Parameter	Groundwater Standard	MU-5 Baseline	MU-5 Standard Deviation	MU-5 NDEQ Restoration Value
Ammonium (mg/L)	10.0	0.28	0.05	10.0
Arsenic (mg/L)	0.05	<0.001	N/A	0.05
Barium (mg/L)	1.0	<0.10	N/A	1.0
Cadmium (mg/L)	0.005	<0.01	N/A	0.005
Chloride (mg/L)	250.0	191.9	7.9	250.0
Copper (mg/L)	1.0	<0.01	N/A	1.0
Fluoride (mg/L)	4.0	0.64	0.07	4.0
Iron (mg/L)	0.3	<0.05	N/A	0.3
Mercury (mg/L)	0.002	<0.001	N/A	0.002
Manganese (mg/L)	0.05	<0.01	N/A	0.05
Molybdenum (mg/L)	1.0	<0.10	N/A	1.0
Nickel (mg/L)	0.15	<0.05	N/A	0.15
Nitrate (mg/L)	10.0	<0.1	N/A	10.0
Lead (mg/L)	0.05	<0.05	N/A	0.05
Radium (pCi/L)	5.0	166.0	184.6	535.0
Selenium (mg/L)	0.05	<0.002	N/A	0.05
Sodium (mg/L)	N/A	397.6	14.4	3976
Sulfate (mg/L)	250.0	364.5	10.5	385.0
Uranium (mg/L)	5.0	0.072	0.056	5.0
Vanadium (mg/L)	0.2	<0.10	N/A	0.2
Zinc (mg/L)	5.0	<0.02	N/A	5.0
pH (Std. Units)	6.5 - 8.5	8.5	0.1	6.5 – 8.5
Calcium (mg/L)	N/A	12.6	1.8	126.0
Total Carbonate (mg/L)	N/A	372	13.0	590.0
Potassium (mg/L)	N/A	11.5	1.2	115.0
Magnesium (mg/L)	N/A	3.4	0.4	34.0
TDS (mg/L)	N/A	1179.5	22.5	1202.0

Notes:
N/A = Not Applicable

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

August 20, 2007

Mr. Michael Linder
Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: **UIC Permit NE0122611**
Mine Unit 5 Cessation of Mining

Dear Mr. Linder:

Crow Butte Resources, Inc. (CBR) terminated mining in Mine Unit 5 at the Crow Butte Uranium Mine on August 14, 2007. In accordance with Part II(C)(3) of the permit, a representative post-mining sample of the injection fluid was collected on August 14, 2007 to determine the aquifer's water quality. The groundwater restoration process will initially use groundwater sweep to pull fresh water into the mining unit.

If you have any questions, please do not hesitate to call (308) 665-2215.

Sincerely,
CROW BUTTE RESOURCES, INC.

John Cash
Operations Superintendent

cc: Mr. Steve Collings - CBR, Denver
Mr. Dave Carlson – NDEQ, Chadron
Mr. Larry Teahon – CBR, Crawford
Mr. Jim Stokey – CBR, Crawford

Dave Heineman
Governor

STATE OF NEBRASKA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Michael J. Linder
Director
Suite 400, The Atrium
1200 'N' Street
P.O. Box 98922
Lincoln, Nebraska 68509-8922
Phone (402) 471-2186
FAX (402) 471-2909
website: www.deq.state.ne.us

AUG 06 2007

Mr. Stephen Collings, President
Crow Butte Resources, Inc.
141 Union Blvd., Ste. 330
Lakewood, Colorado 80228

Dear Mr. Collings:

On July 3, 2007 the Nebraska Department of Environmental Quality (NDEQ) received a Restoration Plan from Crow Butte Resources, Inc. for Mine Unit 5 (MU5) at the Crow Butte Uranium Mine. The plan included projected activities and reporting requirements to be conducted in the Mine Unit during restoration.

NDEQ staff have reviewed the Restoration Plan and determined that it is adequate as proposed. The Department hereby approves the implementation of restoration activities in Mine Unit 5. Restoration values for parameters listed in Table 1 of the Restoration Plan will be those values approved for the restoration wells specified in the Notice of Intent to Operate for MU5.

If you have any questions or comments, please contact Steve Fischbein of my staff at (402) 471-4290.

Sincerely,

Michael J. Linder
Director

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

July 9, 2007

Mr. Michael Linder, Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: **UIC Permit NE0122611**
Mine Unit 5-Restoration Plan

Dear Mr. Linder:

On July 3, 2007, a draft revision of the Mine Unit 5 Restoration Plan was submitted to your office via e-mail for review. Please accept this letter as a formal request for approval of the afore mentioned Mine Unit 5 Restoration Plan.

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

Sincerely,
CROW BUTTE RESOURCES, INC.

John W. Cash
Operations Superintendent

cc: Mr. Dave Carlson – NDEQ
Mr. Steve Collings - CBR, Denver
Mr. Jim Stokey – CBR, Crawford
Mr. Larry Teahon

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 5

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

June 26, 2007

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 5.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 5 were approved by a letter received by CBR from DEQ on October 24, 1995.

The commercial groundwater restoration program consists of two stages, the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 at least 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 submit documentation 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.

Prior to commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 5. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation.

Another potential method for reducing the wellfield is through bioremediation. Bioremediation entails adding an organic electron donor, such as cheese whey, to the aquifer to stimulate native bacteria. As the bacteria feed on the organic media they generate a reducing environment which in turn causes most metals in solution to precipitate back to their original state. The concentration of native bacteria colonies returns to normal levels once the organic media is consumed. Crow Butte Resources, Inc. will seek approval from the NDEQ before initiating bioremediation in Mine Unit 5.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater and 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 (Na_2S) 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved, 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 approved concentrations. 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 at least 6 months, and if the six samples show that the restoration values for all wells are maintained during the stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab sample for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization sampling). A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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 minimum stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

If one or more of the monitored constituents exhibits significant increasing trends after the minimum 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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 minimum 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. At that time 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)
Fluorine (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]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

DATE

MINE UNIT 5

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

June 26, 2007

Mr. Michael Linder, Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: **UIC Permit NE0122611**
Revision 2, Mine Unit 5 Restoration Plan

Dear Mr. Linder:

Please find behind this cover the second revision to the Mine Unit Five Restoration Plan. This revision clarifies that the stabilization period must last for a minimum of six months as described in the Class 3 Permit.

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

Sincerely,
CROW BUTTE RESOURCES, INC.

John W. Cash
Operations Superintendent

cc: Mr. Dave Carlson – NDEQ
Mr. Steve Collings - CBR, Denver
Mr. Jim Stokey – CBR, Crawford
Mr. Larry Teahon

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 5

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

June 26, 2007

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 5.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 5 were approved by a letter received by CBR from DEQ on October 24, 1995.

The commercial groundwater restoration program consists of two stages, the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 at least 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 submit documentation 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.

Prior to commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 5. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation.

Another potential method for reducing the wellfield is through bioremediation. Bioremediation entails adding an organic electron donor, such as cheese whey, to the aquifer to stimulate native bacteria. As the bacteria feed on the organic media they generate a reducing environment which in turn causes most metals in solution to precipitate back to their original state. The concentration of native bacteria colonies returns to normal levels once the organic media is consumed. Crow Butte Resources, Inc. will seek approval from the NDEQ before initiating bioremediation in Mine Unit 5.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;

- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;

- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and

- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater and 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 (Na_2S) 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved, 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 approved concentrations. 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 at least 6 months, and if the six samples show that the restoration values for all wells are maintained during the stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab sample for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization sampling). A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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 minimum stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

If one or more of the monitored constituents exhibits significant increasing trends after the minimum 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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 minimum 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

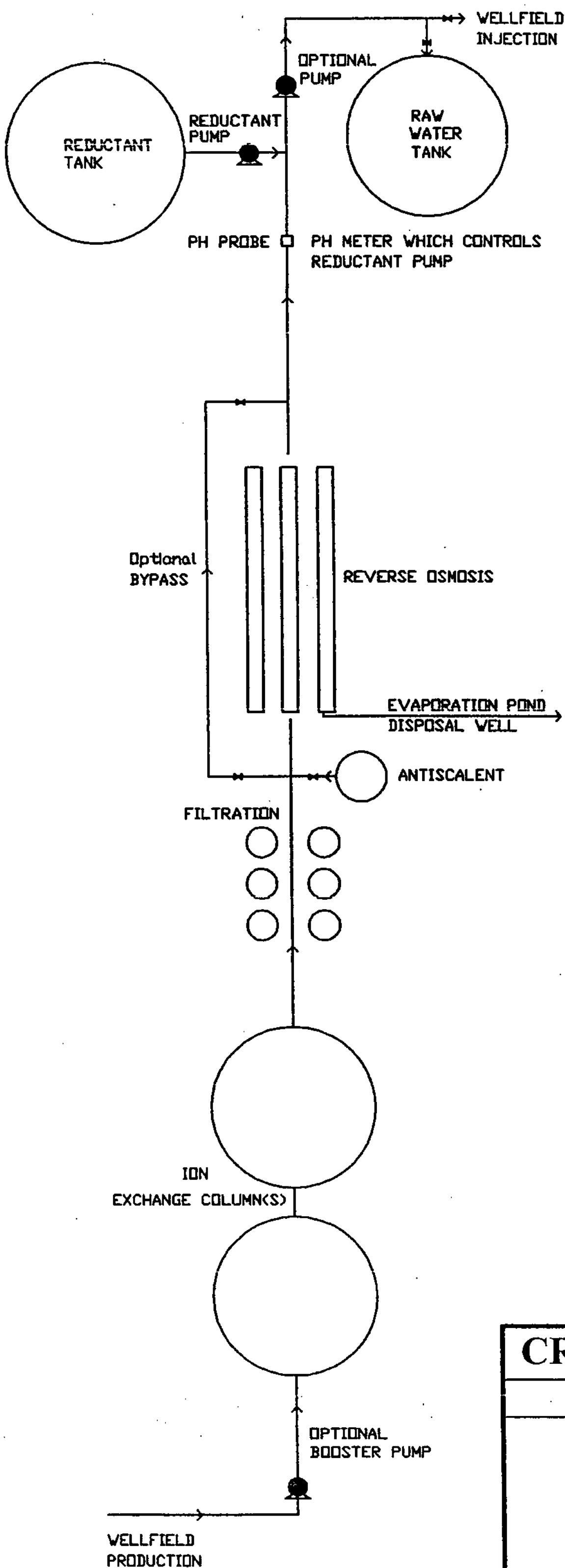
Element
Ammonia (NH4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluorine (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium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

Table 2
Typical Membrane Rejection[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

FIGURE 1
Mine Unit #5 Restoration



CROW BUTTE RESOURCES	
DAWES COUNTY, NEBRASKA	
Mine Unit #5 Restoration Figure 1 Revision 2, June 26, 2007	
Prepared By : JD	
Drawn By: JD	Date: 6/26/07

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

DATE

MINE UNIT 5

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

Dave Heineman
Governor

STATE OF NEBRASKA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Michael J. Linder
Director
Suite 400, The Atrium
1200 'N' Street
P.O. Box 98922
Lincoln, Nebraska 68509-8922
Phone (402) 471-2186
FAX (402) 471-2909
website: www.deq.state.ne.us

JUN 14 2007

Mr. John W. Cash
Crow Butte Resources, Inc.
86 Crow Butte Road
P.O. Box 169
Crawford, NE 69339-0169

RE: UIC Permit NE0122611 - Revised Mine Unit 5 Restoration Plan

Dear Mr. Cash,

The Nebraska Department of Environmental Quality (NDEQ) has reviewed the revised restoration plan for mine unit 5 submitted by you on May 30, 2007. Based on our review, we request that the following modifications be made to the plan. These modifications are being requested to ensure that the language in the restoration plan reflects the language used in permit NE0122611. Specifically we are requesting the following minor changes:

1) On page 1, section 1, last paragraph, first sentence, please change the following language: *"the restoration wells for six months..."* to *"the restoration wells for **at least** six months..."*.

