CROW BUTTE RESOURCES, INC.

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November 14, 2003

Mr. Gary Janosko
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: License Amendment Request
Source Materials License SUA-1534
Docket Number 40-8943

Dear Mr. Janosko:

Crow Butte Resources, Inc. (CBR) is submitting this request for an amendment to Source Materials License SUA-1534 concerning the approved groundwater restoration plan. License Condition 10.3C states:

> C. *Groundwater restoration goals shall be established on a parameter-by-parameter basis for the constituents identified in License Condition 10.3B. The primary goal of restoration shall be on a parameter-by-parameter basis to return the average well field unit concentration to baseline conditions. The secondary goal of groundwater restoration shall be on a parameter-by-parameter basis to return the average well field unit concentration to the numerical class-of-use standards established by the Nebraska Department of Environmental Quality, as described in section 6.1.3 of the approved license application. The licensee shall conduct groundwater restoration activities in accordance with the groundwater restoration plan submitted by letter dated January 30, 2003.*

CBR proposes a change to the stabilization monitoring program specified in the groundwater restoration plan that is incorporated by reference in License Condition 10.3C. This request provides a description and analysis of the requested change, a revision to the approved groundwater restoration plan, and requests that NRC amend License Condition 10.3C to approve the revised plan.

Introduction

The purpose of the stability monitoring program is to ensure that the concentration of restoration parameters does not increase significantly following groundwater restoration. At

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the completion of active groundwater restoration activities, CBR is required by the current groundwater restoration plan to sample all designated restoration wells. The purpose of this post-restoration monitoring is to confirm that restoration has successfully returned the mine unit to the restoration standards. Stability monitoring must then continue for at least six months. The approved plan requires that "*...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.*" At the end of stabilization, the "*...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.*"

Proposed Program

As currently written, the Stabilization Program in Section 3 of the approved groundwater restoration plan requires sampling and analysis of each individual restoration well on a monthly basis throughout the stabilization period. In the revised groundwater restoration plan (attached), CBR proposes the following stabilization sampling plan:

1. CBR will sample and analyze discrete grab samples from each individual restoration well during the post-restoration (i.e., first round of stabilization) sampling. These samples will be split with the Nebraska Department of Environmental Quality (NDEQ) according to Underground Injection Control (UIC) permit requirements. This analytical data will confirm that the restoration standards have been met and that the wellfield recirculation step has successfully mixed the groundwater in the mine unit.

2. In subsequent monthly stabilization samples, each designated restoration well will be sampled as required in the current plan. A composite sample of these individual well samples will be prepared in the CBR laboratory and submitted to the contract laboratory for analysis of the restoration parameters. The individual samples from the restoration wells will be properly preserved and retained at the CBR laboratory until analytical results are received from the contract laboratory. If the composite analytical results indicate increasing trends in any monitored parameter(s), some or all of the individual well samples may be sent to the contract laboratory to determine whether the changes are due to increases in specific areas of the mine unit.

3. During the final stabilization sample, CBR will again sample and analyze each individual restoration well. The individual well data from this final stabilization sample will be compared with similar data from the first stabilization sample to

confirm that all areas of the mine unit have remained stable during the monitoring period.

CBR believes that this proposed change will meet the program goals of ensuring that the concentrations of the restoration parameters will not increase significantly following groundwater restoration while reducing the analytical cost to CBR. As currently implemented, the monthly stabilization results from each restoration well are used to calculate the mathematical average concentration of each parameter in the mine unit. This mathematical average is then compared to the restoration standard, which is applied on a mine unit average. The mathematical average for each parameter is also compared to the previous stabilization results and analyzed for significant trends.

In the proposed change, CBR would achieve the same goal of determining the stability of the mine unit. The principal difference would be replacing the mathematical determination of the average concentration in the mine unit with a composite, which acts as a "physical average".

Technical Basis

In preparing the revised groundwater restoration plan, CBR has referred to several technical and regulatory guidance documents. ASTM Standard D 6051-96 (2001)[1] provides guidance on composite sampling and when it is acceptable and useful for environmental programs. As noted in the ASTM Standard, the principal advantage of composite sampling is a significant reduction in analytical costs. In this case, the current laboratory list price for analysis of the restoration parameters is several hundred dollars per sample, resulting in a minimum stabilization analytical cost for Mine Units 2 through 9 of over $300,000. The proposed change would reduce this cost to CBR by nearly two-thirds while continuing to meet the goal of monitoring the mine unit for significant trends.

