weak because the relatively low profile (3 feet high) and small size of these would disappear into the surrounding textures of soil and vegetation. Generally, color contrasts are most likely to be visible in foreground-middleground distance zone. However, the wellhead covers would be painted a tan color that would harmonize with the surrounding vegetation and soil colors. Therefore, contrast of line, form, texture, and color would be low. The facilities would not be noticeable to the casual observer. Wellhead covers would be visually subordinate to the landscape in foreground-middleground distance zone.

9.2.7.4 Land Access Restrictions

Property owners of land located within the immediate wellfield and facility boundaries will lose access and free use of these areas during mining and reclamation. The areas impacted are all used for agricultural purposes and the owners will lose the ability to use the areas for production purposes. Offsetting these land use restrictions are the surface lease and mineral royalty payments to the landowners.

9.2.8 Most Affected Population

The expected impacts from the proposed satellite facility can be characterized as an incremental increase in the impacts from operation of the current facility. For the most part, the impact from operation of the current Crow Butte Uranium Project has been positive for the City of Crawford and the surrounding communities. CBR has provided much-needed well compensated employment opportunities for the local population. Additionally, the policy of purchasing goods and services locally to the extent possible has had a positive economic impact on an area facing economic challenges. Tax expenditures and particularly the recent increases in local property taxes paid due to the increase in the price of uranium have had a significant economic impact on local government-provided services.

Offsetting these positive impacts to the local population are increases in noise, congestion, and aesthetic impacts for residents in and adjacent to the proposed satellite facility. Most residents located in the proposed license area are land owners that have mineral and/or surface leases with CBR and will benefit economically from the presence of the facility.

9.2.9 Satellite Facility Decommissioning Costs

Approval of the proposed satellite facility will result in CBR incurring additional decommissioning liabilities for the installed facilities. The actual estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

9.3 The Benefit Cost Summary

The benefit-cost summary for a fuel-cycle facility such as the CPF involves comparing the societal benefit of a constant U_3O_8 supply (ultimately providing energy) against possible local environmental costs for which there is no directly related compensation. For this project, there are basically three of these potentially uncompensated environmental costs:

- Groundwater impact

- Radiological impact
- Disturbance of the land

The groundwater impact is considered to be temporary in nature, as restoration activities will restore the groundwater to a pre-mining quality. The successful restoration of groundwater during the R&D project and the commercial restoration of Mine Unit 1 have demonstrated that the restoration process can meet this criterion successfully.

The radiological impacts of the current and proposed project are small, with all radioactive wastes being transported and disposed of off-site. Radiological impacts to air and water are also minimal. Extensive on-going environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the CPF.

The disturbance of the land for an ISL facility is quite small, especially when compared with conventional surface mining techniques. All of the disturbed land will be reclaimed after the project is decommissioned and will become available for previous uses.

9.4 Summary

In considering the energy value of the U_3O_8 produced to U.S energy needs, the economic benefit to the local communities, the minimal radiological impacts, minimal disturbance of land, and mitigable nature of all other impacts, it is believed that the overall benefit-cost balance for the proposed TCEA is favorable, and that issuing an amendment to SUA-1534 is the appropriate regulatory action.

9.5 References

City-Data.com. (City-Data). 2010a. *Crawford, NE (Nebraska) Houses and Residents.* [Web Page]. Located at: http://www.city-data.com/housing/houses-Crawford-Nebraska.html. Accessed on: February 15, 2010.

City-Data.com. (City-Data). 2010b. *Chadron, NE (Nebraska) Houses and Residents*. [Web Page]. Located at: http://www.city-data.com/housing/houses-Chadron-Nebraska.html. Accessed on: February 15, 2010.

Nebraska Department of Economic Development. (NDED). 2010. *Nebraska Databook.* [Web Page]. Located at: http://www.neded.org/content/view/411/699/. Accessed on: February 03, 2010.

Nebraska Department of Roads. (NDOR). 2010. *Traffic Flow Map of the State Highways, State of Nebraska* (for year 2008). [Web Page]. Located at: http://www.nebraskatransportation.org/maps/#traffvol. Accessed on: February 03, 2010.

The Ux Consulting Company. (UxC). 2010. *Ux Weekly.* [Web Page]. Located at: http://www.uxc.com/review/uxc_Prices.aspx. Accessed on: June 28, 2010.