2) On page 4, section 3, paragraph 1, second sentence, please change the following language: *"Sampling frequency will be one sample per month for a period of 6 months,..."* to *"Sampling frequency will be one sample per month for a period of **at least** 6 months,..."*.

3) On page 5, section 3.4, paragraph 1, second sentence, please change the following language: *"If the stabilization samples show that the restoration standards are met during the stabilization period..."* to *"If the stabilization samples show that the restoration standards are met during the **minimum** stabilization period..."*.

4) Same section as #3 above, third sentence, please change the following language: *"If one or more of the monitored constituents exhibits significant increasing trends after the 6 month stability monitoring period..."* to *"If one or more of the monitored constituents exhibits significant increasing trends after the **minimum** 6 month stability monitoring period..."*.

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

May 30, 2007

Mr. Michael Linder, Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: UIC Permit NE0122611
Revised Mine Unit 5-Restoration Plan

Dear Mr. Linder:

In response to the Nebraska Department of Environmental Quality's (NDEQ) recent letter regarding the proposed Mine Unit 5 Restoration Plan, please find attached for your review and approval a revised Restoration Plan. The revision includes additional information regarding the stabilization stage as well as composite sampling.

Item 3 of your letter relayed concerns regarding the use of physical compositing versus mathematical averaging of water samples. Physical compositing was originally proposed by Crow Butte Resources, Inc. in a memo to NDEQ on November 14, 2003. The November 14, 2003 memo addressed both the technical and regulatory issues regarding sample compositing. In response to questions from NDEQ regarding composite sampling, an additional memo was submitted to NDEQ on February 24, 2004. The February 24, 2004 memo included provisions for verifying the accuracy of physical compositing during the course of mine unit stabilization. After review of the February 24, 2004 memo, NDEQ approved the use of composite sampling during restoration in a memo received by CBR on May 11, 2004. The memos listed above are attached behind this cover for your convenience. I believe they will answer any questions you may have regarding the use of sample compositing.

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

Sincerely,
CROW BUTTE RESOURCES, INC.

John W. Cash
Operations Superintendent

cc: Mr. Dave Carlson – NDEQ
Mr. Steve Collings - CBR, Denver
Mr. Jim Stokey – CBR, Crawford
Mr. Larry Teahon

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 5

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

May 30~~April 27~~, 2007

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 5.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 5 were approved by a letter received by CBR from DEQ on October 24, 1995.

The commercial groundwater restoration program consists of two stages, the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Prior to commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 5. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in

Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation.

Another potential method for reducing the wellfield is through bioremediation. Bioremediation entails adding an organic electron donor, such as cheese whey, to the aquifer to stimulate native bacteria. As the bacteria feed on the organic media they generate a reducing environment which in turn causes most metals in solution to precipitate back to their original state. The concentration of native bacteria colonies returns to normal levels once the organic media is consumed. Crow Butte Resources, Inc. will seek approval from the NDEQ before initiating bioremediation in Mine Unit 5.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater and 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 (Na_2S) 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved~~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 approved concentrations. 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, and if the six samples show that the restoration values for all wells are maintained during the stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab sample for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization sampling). A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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.

If one or more of the monitored constituents exhibits significant increasing trends after the 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, 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 NDEQ.~~ The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

Element
Ammonia (NH_4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluorine (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO_3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO_4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium (Ca)
Total Carbonate
Potassium (K)
Magnesium (Mg)
Total Dissolved Solids (TDS)

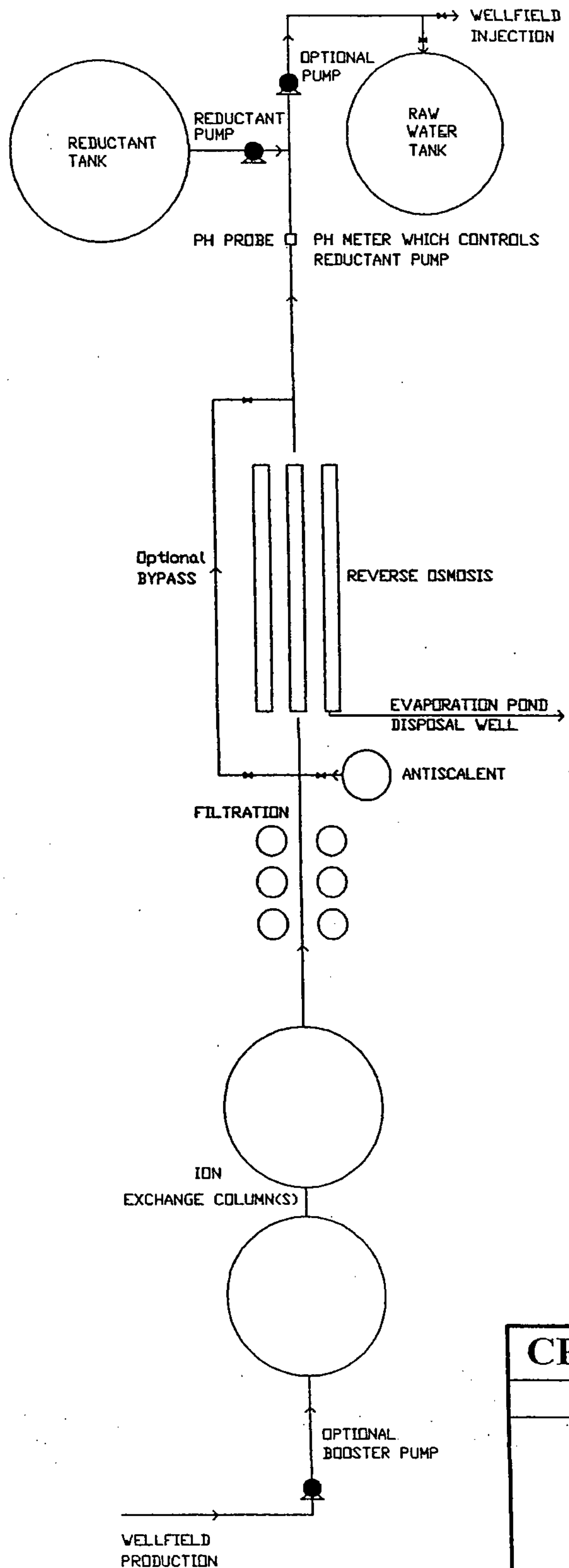
Table 2
Typical Membrane Rejection[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

Mine Unit #5 Restoration

FIGURE 1



CROW BUTTE RESOURCES

DAWES COUNTY, NEBRASKA

Mine Unit #5 Restoration Figure 1

Revision 1, May 30, 2007

Prepared By : JD

Drawn By: JD **Date: 4/12**

FIGURE 2

CROW BUTTE MINE MONTHLY RESTORATION REPORT DATE MINE UNIT 5			
1. RESTORATION ACTIVITY DURING MONTH:			
	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX & RO treatment continues
d. Wellfield Recirculation			
e. Other (explain):			
2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:			
3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:			
4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:			

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

April 27, 2007

Mr. Michael Linder, Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: UIC Permit NE0122611
Mine Unit 5-Restoration Plan

Dear Mr. Linder:

Crow Butte Resources, Inc. (CBR) is making plans to terminate commercial mining in Mine Unit 5 and place it into restoration before Mine Unit 10 is placed into production. In preparation, Crow Butte Resources is submitting, under this cover, the Mine Unit 5 Restoration Plan in accordance with Part II(C)(3) of the permit. Once the Restoration Plan is approved and production conditions warrant, Crow Butte Resources will notify NDEQ of our intent to place Mine Unit 5 into restoration and we will collect a representative post-mining sample of the injection fluid.

CBR would like to begin discussions with NDEQ regarding the potential use of bioremediation in place of or in addition to sodium sulphide reductant. Bioremediation has been used to effectively restore groundwater at other uranium mines without the addition of undesirable chemicals such as hydrogen sulphide or sodium sulphide. Bench tests have already been performed, with the aid of Shaw Environmental, to determine the best organic carbon sources for bioremediation. CBR is not asking for approval of bioremediation with this letter or as part of the restoration plan, but we would like to begin exploring it as an option.

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

Sincerely,
CROW BUTTE RESOURCES, INC.

John W. Cash
Operations Superintendent

cc: Mr. Dave Carlson – NDEQ
Mr. Steve Collings - CBR, Denver
Mr. Jim Stokey – CBR, Crawford
Mr. Larry Teahon

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 5

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

April 27, 2007

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 5.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 5 were approved by a letter received by CBR from DEQ on October 24, 1995.

The commercial groundwater restoration program consists of two stages, the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Prior to commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 5. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion

exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation.

Another potential method for reducing the wellfield is through bioremediation. Bioremediation entails adding an organic electron donor, such as cheese whey, to the aquifer to stimulate native bacteria. As the bacteria feed on the organic media they generate a reducing environment which in turn causes most metals in solution to precipitate back to their original state. The concentration of native bacteria colonies returns to normal levels once the organic media is consumed. Crow Butte Resources, Inc. will seek approval from the NDEQ before initiating bioremediation in Mine Unit 5.