The ASTM Standard also notes that composite sampling is particularly useful in situations where the contaminant distribution is contiguous and non-random and where a majority of the analytical results are "non-detects" for the contaminants of interest. As the data from Mine Unit 1 shows, the water quality in a post-restoration mine unit generally does not vary widely due to the limited area involved, the density of sampling (i.e., one per acre), and the effectiveness of the wellfield recirculation step. As also shown during the stabilization of Mine Unit 1, over one third of the parameters listed in the restoration table are routinely below analytical reporting levels in all samples. Based on these factors, the intermediate monthly stabilization samples would appear to be well suited for composite sampling.

[1] American Society for Testing and Materials (ASTM) Standard D 6051-96 (2001), *Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities.*

The ASTM Standard also discusses the following limitations where composite sampling would not be appropriate:

1. Composite sampling is not acceptable when the integrity of the individual sample changes because of compositing. Examples of this limitation would be chemical interactions between constituents in the individual samples or the loss of volatile compounds during mixing. In the proposed application, the water quality of the discrete samples is very similar, so no chemical interactions are expected. The restoration parameter list does not include volatile or semivolatile compounds that could be affected by mixing.

2. Composite sampling should not be used when the sample cannot be properly mixed. This limitation would generally apply to solid or semisolid samples and should not be a concern with water samples.

3. If the goal of sampling is to detect "hot spots" and a large proportion of the samples are expected to test positive, the cost of compositing and retesting may be excessive. In the proposed application, composite analytical results will be reviewed for significant increasing trends. If such trends are noted, the individual well samples may be sent to the laboratory for analysis of the parameters of concern. The cost of sampling and compositing will be incurred during the initial sampling. Analysis of individual samples will be for the parameters of concern only, which will still result in significant cost savings to CBR over the current method.

4. Composite sampling is not cost effective when the analytical costs are low relative to the sampling costs. In this case, the analytical cost to CBR is at least an order of magnitude above the sample collection and compositing cost.

5. Composite sampling is not appropriate when regulations require grab samples, although the ASTM Standard notes that even in these cases, a composite sample covering a limited area is usually preferred from a technical standpoint. There are no regulatory requirements that stabilization samples must be grab samples. In fact, the restoration standards are applied on a mine unit average basis and are not applied to individual restoration wells. The regulatory basis of the proposed change is the topic of the next section.

Regulatory Basis

The principal NRC regulatory guidance for acceptable approaches for groundwater protection at in situ leach (ISL) uranium facilities is NUREG-1569[2], which provides the NRC staff with guidance for reviewing license applications. Chapter 6 of NUREG-1569 discusses groundwater restoration following mining activities. The NRC acceptance criteria for stabilization monitoring programs is provided in Section 6.1.3 (5), which states:

> *The purpose of a stability monitoring program is to ensure that chemical species of concern do not increase in concentration subsequent to restoration. The applicant should specify the length of time that stability monitoring will be conducted, the number of wells to be monitored, the chemical indicators to be monitored, and the monitoring frequency. These requirements will vary based on site-specific post-extraction water quality and geohydrologic and geochemical characteristics. Before final wellfield decommissioning is completed, all designated monitor wells must be sampled for all monitored constituents.*

The proposed stabilization program meets or exceeds these acceptance criteria. The criteria would allow sampling a representative number of monitor wells for an approved list of indicator parameters with the proviso that the final stabilization samples encompass all wells and all restoration parameters. In the proposed program, CBR would continue to sample all wells and analyze a composite for all constituents during each monthly sample event. The final stabilization sample would require analysis of each grab sample for all restoration parameters.

In addition to the licensing guidance contained in NUREG-1569, the NRC provides decommissioning guidance for materials licensees in NUREG-1757[3]. Appendix F of Volume 2 of NUREG-1757 provides guidance for ground and surface water characterization during the decommissioning process. In section F.5, acceptable sample frequencies for determining variations in ground water quality during decommissioning are discussed. NRC states that "*...(a)fter an initial sampling round in which each monitoring well is sampled, representative samples should be collected and analyzed on a monthly basis...*" The proposed CBR program includes analysis of each individual well sample during the initial and final sampling rounds, which would meet this NRC decommissioning guidance.

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[2] US Nuclear Regulatory Commission, NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*, June 2003.

[3] US Nuclear Regulatory Commission, NUREG-1757, Volume 2, *Consolidated NMSS Decommissioning Guidance; Characterization, Survey, and Determination of Radiological Criteria*, September 2002.