Table 9.1-1 Tax Revenues from the Current Crow Butte Project

Type of Taxes	2009	2008	2007	2006	2005
Property Taxes	914,000	1,120,000	1,102,000	627,000	351,000
Sales and Use Taxes	136,000	140,000	90,000	238,000	185,000
Severance Taxes	403,000	512,000	1,066,000	545,000	338,000
Total	**1,453,000**	**1,772,000**	**2,258,000**	**1,410,000**	**874,000**

Table 9.1-2 Current Economic Impact of Crow Butte Uranium Project and Projected Impact from TCEA

Activity	Current Crow Butte Operation	Estimated Economic Impact due to Three Crow Expansion Area
Employment		
Full Time Employees	67	+ 10 to 12
Full Time Contractor employees	14	+ 4 to 7
Part Time Employees and Short Term Contractors	3	+ 4 to 7**
CBR Payroll, 2009	$4,216,870*	+ $400,000 to $480,000
Taxes		
Property Taxes	$914,000	-
Sales and Use Taxes	$136,000	-
Severance Taxes	$403,000	-
Total Taxes	$1,453,000	+ $1,000,000 to $1,200,000
Production Royalties		
Royalty Payments, 2009	462,000	+ 325,000
Local Purchases		
Local Purchases, 2009	$7,838,700	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	**$13,970,570**	**+ $5,375,000 to $6,355,000**

*Estimated
**All construction workers

10 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

10.1 Environmental Approvals for the Current Licensed Area

As discussed previously, this is an amendment application for Radioactive Source Materials License SUA-1534, originally submitted in September of 1987 and renewed in 1998. A license renewal application for continued operation of the CPF was submitted to the NRC on November 27, 2007. NRC approval is pending. A license amendment for the addition of the proposed NTEA satellite facility was submitted to the NRC on May 30, 2007. NRC approval is pending.

All other required permits for the existing CPF have been obtained and maintained as required by applicable regulatory requirements. A summary of the relevant permits and authorizations for the current license area is given in **Table 10.1-1**. Permits and authorizations anticipated for the satellite facility are shown in **Table 10.1-2**.

10.2 Environmental Approvals and Consultations for the Proposed Three Crow Expansion Area

10.2.1 Environmental Approvals and Permits

The TCEA will be subject to similar permitting requirements as the CPF. **Table 10.1-2** contains a summary list of the type of permit or authorization, the granting authority, and the status.

10.2.2 Licensing and Permitting Consultations

During the course of the preparation of this License Amendment application and the NDEQ Class III UIC Application for TCEA, consultations were conducted with the following agency contacts:

U.S. Nuclear Regulatory Commission

Mr. Ronald Burrows, Project Manager
Decommissioning and Uranium Recovery Licensing Directorate
Davison of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
Mailstop T8-5
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Nebraska Department of Environmental Quality

Ms. Jenny Abrahamson
Nebraska Department of Environmental Quality
Suite 400, The Atrium
1200 North N Street
P.O. Box 98922
Lincoln, NE 68509-8922

10.2.3 Environmental Consultations

During the course of the preparation of this license amendment application, consultations were conducted with several agencies in regard to information required for various sections of the application:

10.2.3.1 Meteorology (Section 2.5)

Requested meteorology data available for Whitney, NE (WHN5) meteorology station near Crawford, NE.

Seth I. Gutman
Physical Scientist
NOAA Earth System Research Laboratory (ESR)
325 Broadway R/GSD7
Boulder, CO 80305-3328
Phone: 303.497.7031
Fax: 303.497.6014
Seth.I.Gutman@noaa.gov

10.2.3.2 Seismology (Section 2.6.4)

Requested assistance as to available list of historical earthquakes for Nebraska.

Lisa Wald, Geophysicist
Web Team Manager
USGS Earthquake Hazards Program
Golden, CO

10.2.3.3 Surface Water (Section 2.7.1)

Assistance was requested in providing available surface water flow and water quality data for the White River and other streams in the proposed project area:

Dwain Curtis
NWIS DBA
Nebraska Water Science Center
U.S. Geological Survey
5231 South 19th
Lincoln, Ne 68512-1271
402.328.4142 Work
402.416.6144 Mobile

Tom Hayden
Supervisor
Water Field Office Operations
Nebraska Department of Natural Resources
Bridgeport Field Office

Kimberley Martz
IT Specialist
U.S. Geological Survey, Water Resources Discipline
Email: kimmartz@usgs.gov

Assistance requested for information on City of Crawford's Wellhead Protection Area.