A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater and 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 (Na_2S) 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 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 approved concentrations. 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, and if the six samples show that the restoration values for all wells are maintained during the stabilization period and that there are no significant increasing trends, restoration shall be deemed complete.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, 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 NDEQ. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

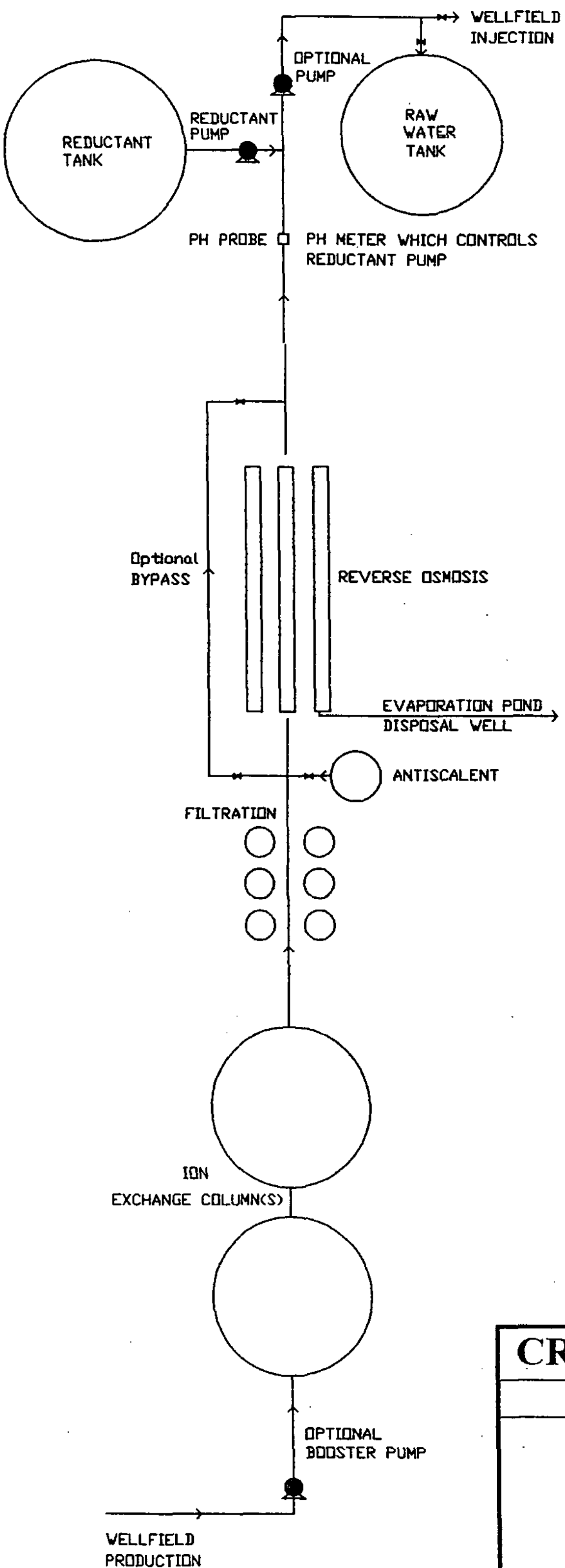
Element
Ammonia (NH4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluorine (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium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

Table 2
Typical Membrane Rejection[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

Mine Unit #5 Restoration
FIGURE 1



CROW BUTTE RESOURCES	
DAWES COUNTY, NEBRASKA	
Mine Unit #5 Restoration Figure 1	
Prepared By : JD	
Drawn By: JD	Date: 4/12

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

DATE

MINE UNIT 5

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX & RO treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

Parameter	Groundwater Standard	MU-4 Baseline	MU-4 Standard Deviation	MU-4 NDEQ Restoration Value
Ammonium (mg/L)	10.0	0.288	0.08	10.0
Arsenic (mg/L)	0.05	<0.00209	N/A	0.05
Barium (mg/L)	1.0	<0.1	N/A	1.0
Cadmium (mg/L)	0.005	<0.01	N/A	0.005
Chloride (mg/L)	250.0	217.5	34.9	250.0
Copper (mg/L)	1.0	<0.0114	N/A	1.0
Fluoride (mg/L)	4.0	0.745	0.05	4.0
Iron (mg/L)	0.3	<0.0504	N/A	0.3
Mercury (mg/L)	0.002	<0.001	N/A	0.002
Manganese (mg/L)	0.05	<0.01	N/A	0.05
Molybdenum (mg/L)	1.0	<0.1	N/A	1.0
Nickel (mg/L)	0.15	<0.05	N/A	0.15
Nitrate (mg/L)	10.0	<0.114	N/A	10.0
Lead (mg/L)	0.05	<0.05	N/A	0.05
Radium (pCi/L)	5.0	154.3	171.5	496.0
Selenium (mg/L)	0.05	<0.00244	N/A	0.05
Sodium (mg/L)	N/A	416.6	27.8	4166
Sulfate (mg/L)	250.0	337.2	19.3	375.0
Uranium (mg/L)	5.0	<0.122	N/A	5.0
Vanadium (mg/L)	0.2	<0.0984	N/A	0.2
Zinc (mg/L)	5.0	<0.0143	N/A	5.0
pH (Std. Units)	6.5 - 8.5	8.68	0.3	6.5 – 9.28
Calcium (mg/L)	N/A	11.2	2.9	112.0
Total Carbonate (mg/L)	N/A	374.4	28	610.0
Potassium (mg/L)	N/A	16.7	4.7	167.0
Magnesium (mg/L)	N/A	2.8	0.8	28.0
TDS (mg/L)	N/A	1221.1	73.5	1221.1

Notes:
N/A = Not Applicable

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

November 9, 2007

Mr. Michael Linder, Director
Nebraska Department of Environmental Quality
P.O. Box 98922
Lincoln, NE 68509-8922

Subject: Bioremediation Test in Mine Unit 4

Dear Mr. Linder:

Crow Butte Resources (CBR) is seeking approval from Nebraska Department of Environmental Quality (NDEQ) for a proposed Bioremediation Test in the north section of Mine Unit 4, Wellhouse 9 (Fig. 1).

Introduction

The ability of microcosms to effect a change in the oxidation state of metal ions has been well documented (see appendix A for articles). In recent years the use of microcosms in the areas of environmental remediation and land reclamation has increased exponentially with their continued success. CBR has successfully completed bench test analysis, carried out by Shaw Environmental, Inc., that illustrated the validity of this approach as a method for mine unit aquifer reclamation.

CBR would like to proceed to the next level in assessing the effectiveness of in-situ bioremediation by applying it to a field scale test in a small well pattern consisting of up to five producer wells and their associated injector wells (Fig. 2).

Test Description

The in-situ Bioremediation Test would be conducted in a pattern area of Wellhouse 9 (Fig. 2) using native bacteria found in the mining unit. The total potential number of wells in the test pattern area is thirteen (five producers and eight injectors). The outline of the test program is as follows:

- Begin recirculation of pattern test area.
- Slowly add nutrients (Food grade Protein and/or Edible Oil Substrate) into the injection stream. Nutrients will be injected at a rate of 10 ppm to 2000 ppm. The total amount of nutrients to be injected is not known at this time and is dependent upon injection pressure, volume and monitoring. The nutrients will come by truck and be transferred to storage locations.

- Monitoring of test area flow and chemistry.

Testing Goals

- Observe the effects of bioremediation on an un-remediated post mining area of the well field.

- Reduce the water-soluble redox sensitive metals in the formation before applying RO permeate flush to the area. Reducing the metals in-situ would return the metals in the formation back to their pre-mining composition and reduce the time period of any future RO permeate flush.

- Determine the operational successes or problems that would be encountered if bioremediation was applied at CBR.

Possible Areas of Concern

The biggest concern is the possibility of bio-fouling the injection wells from an over reactive bacterial community feeding on the injected nutrients at the well screen. CBR hopes to mitigate this by modulating the amount of nutrients being added to the injection system at one time. Alternative methods of control would be those that are already accepted and practiced on site and include treatment and recovery of biocides such as bleach or hydrochloric acid, swabbing, and short injection periods of hydrogen peroxide. In addition CBR requests the use of ultraviolet light down the well casing to mitigate bacterial growth on the well screen.

CBR does not anticipate any adverse impacts to the environment from this test due to the use of non-toxic materials and the test's limited size. It should be noted that similar bioremediation techniques have been successfully used at Power Resources Inc., Wyoming; The Oak Ridge Field Research Center, Tennessee; and other locations.

Conclusion

With the number of successful, heavy metal reduction, in-situ bioremediation projects growing, CBR feels that this approach has matured to the point for it to be a viable option for well-field remediation.

Sincerely,
CROW BUTTE RESOURCES, INC.

Steve Collings

Steve Collings
President

Enclosures: Figures 1 & 2
Appendix A – Research Articles

Cc: Steven A. Fischbein, NDEQ
Stephen Cohen, NRC
Jim Stokey, CBR
Larry Teahon, CBR

