CROW BUTTE RESOURCES, INC.

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January 30, 2003

Mr. Daniel M. Gillen
Branch Chief
Fuel Cycle Licensing Branch
Division of Fuel Cycle Safety and Safeguards
c/o Document Control Desk
U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Subject: Groundwater Restoration Plan
Source Materials License SUA-1534
Docket Number 40-8943

Dear Mr. Gillen:

Crow Butte Resources, Inc. (CBR) is submitting a proposed revision to the approved Groundwater Restoration Plan. The principal purpose of this revision is to clarify stabilization data review requirements. These revisions were discussed with CBR's NRC Project Manager, Mr. John Lusher, on January 27 and 30, 2003. If the proposed revisions are acceptable, CBR requests that License Condition 10.3 be amended to incorporate Revision 2 of the Groundwater Restoration Plan.

If you have any questions, please feel free to contact me at (308) 665-2215.

Sincerely,
CROW BUTTE RESOURCES, INC.

Michael L. Griffin
Manager of Health, Safety, and Environmental Affairs

Attachments: As Stated

NMSS01

CROW BUTTE RESOURCES, INC.

cc: U.S. Nuclear Regulatory Commission
Mr. John Lusher - ADDRESSEE ONLY
Fuel Cycle Licensing Branch
Mail Stop T-8A33
Washington, DC 20555

Nebraska Department of Environmental Quality
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CROW BUTTE RESOURCES, INC.

GROUNDWATER RESTORATION PLAN

Crow Butte Uranium Project

January 30, 2003

Revision 2

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1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) submitted a plan to the US Nuclear Regulatory Commission (NRC) for restoration of groundwater affected by mining activities in November 1993 as required by Source Materials License SUA-1534. The plan was based on experience from restoration operations in Wellfield No. 2 of the R&D facility during 1987. This plan is updated to include experience gained during commercial restoration activities in Mine Units 1 and 2.

The goal of the restoration program is to return the groundwater on a mining unit average to baseline concentrations. The restoration parameters required by SUA-1534 are listed in Table 1. If baseline concentrations are not achieved after reasonable efforts have been made, CBR commits to restoring the groundwater to a quality consistent with pre-mining uses.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four activities:

1) groundwater transfer;
2) groundwater sweep;
3) groundwater treatment; and
4) wellfield recirculation.

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

A reductant may be added at any time 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.

The stabilization stage consists of monitoring the restoration wells for six months following successful completion of the restoration stage. Stabilization will begin once restoration activities have returned the average concentration of restoration parameters to acceptable levels. Following the stabilization period, CBR will make a request to the regulatory agencies that the wellfield is restored.

2 RESTORATION STAGE

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. 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.

2.1 GROUNDWATER TRANSFER

During the groundwater transfer step, water will be transferred between the mining unit (MU) commencing restoration and a MU commencing mining operations.

Baseline quality water from the MU starting mining will be pumped and injected into the MU in restoration. The higher TDS water from the MU in restoration will be recovered and injected into the MU commencing mining. The direct transfer of water will act to lower the TDS in the MU 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 MU's until they become similar in conductivity. The recovered water may be passed through ion exchange (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 MU must be ready to commence mining. If a MU 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.

2.2 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 water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The plume of affected water near the edge patterns of the wellfield is also drawn into the boundaries of the MU.

The number of pore volumes transferred during groundwater sweep, if any, is dependent upon the capacity of the wastewater disposal system and the success of the groundwater transfer step in lowering TDS.

2.3 GROUNDWATER TREATMENT

Following the groundwater sweep step water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. Ion exchange (IX) and reverse osmosis (RO) treatment equipment will be utilized during this stage as necessary to achieve the desired restoration goals..

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

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit 1) reduces the total dissolved solids in the contaminated groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration. Before the water can be processed by the RO, soluble uranium can be removed by the IX system. The RO unit contains membranes that pass about 60 to 75 percent of the water through, leaving 60 to 90 percent of the dissolved salts in the water that will not pass the membranes. Table 2 shows typical 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 twenty-five to forty percent of water that is rejected is called brine and contains the majority of dissolved salts that contaminate the groundwater. The RO brine is sent for disposal in the wastewater system. Make-up water may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

The sulfide reductant added to the injection stream during this 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 (Na2S), or a similar compound will be added as a reductant. A comprehensive safety plan regarding reductant use will be 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.

2.4 WELLFIELD RECIRCULATION

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

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 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 parameters. 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.

3 STABILIZATION STAGE

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 assayed. Sampling frequency will be one sample per month for a period of 6 months. The stabilization data will be reviewed to determine whether the restoration goals are met and for significant increasing trends in the monitored parameters. If the stabilization samples show that the restoration goals on a mine unit average for monitored constituents are met during the stabilization period and that there is the absence of significant increasing trends, restoration shall be deemed complete.

4 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 USNRC Semiannual Radiological Effluent and Environmental Monitoring Report. 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 1. Assay results will be submitted to the USNRC. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the USNRC, CBR will proceed with the stabilization phase of restoration.

During stabilization, all designated restoration wells will be sampled monthly for constituents listed in Table 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 restoration criteria is met as discussed in Section 3, CBR would request the mine unit be declared restored.

TABLE 1: RESTORATION PARAMETERS

Element
Ammonia (NH4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluoride (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium (Ca)
Total Carbonate
Potassium (K)
Magnesium (Mg)
Total Dissolved Solids (TDS)

TABLE 2: TYPICAL MEMBRANE REJECTION[1]

Element	Symbol	Percent Rejection
	Cations	
Sodium	Na^{+}	94-96
Calcium	Ca^{+2}	96-98
Magnesium	Mg^{+2}	96-98
Potassium	K^{+1}	94-96
Iron	Fe^{+2}	98-99
Manganese	Mn^{+2}	98-99
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Copper	Cu^{+2}	98-99
Nickel	Ni^{+2}	98-99
Zinc	Zn^{+2}	98-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Mercury	Hg^{+2}	96-98
	Anions	
Chloride	Cl^{-1}	94-95
Bicarbonate	HCO_3^{-1}	95-96
Sulfate	SO_4^{-2}	99+
Nitrate	NO_3^{-1}	95+
Fluoride	F^{-1}	94-96
Silicate	SiO_2^{-8}	80-95
Phosphate	PO_4^{-3}	99+
Bromide	Br^{-1}	94-96
Chromate	CrO_4^{-2}	90-98
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

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