Nadine
Nebraska Department of Environmental Quality (NDEQ)
NDEQ Records Management Unit
Lincoln, NE
Email: ndeq.records@nebraska.gov

10.2.3.4 Groundwater Quality Restoration, Surface Reclamation and Facility Decommissioning (Section 6)

Ms. Jenny Abrahamson
Nebraska Department of Environmental Quality
Suite 400, The Atrium
1200 North N Street
P.O. Box 98922
Lincoln, NE 68509-8922

10.2.3.5 Ecology (Section 2.8)

Preparation of the ecology discussion (Section 2.8) required consultations with the following individuals and agencies:

- S. Anschutz, Nebraska Field Supervisor, U.S. Dept. of Interior, Fish and Wildlife Service, Grand Island, NE;
- M. Fritz, Raptor Biologist, Nebraska Game and Parks Commission. Lincoln, NE;
- K. Hams, Big Game Biologist, Nebraska Game and Parks Commission, Lincoln, NE;
- D. Ferraro, Herpetologist, University of Nebraska, Lincoln, NE;
- J. Godberson, Environmental Analyst Supervisor, Nebraska Game and Parks Commission, Lincoln, NE; and
- T. Nordeen, Biologist, Nebraska Game and Parks Commission, Alliance, NE..

10.2.3.6 Historic, Scenic and Cultural Resources (Section 2.4.1)

Preparation of the historic, scenic and cultural resources discussion required consultations with the following individuals and agencies:

- Steinacher, Terry, H.P. Archaeologist and L. Robert Puschendorf, Deputy, Nebraska State Historic Preservation Officer, Nebraska State Historical Society.
- Tribal Authorities (**Table 10.1-3**)

10.2.3.7 Population Distribution (Section 2.3)

Preparation of the population distribution discussion (Section 2.3) required consultations with the following individuals and agencies:

- T. Vogl, School Clerk, Crawford Public Schools.

10.2.4 List of Preparers

The following individuals and organizations were involved in the preparation of the Technical Report and this Technical Report supporting the amendment request for Source Materials License SUA-1534 to allow development of the TCEA:

Crow Butte Resources, Inc.
PO Box 169
Crawford, Nebraska 69339

Jim Stokey, Ph.D.	Mine Manager
Larry Teahon	Manager, Health Safety & Environmental Affairs
Wade Beins	Senior Geologist
Rhonda Grantham	Supervisor of Radiation Safety & Regulatory Affairs / RSO

Cameco Resources
1141 Union Blvd.
Suite 330
Lakewood, CO 80228

Lee Snowhite	Senior Engineer
John Schmuck	Senior Permitting Manager

Petrotek Engineering Corporation
10288 West Chatfield Avenue, Suite #201
Littleton, Colorado 80127

Hal Demuth	Principal, Hydrogeologist & Engineer
Connie Walker	Hydrogeologist
Errol Lawrence	Hydrogeologist
Ken Cooper	Principal, Engineer
Ken Schlieper	Hydrologist & Graphics Specialist

ARCADIS US Inc.
630 Plaza Drive, Suite 100
Highlands Ranch, Colorado 80129

Jerry Koblitz	Principal-in-Charge/Quality Control Officer
Jack Cearley	Project Manager
Eric Cowan	Project Management/Document Coordination

Jason Adams	Staff Scientist – Geologist
Matt Spurlin	Staff Scientist – Hydrologist
Leone Gaston	Senior Scientist
Lisa Welch	Senior Scientist
Kelly Stringham	Staff Scientist – Biologist
Carl Spath, Ph.D.	Archeologist
Susan Riggs	Air Quality Specialist
Mike Holle	GIS Specialist
Jie Chen	GIS Specialist/CAD Specialist
Clayre Brown	Word Processing