Figure 1

Mine Unit 4 Wellhouse 9
Proposed In-Situ Bioremediation Test Experiment

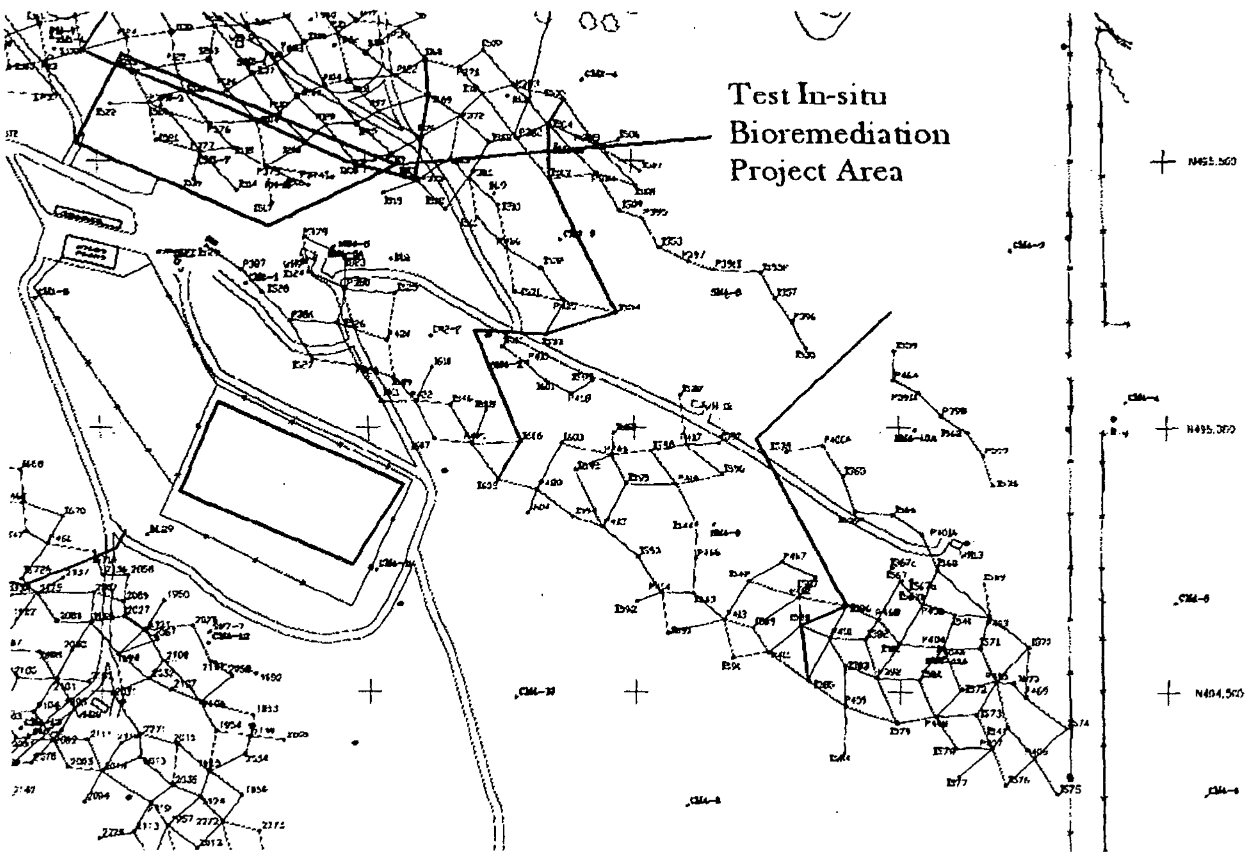
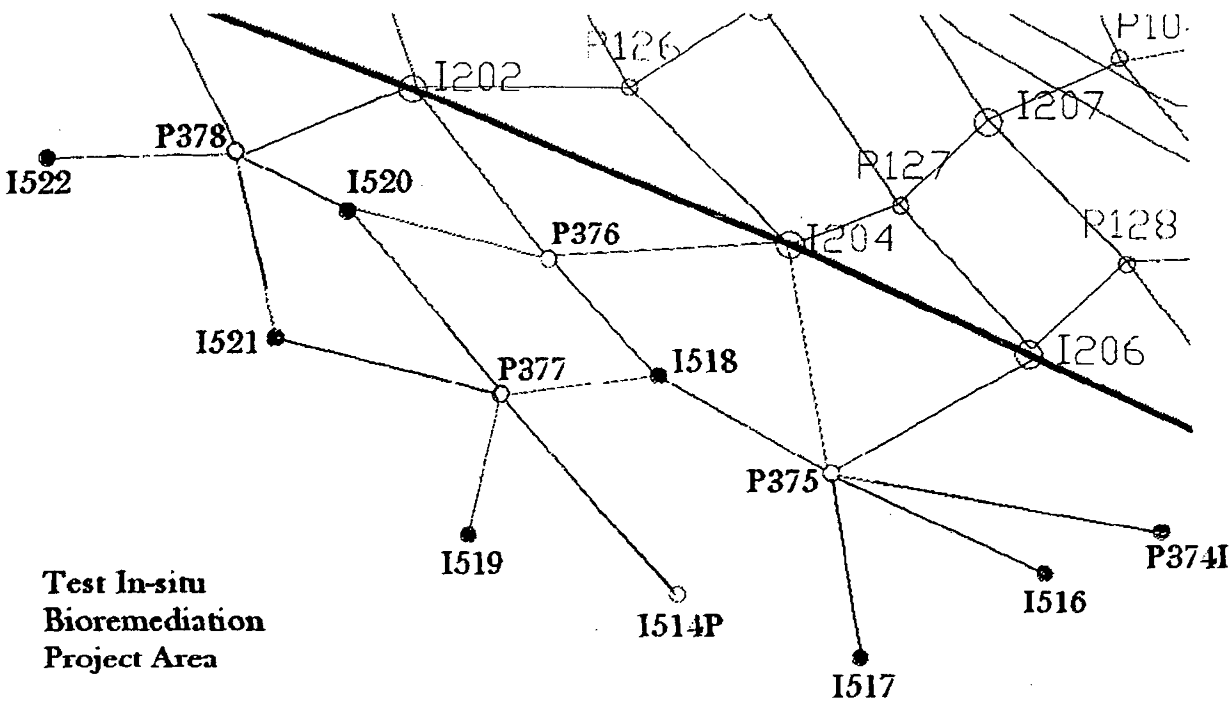


Figure 2

Enhanced
Mine Unit 4 Wellhouse 9
Proposed In-Situ Bioremediation Test Experiment



Appendix A

Research Articles

1. Abdelouas, Abdesselam; Lutze, Werner; Nuttall Eric H. *Uranium Contamination in the Subsurface*: Characterization and Remediation. Reviews in Mineralogy, Volume 38, Uranium: Mineralogy, Geochemistry, and the Environment. Burns, Peter C.; Finch, Robert. Editors. Mineralogical Society of America. 1999.

2. Borden, R. C. et all; Solutions Industrial & Environmental Services, Inc. *Use of Edible Oil Substrate (EOS®) For In Situ Anaerobic Bioremediation.* Presented at: 2003 AFCEE Technology Transfer Workshop, San Antonio, Texas.

3. Ginder-Vogel, M; Wu, W.M.; Carley, J.; Jardine, P.; Fendorf, S.; Criddle, C. *In Situ Biological Remediation within a Highly Contaminated Aquifer.* On-Line Report, SSRL Science Highlight-October 2006

4. Gu, Baohua; Yan, Hui; Zhou, Ping; Watson, David, B.; *Natural Humics Impact Uranium Bioreduction and Oxidation.* . Sci. Technol. 2005, vol. 39, No. 14, p. 5268-5275

5. Hughes, Joseph B. Ph.D.: Duston, Karen L Ph. D.: Ward, C. Herb Ph. D, *Technology Evaluation Report,* Engineered Bioremediation Department of Civil and Environmental Engineering, Rice University, Houston, TX, Prepared for Ground-Water Remediation Technologies Analysis Center

6. Jeon, Byong-Hun; Kelly, Shelly, D.; Kemner, Kenneth, M.; Barnett, Mark, O.; Burgos, William, D.; Dempsey, Brian, A.; Roden, Eric, E.; *Microbial Reduction of U(VI) at the Solid-Water Interface.* Environ. Sci. Technol. 2004, vol. 38, No. 21, p. 5649-5655

7. Lutes, C.; Frizzell, A.; Thornton, T.; Harrington, J. *In-situ Chemical Stabilization of Metals and Radionuclide's through Enhanced Anaerobic Reductive Precipitation*: Submitted under contract # BE-AC26-01NT41304 to U.S. Department of Energy, National Energy Technology Laboratory. August 2003.

8. McCullough, Julie; Hazen, Terry C.; Benson, Sally M.; Metting, F. Blaine; Palmisano, Anna C.; *Bioremediation of Metals and Radionuclides...What it is and How it Works.* a Natural and Accelerated Bioremediation Research program (NABIR) Primer, Office of Biological and Environmental Research of the U.S. Department of Energy's Office of Science 1999; available from the NABIR Website www.lbl.gov/ERSP/.

9. Nevin, Kelly P.; Finneran, Kevin T.; Lovley, Derek R.; *Microorganisms Associated with Uranium Bioremediation in a High-Salinity Subsurface*

Sediment. Applied and Environmental Microbiology, June 2003, p. 3672–3675

10. *The Role of Microbial Systems in Remediation.* Available from genomics.energy.gov Website http://genomicsgtl.energy.gov/benefits/remediation.shtml

11. Wu, Qingzhong; Sanford, Robert, A.; Löffler, Frank, E.; *Uranium (VI) Reduction by Anaeromyxobacter dehalogenans Strain 2CP-C.* Applied and Environmental Microbiology, May 2006, Vol. 72, No. 5, p. 3608-3614.

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 4

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

March 24, 2003

Revision 1 – February 24, 2004

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 4.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 4 were approved by the NDEQ on March 11, 1994.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 4. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved, 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization) sampling. A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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.

If one or more of the monitored constituents exhibit significant increasing trends after the 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the

NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

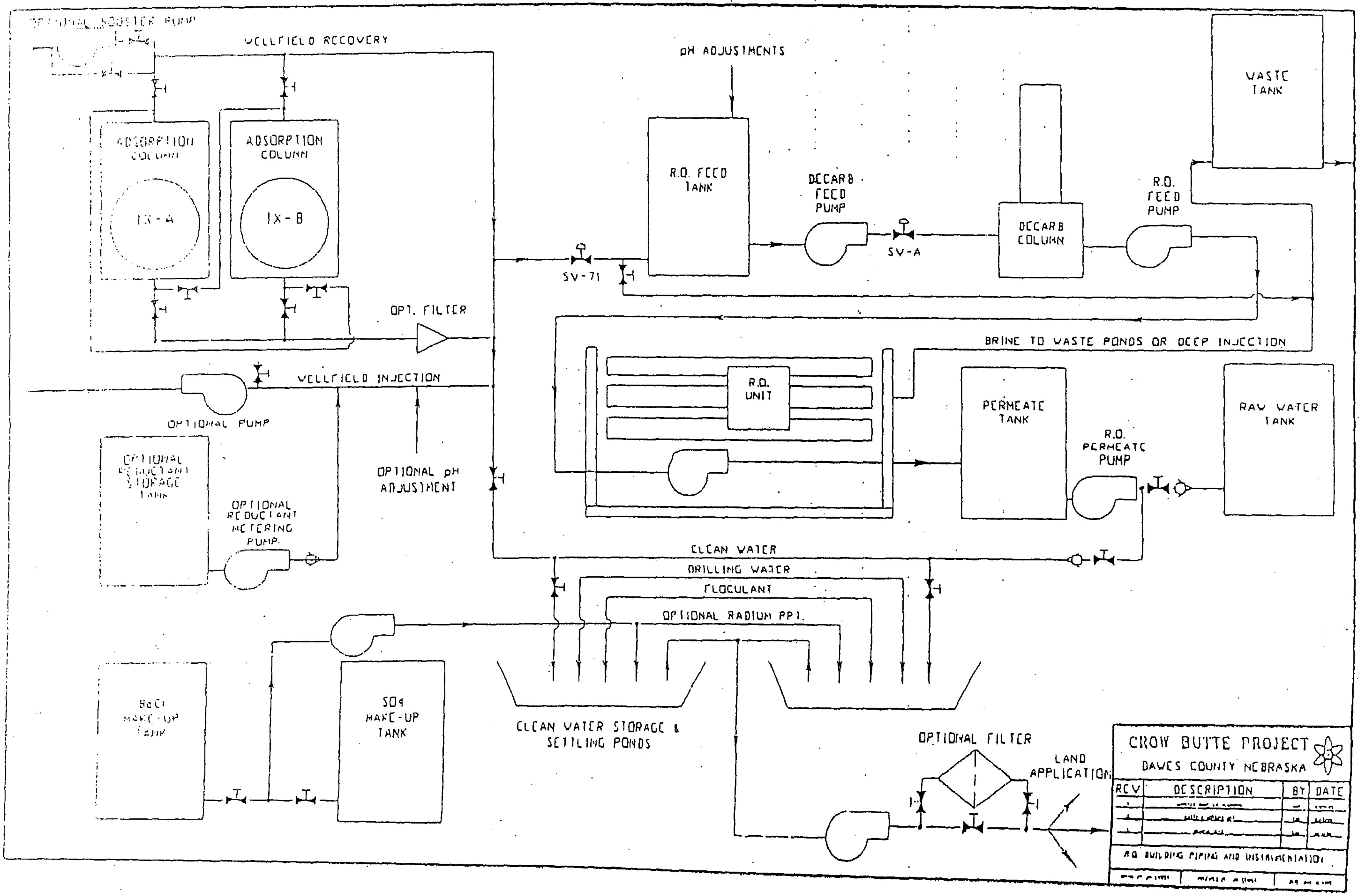
Element
Ammonia (NH4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluoride (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium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

Table 2

Typical Membrane Rejection[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.