Program Implementation

In order to implement the proposed change to the groundwater restoration plan, CBR will take the following actions:

1. Field samples will be collected from individual monitor wells using approved groundwater sampling procedures contained in Volume VI of the CBR Environmental Management System (EMS) Program, *Environmental Manual*. Samples will be properly filtered and preserved according to the approved analytical method.

2. Composite samples will be prepared in the CBR Laboratory by trained Chemistry Technicians using standard composite preparation procedures. Composite samples will be properly preserved and shipped to the contract analytical laboratory using standard chain-of-custody procedures.

3. The individual well samples will be maintained in storage at the CBR Laboratory until composite analytical results are received. The hold times for restoration parameters range from 28 days for water quality parameters to 6 months for metals and radionuclides. CBR will ensure that results from the composite samples are available before sample hold times are exceeded to allow analysis of individual samples, if needed.

4. Upon receipt of the composite data, the results will be reviewed and compared with previous analytical results for significant trends in any restoration parameters. If trends are noted, the individual samples from some or all of the restoration wells may be shipped to the analytical laboratory for analysis of the parameter(s) of concern.

Conclusion

Based on this evaluation, CBR believes that analysis of composite stabilization samples during the second through fifth months of stabilization monitoring will meet the goal of determining whether restoration activities have returned the mine unit water quality to a stable condition and will representing a significant cost savings to CBR. CBR requests that NRC amend License Condition 10.3C of SUA-1534 to accept the revised groundwater restoration plan dated November 14, 2003.

Performance-Based Restoration Plan Revisions

The current restoration plan requires that CBR submit post-restoration data to the NRC before initiation of stabilization. This data must demonstrate that the mine unit meets the established restoration criteria. CBR believes that the CBR Safety and Environmental Review Panel (SERP) can effectively determine whether the mine unit meets the restoration standards and can approve initiation of stabilization based on the NRC performance-based license. The CBR SERP will review the post-restoration data against the standards established in the approved License Renewal Application[4] and, if those standards are met, may approve stabilization. If the standards are not met, the proposed groundwater restoration plan requires that restoration be reinitiated or that documentation be submitted to the regulatory agencies (i.e., NRC and NDEQ) demonstrating efforts to meet the standards and justifying alternate parameter value(s).

CBR is submitting a similar request to the NDEQ to approve revisions to the NDEQ-approved Restoration Plans for Mine Units 2, 3 and 4. If you have any questions concerning this request, 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

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

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[4] Crow Butte Resources, Inc., *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, December 1995.

CROW BUTTE RESOURCES, INC.

GROUNDWATER RESTORATION PLAN

Crow Butte Uranium Project

November 14, 2003

Revision 3

Table of Contents

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 mine units 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. The CBR Safety and Environmental Review Panel (SERP) will determine if restoration has achieved the restoration standards on a mine unit basis. If so, the SERP will approve initiation of the Stabilization Stage. If, at the end of restoration activities, the parameters are not at or below the approved standards, CBR will either re-initiate certain steps of the restoration plan or submit documentation to the NRC 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 analyzed for the restoration parameters. 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. The stabilization samples will be collected on the following schedule:

3.1 Initial Stabilization Sample

CBR will sample and analyze discrete grab samples from each individual restoration well during the post-restoration (i.e., first round of stabilization) sampling. These samples will be analyzed for the restoration parameters listed in Table 1.

3.2 Subsequent Stabilization Samples

In subsequent monthly stabilization sampling, each designated restoration well will be sampled. A composite sample of these individual well samples will be prepared in the CBR laboratory and submitted to the contract laboratory for analysis of the constituents listed in Table 1. The individual samples from the restoration wells will be properly preserved and retained at the CBR laboratory until analytical results are received from the contract laboratory. If the analytical results indicate increasing trends in any monitored parameter(s), individual well samples may be sent to the contract laboratory to determine whether the changes are due to increases in specific areas of the mine unit.

3.3 Final Stabilization Sample

During the final stabilization sample, CBR will sample and analyze discrete grab samples from each individual restoration well for the constituents listed in Table 1.

3.4 Stabilization Determination

The data from the stabilization period will be evaluated to confirm that the mine unit has remained stable during the monitoring period. If the stabilization samples show that the restoration standards are met during the stabilization period and that there are no 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. Analytical results will be reviewed by the CBR SERP. If restoration activities have returned the wellfield average of the restoration parameters to concentrations at or below the standards approved by the NRC, the CBR SERP will approve initiation of the stabilization phase of restoration. SERP evaluations are summarized in an annual report to the NRC.

During stabilization, all designated restoration wells will be sampled monthly and analyzed according to the schedule in Section 3. 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.