Table 10.1-1 Environmental Approvals for Crow Butte Project

Issuing Agency	Permit Description
U.S. Nuclear Regulatory Commission Washington, DC 20555	Source Materials License SUA – 1534 Amendment to Increase Flow Issued: November 30, 2007 Source Material License SUA – 1534 License Renewal request by CBR Submitted: November 27, 2007 NRC Approval: Pending Source Material License SUA – 1534 Amendment for New Satellite Facility: North Trend Expansion Area Submitted: May 30, 2007 NRC Approval: Pending Source Materials License SUA-1534 Issued: December 29, 1989 Renewed: February 28, 1998
U.S. Environmental Protection Agency 1200 Pennsylvania Ave, NW, Washington, DC 20460	Aquifer Exemption Approval Effective: June 22, 1990
Nebraska Department of Environmental Quality PO Box 98922 Lincoln, Nebraska 68509-8922	Underground Injection Control Class III Authorization NE0122611 Approved: April 24, 1990 Amended to increase flow on August 16, 2007
	Aquifer Exemption Approval Effective: March 23, 1984 Aquifer Exemption for North Trend Expansion Area Submitted: August 15, 2007 Approval: Petition denied due to deficiencies Resubmittal: August 20,2008 Approval: Pending
	Underground Injection Control Class III Permit Application for the North Trend Expansion Area Submitted: August 15, 2008 Approval: Pending
	Underground Injection Control Class I Authorization NE0206369 Approved: September 9, 1994 Replaced: July 2, 2004

Table 10.1-1 Environmental Approvals for Crow Butte Project

Issuing Agency	Permit Description
Nebraska Department of Environmental Quality PO Box 98922 Lincoln, Nebraska 68509-8922	Underground Injection Control Class I Authorization NE0210457 Approved: July 2, 2004
	National Pollutant Discharge Elimination System Permit NE0130613 Approved: September 30, 1994
	Mineral Exploration Permit NE0209317 Approved: June 3, 2003 Replaced July 16, 2007
	Mineral Exploration Permit NE0210679 Approved: July 16, 2007
	Mineral Exploration Permit NE0210678 Approved: July 16, 2007
	Mineral Exploration Permit NE0210680 Approved: July 18, 2007
	Mineral Exploration Permit NE0210824 Approved August 19, 2009
	Underground Injection Control Class V Authorization NE0207388 Approved: November 6, 2000
	Evaporation Pond Design Approved: July 21, 1988
	Construction Stormwater NPDES General Permit NER 100000 Authorization #NER105203 Approved December 19, 2006
Nebraska Department of Natural Resources 301 Centennial Mall South Lincoln, Nebraska 68509-4676	Industrial Ground Water Permit Approved: August 7, 1991
Nebraska Department of Health and Human Services Regulation and Licensure PO Box 95007 Lincoln, Nebraska 68509-5007	Class IV Public Water Supply Permit NE3121024 Approved: April 12, 2002

Table 10.1-2 Environmental Approvals for Proposed Three Crow Expansion Area

Issuing Agency	Description	Status
U.S. Nuclear Regulatory Commission Washington, DC 20555	Amendment to Source Materials License SUA-1534 (10 CFR 40)	This document has been submitted as the License Amendment for the Three Crow Expansion Area
U.S. Environmental Protection Agency 1200 Pennsylvania Ave, NW Washington, DC 20460	Aquifer exemption application forwarded to EPA following NDEQ action	Aquifer exemption application will be forwarded to EPA following NDEQ action
Nebraska Department of Environmental Quality PO Box 98922 Lincoln, Nebraska 68509-8922	Underground Injection Control Class III Permit (NDEQ Title 122)	Class III UIC Permit application submitted to NDEQ on July 6, 2010.
	Aquifer Exemption (NDEQ Title 122)	Aquifer exemption application submitted to NDEQ on July 6, 2010
	Underground Injection Control Class I (NDEQ Title 122)	Class I UIC Permit application under preparation; expected submittal to NDEQ in fourth quarter 2010
	Industrial Stormwater NPDES Permit (NDEQ Title 119)	An Industrial Stormwater NPDES may not be required for a satellite facility depending on processes included and the final facility design. If required, an application will be submitted as per NDEQ requirements.
	Construction Stormwater NPDES Permit (NDEQ Title 119)	Construction Stormwater NPDES authorizations are applied for and issued annually under a general permit based on projected construction activities. The Notice of Intent will be filed at least 30 days before construction activities begin in accordance with NDEQ requirements.
	Mineral Exploration Permit (NDEQ Title 135)	Mineral Exploration Permit NE0209317 Approved: June 3, 2003
	Underground Injection Control	The Class V UIC permit will be

Table 10.1-2 Environmental Approvals for Proposed Three Crow Expansion Area

Issuing Agency	Description	Status
	Class V (NDEQ Title 122)	applied for following installation of an approved site septic system during facility construction.
Nebraska Department of Environmental Quality PO Box 98922 Lincoln, Nebraska 68509-8922	Evaporation Pond Design	The evaporation pond design will be submitted following final facility design
Nebraska Department of Natural Resources 301 Centennial Mall South Lincoln, Nebraska 68509-4676	Industrial Ground Water Permit (NDNR Title 456)	The Industrial Groundwater Permit application will be prepared for submittal to the NDNR; expected in the fourth quarter 2010