WELLFIELD RECOVERY
pH ADJUSTMENTS
WASTE TANK
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
R.O. FEED TANK
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
SV-71
OPT. FILTER
BRINE TO WASTE PONDS OR DEEP INJECTION
WELLFIELD INJECTION
OPTIONAL PUMP
R.O. UNIT
PERMEATE TANK
RAW WATER TANK
R.O. PERMEATE PUMP
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
RO BUILDING PIPING AND INSTRUMENTATION

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

Parameter	Groundwater Standard	MU-3 Baseline	MU-3 Standard Deviation	MU-3 NDEQ Restoration Value
Ammonium (mg/L)	10.0	<0.329	N/A	10.0
Arsenic (mg/L)	0.05	<0.001	N/A	0.05
Barium (mg/L)	1.0	<0.1	N/A	1.0
Cadmium (mg/L)	0.005	<0.01	N/A	0.005
Chloride (mg/L)	250.0	197.6	16.7	250.0
Copper (mg/L)	1.0	<0.0108	N/A	1.0
Fluoride (mg/L)	4.0	0.719	0.05	4.0
Iron (mg/L)	0.3	<0.05	N/A	0.3
Mercury (mg/L)	0.002	<0.001	N/A	0.002
Manganese (mg/L)	0.05	<0.01	N/A	0.05
Molybdenum (mg/L)	1.0	<0.1	N/A	1.0
Nickel (mg/L)	0.15	<0.05	N/A	0.15
Nitrate (mg/L)	10.0	<0.0728	N/A	10.0
Lead (mg/L)	0.05	<0.05	N/A	0.05
Radium (pCi/L)	5.0	165	222.5	611.0
Selenium (mg/L)	0.05	<0.00115	N/A	0.05
Sodium (mg/L)	N/A	428	27.6	4280
Sulfate (mg/L)	250.0	377.0	13.4	404.0
Uranium (mg/L)	5.0	0.115	0.158	5.0
Vanadium (mg/L)	0.2	<0.1	N/A	0.2
Zinc (mg/L)	5.0	<0.0131	N/A	5.0
pH (Std. Units)	6.5 - 8.5	8.37	0.3	6.5 – 8.5
Calcium (mg/L)	N/A	13.3	3.1	133.0
Total Carbonate (mg/L)	N/A	358.7	24.8	592.0
Potassium (mg/L)	N/A	13.9	4.0	139.0
Magnesium (mg/L)	N/A	3.5	0.9	35.0
TDS (mg/L)	N/A	1183.0	47.4	1183.0

Notes:
N/A = Not Applicable

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 3

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

March 24, 1999

Revision 1 – February 24, 2004

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 3.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 3 were approved by the NDEQ on January 8, 1993.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 3. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved, 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization) sampling. A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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.

If one or more of the monitored constituents exhibit significant increasing trends after the 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the

NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

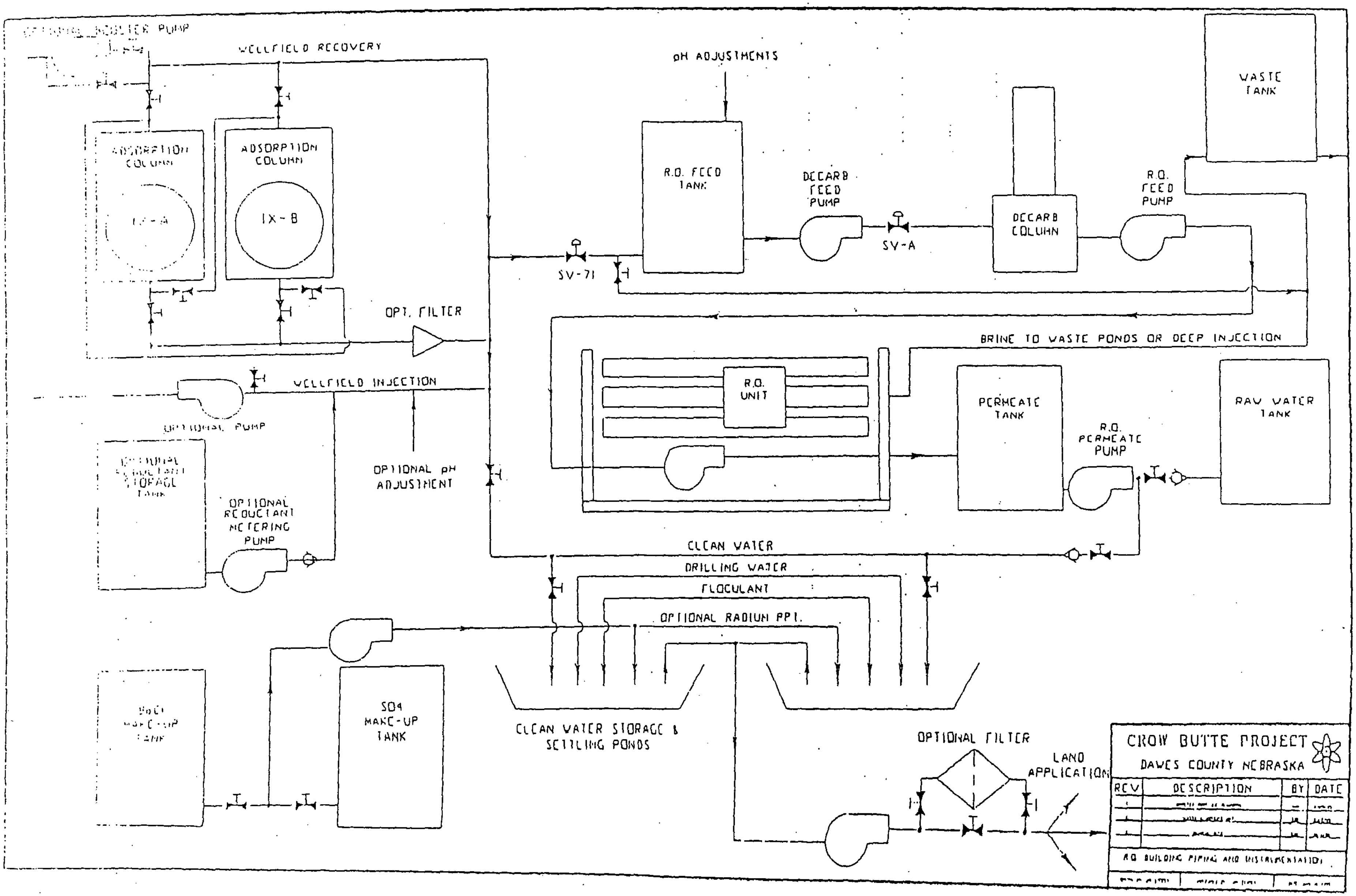
Element
Ammonia (NH_4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluoride (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO_3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO_4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium (Ca)
Total Carbonate
Potassium (K)
Magnesium (Mg)
Total Dissolved Solids (TDS)

Table 2

Typical Membrane Rejection[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.



OPTIONAL BOOSTER PUMP
WELLFIELD RECOVERY
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
OPT. FILTER
WELLFIELD INJECTION
OPTIONAL PUMP
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
NaCl MAKE-UP TANK
SO4 MAKE-UP TANK
pH ADJUSTMENTS
R.O. FEED TANK
SV-71
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
WASTE TANK
BRINE TO WASTE PONDS OR DEEP INJECTION
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
RO BUILDING PIPING AND INSTRUMENTATION

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 3

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer		x	(if yes, complete part 2)
b. Groundwater Sweep		x	(if yes, complete part 3)
c. Groundwater Treatment		x	Turned off on August 9, 2007
d. Wellfield Recirculation	x		P246, I287, and I311
e. Other (explain):		x	

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

No samples were collected during the month.

Parameter	Groundwater Standard	MU-2 Baseline	MU-2 Standard Deviation	MU-2 NDEQ Restoration Value
Ammonium (mg/L)	10.0	0.37	0.07	10.0
Arsenic (mg/L)	0.05	<0.001	N/A	0.05
Barium (mg/L)	1.0	<0.1	N/A	1.0
Cadmium (mg/L)	0.005	<0.007	N/A	0.005
Chloride (mg/L)	250.0	208.6	30.8	250.0
Copper (mg/L)	1.0	<0.013	N/A	1.0
Fluoride (mg/L)	4.0	0.67	0.04	4.0
Iron (mg/L)	0.3	<0.045	N/A	0.3
Mercury (mg/L)	0.002	<0.001	N/A	0.002
Manganese (mg/L)	0.05	<0.01	N/A	0.05
Molybdenum (mg/L)	1.0	<0.073	N/A	1.0
Nickel (mg/L)	0.15	<0.037	N/A	0.15
Nitrate (mg/L)	10.0	<0.039	N/A	10.0
Lead (mg/L)	0.05	<0.035	N/A	0.05
Radium (pCi/L)	5.0	234.5	411.8	1058.0
Selenium (mg/L)	0.05	<0.001	N/A	0.05
Sodium (mg/L)	N/A	410.8	18.2	4108
Sulfate (mg/L)	250.0	348.2	10.3	369.0
Uranium (mg/L)	5.0	0.046	0.037	5.0
Vanadium (mg/L)	0.2	<0.07	N/A	0.2
Zinc (mg/L)	5.0	<0.026	N/A	5.0
pH (Std. Units)	6.5 - 8.5	8.32	0.2	6.5 – 8.5
Calcium (mg/L)	N/A	13.4	2.4	134.0
Total Carbonate (mg/L)	N/A	366.9	13.3	585.0
Potassium (mg/L)	N/A	12.6	2.5	126.0
Magnesium (mg/L)	N/A	3.5	0.4	35.0
TDS (mg/L)	N/A	1170.4	41	1170.4

Notes:
N/A = Not Applicable

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 2

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

December 5, 1995

Revision 1 – February 24, 2004

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 2.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 2 were approved by the NDEQ on March 25, 1992.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 2. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion

exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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. Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved, 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization) sampling. A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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.

If one or more of the monitored constituents exhibit significant increasing trends after the 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

Element
Ammonia (NH_4 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 (NO_3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO_4)
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]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

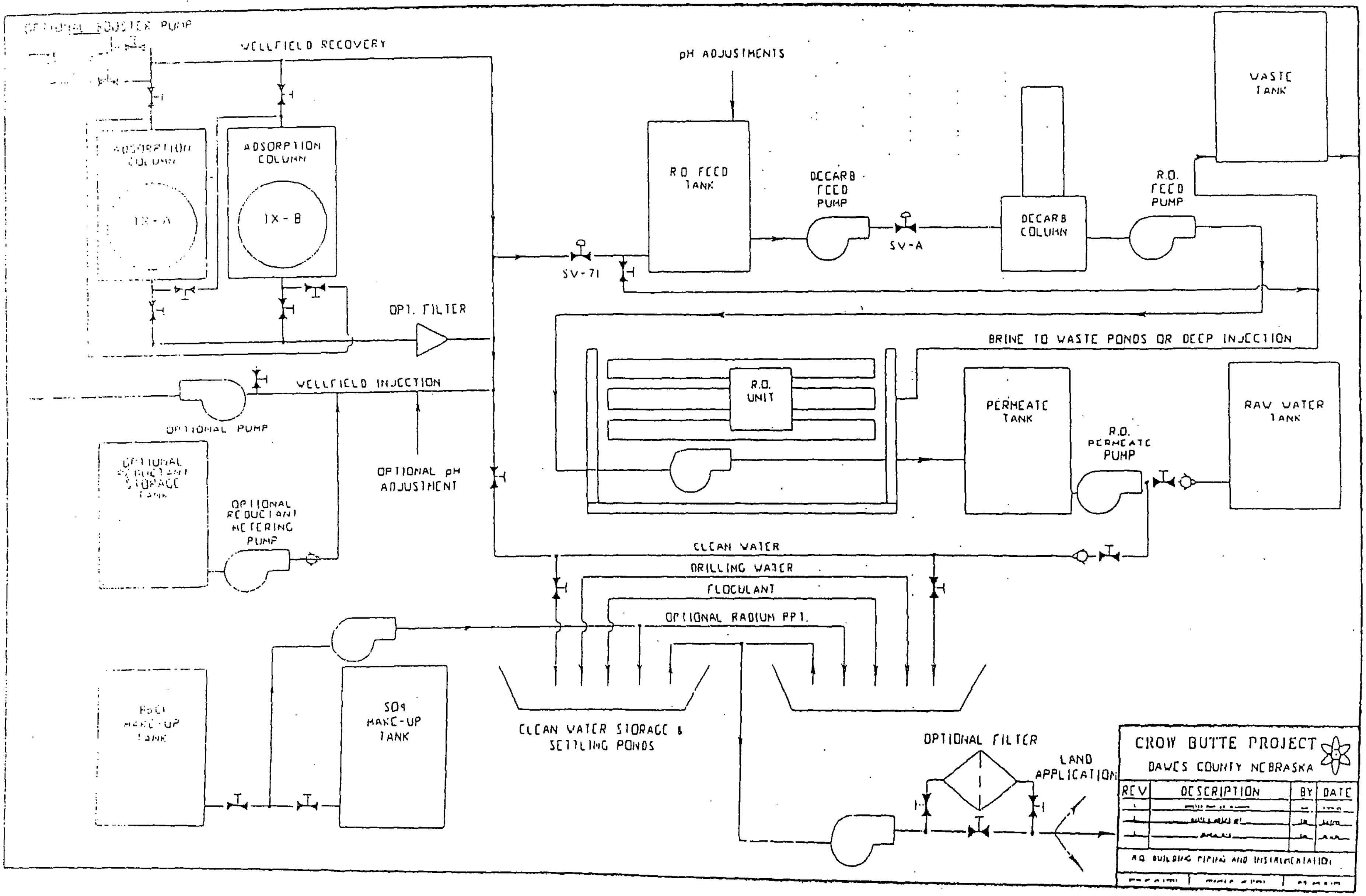

OPTIONAL BOOSTER PUMP
WELLFIELD RECOVERY
ADSORPTION COLUMN
IX - A
ADSORPTION COLUMN
IX - B
OPT. FILTER
WELLFIELD INJECTION
OPTIONAL PUMP
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
pH ADJUSTMENTS
RO FEED TANK
SV-71
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
WASTE TANK
BRINE TO WASTE PONDS OR DEEP INJECTION
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
RO BUILDING PIPING AND INSTRUMENTATION

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

February 24, 2004

Mr. Michael Linder
Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: Request for Revised Restoration Plan Approval, Mine Units 2, 3, and 4 Crow Butte Resources, Inc. Class III Underground Injection Control (Permit Number NE0122611), Dawes County, Nebraska

Dear Mr. Linder:

On November 14, 2003, Crow Butte Resources, Inc. (CBR) submitted a request for approval of a revision to the Restoration Plans for Mine Units 2, 3 and 4. The Restoration Plans are prepared and submitted to the Nebraska Department of Environmental Quality (NDEQ) to ensure that CBR meets the requirements of Part II C of the permit. At the same time, CBR submitted a License Amendment Request to the U.S. Nuclear Regulatory Commission (NRC) to approve similar changes in the NRC Restoration Plan.

Based on recent discussions with the NRC staff, CBR is proposing several minor changes to the Mine Units 2, 3, and 4 Restoration Plans submitted in November 2003. In the proposed changes to the stabilization plan, CBR has added the requirement to obtain one composite sample with the grab samples obtained during the first and last stabilization sample events. CBR has also added the requirement to obtain an additional grab sample with the composite sample taken midway through the stabilization period. This change will result in grab and composite analysis of three of the required six stabilization sample events and will provide assurance that CBR's composite sample methods are representative of the results of grab sampling.

CBR believes that the proposed changes will continue to meet the program goals of ensuring that the concentrations of the restoration parameters will not increase significantly following groundwater restoration. CBR has attached a draft revision of the Mine Unit 2 Restoration Plan with the proposed changes indicated. CBR has also attached final revised groundwater restoration plans for Mine Units 2, 3, and 4 for approval.

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: Mr. Dave Carlson – NDEQ, Chadron Field Office

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 2

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

December 5, 1995

Revision 1 – ~~November 14, 2003~~February 24, 2004

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 2.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 2 were approved by the NDEQ on March 25, 1992.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 2. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion

exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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. -Samples will be split with the Nebraska Department of Environmental Quality (NDEQ) in accordance with CBR's Class III Underground Injection Control (UIC) permit. CBR will submit the results of post-restoration sampling to the NDEQ. If the restoration values have been achieved 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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), 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.

In addition to the composite sampling, CBR will analyze the discrete grab samples from each individual restoration well approximately three months after the post-restoration (i.e., first round of stabilization) sampling. A physical composite sample of the individual wells will also be included with these discrete grab samples.

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. A physical composite sample will also be prepared from the individual well samples as discussed in Section 3.2 and included with the discrete grab samples for analysis.

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.

If one or more of the monitored constituents exhibit significant increasing trends after the 6-month stability monitoring period, the stabilization period may be extended by the Director.

4 REPORTING

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. ~~Analytical results will be submitted to the NDEQ.~~ The results of restoration and notification of the initiation of the Stabilization Stage will be submitted to the NDEQ. The NDEQ Director will either accept or deny initiation of stabilization based on the results of restoration. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

Element
Ammonia (NH_4 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 (NO_3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO_4)
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]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

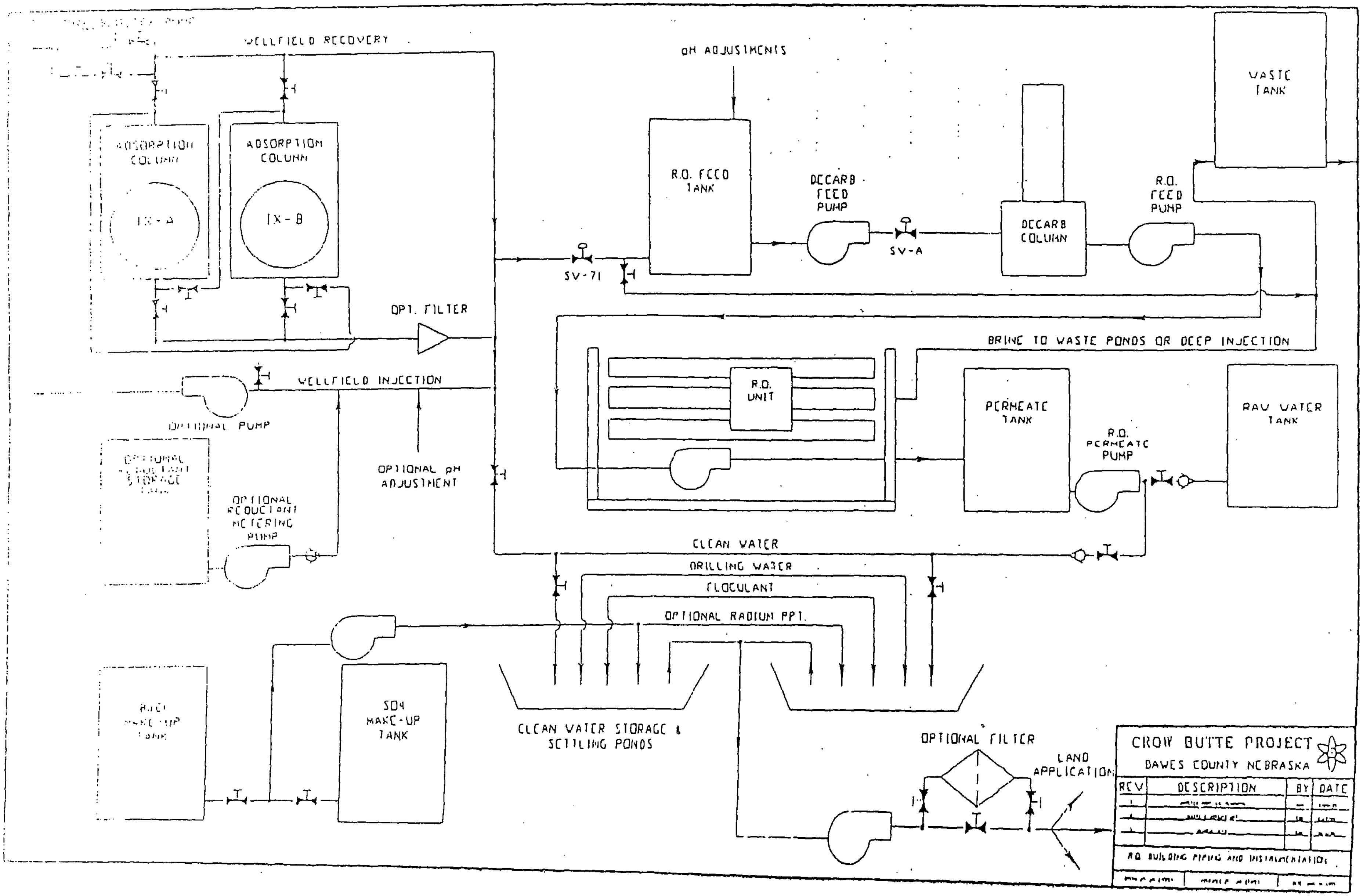

WELLFIELD RECOVERY
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
OPT. FILTER
WELLFIELD INJECTION
OPTIONAL PUMP
OPTIONAL REDUCTANT STORAGE
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
pH ADJUSTMENTS
R.O. FEED TANK
SV-71
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
WASTE TANK
BRINE TO WASTE PONDS OR DEEP INJECTION
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
RO BUILDING PIPING AND INSTRUMENTATION

FIGURE 1

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

CROW BUTTE RESOURCES, INC.