Table 10.1-3 Tribal Contacts for Proposed Three Crow Expansion Area

Nebraska Commission on Indian Affairs Judi M. Gaiashkibos, Executive Director P.O. Box 94981 Lincoln, NE 68509-4981	Mr. Dale Oldhorn Tribal Historic Preservation Officer Crow Nation Cultural Committee P.O. Box 1094 Crow Agency, MT 59022	President Ronald Rice Pawnee Nation of Oklahoma 881 Little Dee Drive Pawnee, OK 74058
Chairman Alonzo Chalepa Apache Tribe of Oklahoma P.O. Box 1220 Anadarko, OK 73005	Chairman Billy Evans Horse Kiowa Business Committee Kiowa Tribe of Oklahoma P.O. Box 369 Carnegie, OK 73015	Mr. Francis Morris Repatriation Coordinator Pawnee Nation of Oklahoma P.O. Box 470 Pawnee, OK 74058
Chairman Joseph J. Brings Plenty, Sr. Cheyenne River Sioux Tribe P.O. Box 590 Eagle Butte, SD 57625	Chairman Michael G. Jandreau Lower Brule Sioux Tribal Council 187 Oyate Circle Lower Brule, SD 57548	Ms. Alice Alexander THPO and Assistant Repatriation Coordinator 881 Little Dee Drive Pawnee, OK 74058
Mr. Albert LeBeau Tribal Historic Preservation Officer Cheyenne River Sioux Tribe P.O. Box 590 Eagle Butte, SD 57625	Chairman Richard Brannan Northern Arapaho Business Council P.O. Box 396 Fort Washakie, WY 82514	President Rodney Bordeaux Rosebud Sioux Tribe P.O. Box 430 Rosebud, SD 57570
Governor Darrell Flyingman Cheyenne & Arapaho Business Committee Cheyenne & Arapaho Tribes of Oklahoma P.O. Box 38 Concho, OK 73022	Mr. Robert Goggles NAGPRA Representative Northern Arapaho Tribe 328 17 Mile Road Arapaho, WY 82514	Mr. Terry Gray NAGPRA Coordinator Rosebud Sioux Tribe SGU Heritage Center P.O. 675 Mission, SD 57555
Mr. Joe Big Medicine NAGPRA Representative Cheyenne & Arapaho Tribes of Oklahoma P.O. Box 38 Concho, OK 73022	Ms. Jo Ann White THPO Director Northern Arapaho Tribe P.O. Box 396 Fort Washakie, WY 82514	Chairman Roger Trudell Santee Sioux Nation 108 Spirit Lake Avenue, West Niobrara, NE 68760
Mr. Gordon Yellowman NAGPRA Representative Cheyenne & Arapaho Tribes of Oklahoma P.O. Box 38 Concho, OK 73022	Chairman Eugene Little Coyote Northern Cheyenne Tribal Council P.O. Box 128 Lame Deer, MT 59043	Chairman Ron His-Horse-is-Thunder Standing Rock Sioux Tribal Council P.O. Box D Fort Yates, ND 58538

Table 10.1-3 Tribal Contacts for Proposed Three Crow Expansion Area

Chairman Lester Thompson, Jr. Crow Creek Sioux Tribe P.O. Box 50 Fort Thompson, SD 57325	Mr. Conrad Fisher Tribal Historic Preservation Officer Northern Cheyenne THPO Office Northern Cheyenne Tribe P.O. Box 128 Lame Deer, MT 59043	Mr. Tim Mentz Cultural Resource Planner Standing Rock Sioux Tribe P.O. Box D Fort Yates, ND 58538
Chairman Carl E. Venne Crow Nation P.O. Box 159 Crow Agency, MT 59022	President John Yellowbird Steele Oglala Sioux Tribal Council P.O. Box 2070 Pine Ridge, SD 57770	Mr. George Reed Secretary of Cultural Education Crow Nation Cultural Committee P.O. Box 1094 Crow Agency, MT 59022
Mr. Edgar Bear Runner Tribal Historic Preservation Officer Oglala Sioux Tribe P.O. Box 2070 Pine Ridge, SD 57770	Harvey Whitewoman Oglala Sioux Tribe email: harvey.ww@rapidnet.com	