86 Crow Butte Road
P.O. Box 169
Crawford, Nebraska 69339-0169

(308) 665-2215
(308) 665-2341 – FAX

November 14, 2003

Mr. Michael Linder
Director
Nebraska Department of Environmental Quality
PO Box 98922
Lincoln, Nebraska 68509-8922

Subject: Request for Restoration Plan Modification, Mine Units 2, 3, and 4
Crow Butte Resources, Inc. Class III Underground Injection Control
(Permit Number NE0122611), Dawes County, Nebraska

Dear Mr. Linder:

Crow Butte Resources, Inc. (CBR) is submitting this request for approval of a revision to the Restoration Plans for Mine Units 2, 3 and 4. The Restoration Plans are prepared and submitted to the Nebraska Department of Environmental Quality (NDEQ) to ensure that CBR meets the requirements of Part II C of the permit. The proposed change to the Restoration Plans concern stabilization monitoring.

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 the completion of active groundwater restoration activities, CBR is required by permit to sample all designated restoration wells and analyze for all restoration parameters. CBR is required to split these post-restoration samples with the NDEQ. The purpose of this post-restoration monitoring is to confirm that restoration has successfully returned the mine unit to the water quality standards specified in the approved Notice of Intent. Stability monitoring must then continue for at least six months. The permit requires that "*...(d)uring stabilization, the permittee will monitor all designated restoration wells on a monthly basis for all of the parameters listed on the restoration table.*" At the end of stabilization, this analytical data is submitted to the Department with a request to approve restoration. Based on the stabilization results, the Director may extend stabilization, require further restoration, or accept the restoration of the mine unit.

Proposed Program

As currently written, the stabilization program in Section 3 of the Restoration Plans for Mine Units 2, 3 and 4 requires sampling and analysis of each individual restoration well on a monthly basis throughout the stabilization period. In the revised Restoration Plans (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 NDEQ. 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 permit. 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 approved restoration parameters. The discrete samples from the individual 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), 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 Restoration Plans, 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.

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.

---

[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.*

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 not to individual wells. The regulatory basis of the proposed change is the topic of the next section.

Regulatory Basis

The State regulatory requirements for stabilization monitoring are contained in CBR's Class III UIC Permit. Title 122[2] does not contain any specific requirements for stabilization monitoring, but does contain a general requirement that samples shall be representative of the monitored activity. This requirement and the requirements in the permit will continue to be met by the proposed change.

Much of the current groundwater restoration program at CBR is based on guidance developed by the US Nuclear Regulatory Commission (NRC) for use at other in situ leach (ISL) facilities. The principal NRC document that discusses the acceptable approaches for groundwater protection is NUREG-1569[3], which provides the NRC staff with guidance for reviewing license applications for ISL facilities. 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:

[2] Nebraska Department of Environmental Quality, Title 122, *Rule and Regulations for Underground Injection and Mineral Production Wells*, April 2, 2002

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

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 NRC acceptance criteria. The NRC 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[4]. 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.

Program Implementation

In order to implement the proposed change to the Restoration Plans, 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.

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

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 NDEQ approve the revised groundwater restoration plans for Mine Units 2, 3, and 4.

CBR is submitting a similar request to the NRC to approve a modification to the NRC-approved Restoration Plan. 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: Mr. Dave Carlson – NDEQ, Chadron Field Office

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 2

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

December 5, 1995

Revision 1 – November 14, 2003

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 2.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 2 were approved by the NDEQ on March 25, 1992.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 2. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for

chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ.

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), 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.

3.3 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

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. Analytical results will be submitted to the NDEQ. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time CBR would request the mine unit be declared restored.

TABLE 1

RESTORATION PARAMETERS

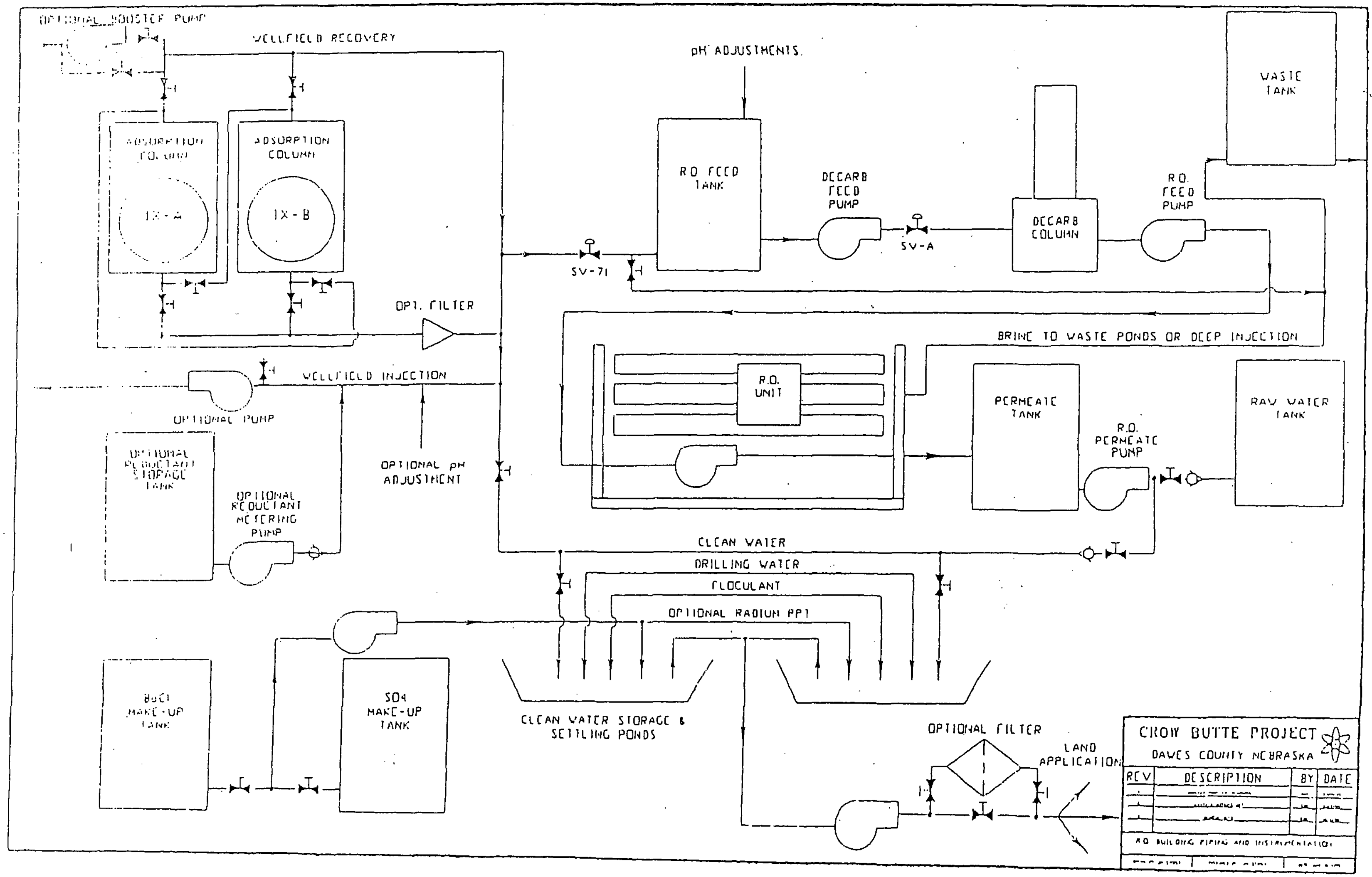
Element
Ammonia (NH4 as N)
Arsenic (As)
Barium (Ba)
Cadmium (Cd)
Chloride (Cl)
Copper (Cu)
Fluoride (F)
Iron (Fe)
Mercury (Hg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Nitrate as N (NO3)
Lead (Pb)
Radium 226 (Ra-226)
Selenium (Se)
Sulfate (SO4)
Uranium (U)
Vanadium (V)
Zinc (Zn)
pH
Sodium (Na)
Calcium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

TABLE 2

TYPICAL MEMBRANE REJECTION[1]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.



OPTIONAL BOOSTER PUMP
WELLFIELD RECOVERY
pH ADJUSTMENTS
WASTE TANK
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
R.O. FEED TANK
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
SV-71
OPT. FILTER
BRINE TO WASTE PONDS OR DEEP INJECTION
WELLFIELD INJECTION
OPTIONAL PUMP
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT
BaCl MAKE-UP TANK
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
R.O. BUILDING PIPING AND INSTRUMENTATION

FIGURE 1

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 3

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

March 24, 1999

Revision 1 – November 14, 2003

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 3.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 3 were approved by the NDEQ on January 8, 1993.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 3. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for

chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ.

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), 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.

3.3 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

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. Analytical results will be submitted to the NDEQ. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time 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]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

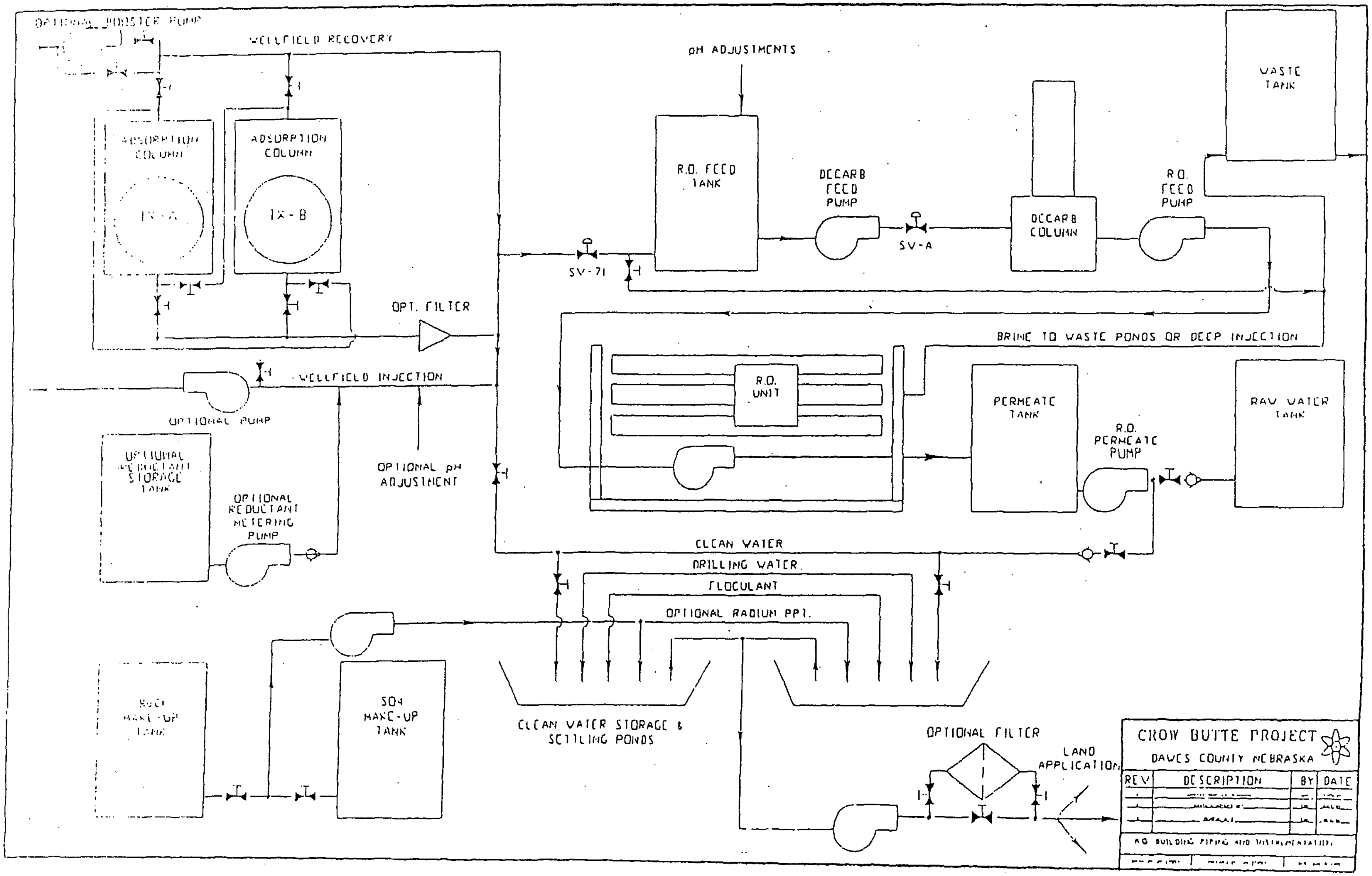

OPTIONAL BOOSTER PUMP
WELLFIELD RECOVERY
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
OPT. FILTER
OPTIONAL PUMP
WELLFIELD INJECTION
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
pH ADJUSTMENTS
R.O. FEED TANK
SV-71
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
WASTE TANK
BRINE TO WASTE PONDS OR DEEP INJECTION
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE

FIGURE 1

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

CROW BUTTE RESOURCES, INC.

CROW BUTTE URANIUM MINE

Mine Unit 4

Groundwater Restoration Plan

Nebraska Department of Environmental Quality

Underground Injection Control Permit Number NE0122611

March 24, 2003

Revision 1 – November 14, 2003

Table of Contents

1 INTRODUCTION

Crow Butte Resources, Inc. (CBR) operates the Crow Butte Uranium Mine in Dawes County, Nebraska. Underground Injection Control (UIC) Permit Number NE0122611 issued by the Nebraska Department of Environmental Quality (DEQ) requires that CBR submit a plan to restore each mine unit after the cessation of mining activities. This document presents CBR's plan for the restoration of Mine Unit 4.

NDEQ Permit NE0122611 requires that each mine unit be returned to a wellfield average of the restoration parameters in Table 1. Concentrations for these parameters are approved by the NDEQ with the Notice of Intent to Operate for each mine unit. The restoration values for Mine Unit 4 were approved by the NDEQ on March 11, 1994.

The commercial groundwater restoration program consists of two stages: the restoration stage and the stabilization stage. The restoration stage consists of four possible 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 waste water system capacity. Not all activities of the restoration stage will be used if deemed unnecessary or not appropriate 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 submit documentation 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.

Before commencing restoration activities, the DEQ will be notified that mining has ceased in Mine Unit 4. CBR will determine post-mining water quality as required in the NDEQ UIC Permit.

2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mining unit (MU) commencing restoration and a MU or wellhouse 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 Total Dissolved Solids (TDS) in the MU being restored by displacing water affected by the mining with baseline quality water. The recovered water may be passed through ion exchange (IX) column(s) 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 or wellhouse 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

During the groundwater treatment step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX and reverse osmosis (RO) treatment equipment at a minimum will be utilized during this stage as shown on the generalized restoration flow sheet in Figure 1.

Water recovered from restoration containing a significant amount of uranium is passed through the ion exchange system (IX). The IX column(s) exchange the majority of the contained soluble uranium for

chloride or sulfate. A small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration and type of trace elements encountered determine the concentration of reductant injected into the formation. 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 accomplishes the following goals:

- Reduces the total dissolved solids in the contaminated groundwater;
- Reduces the quantity of water that must be removed from the aquifer to meet restoration limits;
- Concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and
- 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 ionic 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, called brine, contains the majority of dissolved salts that contaminate the groundwater. This 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 (Na_2S), 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 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 approved concentrations. 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 analyzed for the restoration parameters. Sampling frequency will be one sample per month for a period of 6 months. 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 split with the NDEQ.

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), 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.

3.3 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

The initial step in the restoration process is notification of the NDEQ of the cessation of mining activities and determination of post-mining water quality in the mine unit as required in the NDEQ UIC Permit.

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be provided to NDEQ in the Monthly Restoration Report as shown in Figure 2. A summary of this information will also be included in the final report on restoration.

Upon completion of restoration activities, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table 1. Analytical results will be submitted to the NDEQ. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will continue 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. At that time 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]

Name	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
Strontium	Sr^{+2}	96-99
Hardness	Ca and Mg	96-98
Cadmium	Cd^{+2}	96-98
Silver	Ag^{+1}	94-96
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
Borate	$B_4O_7^{-2}$	35-70
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+
Ferrocyanide	$Fe(CN)_6^{-3}$	99+

[1] Source: Osmonics, Inc.

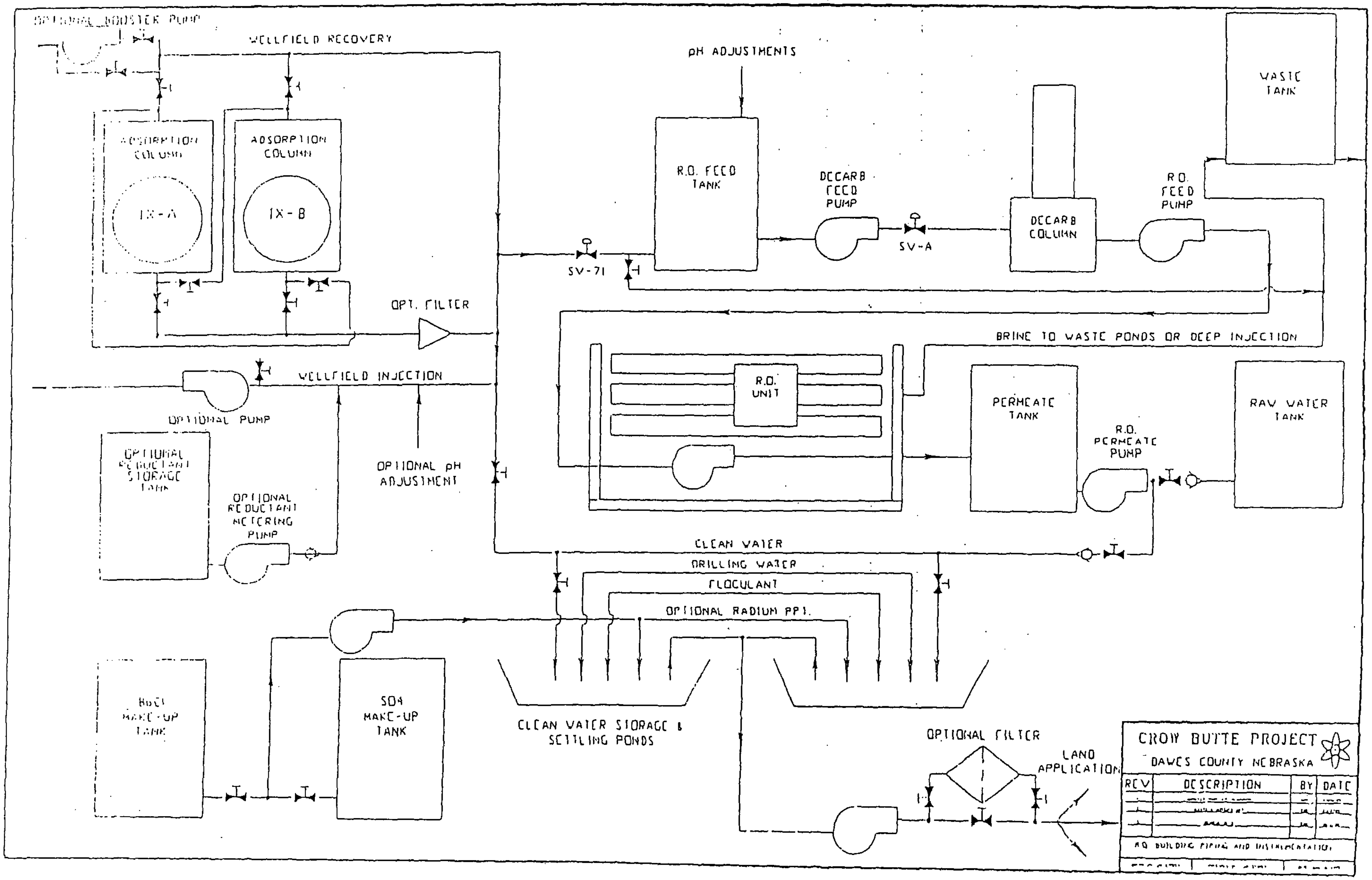

OPTIONAL BOOSTER PUMP
WELLFIELD RECOVERY
ADSORPTION COLUMN
IX-A
ADSORPTION COLUMN
IX-B
OPT. FILTER
WELLFIELD INJECTION
OPTIONAL PUMP
OPTIONAL REDUCTANT STORAGE TANK
OPTIONAL REDUCTANT METERING PUMP
OPTIONAL pH ADJUSTMENT
pH ADJUSTMENTS
R.O. FEED TANK
SV-71
DECARB FEED PUMP
SV-A
DECARB COLUMN
R.O. FEED PUMP
WASTE TANK
BRINE TO WASTE PONDS OR DEEP INJECTION
R.O. UNIT
PERMEATE TANK
R.O. PERMEATE PUMP
RAW WATER TANK
CLEAN WATER
DRILLING WATER
FLOCULANT
OPTIONAL RADIUM PPT.
SO4 MAKE-UP TANK
CLEAN WATER STORAGE & SETTLING PONDS
OPTIONAL FILTER
LAND APPLICATION
CROW BUTTE PROJECT
DAWES COUNTY NEBRASKA
REV
DESCRIPTION
BY
DATE
R.O. BUILDING PIPING AND INSTRUMENTATION

FIGURE 1

FIGURE 2

CROW BUTTE MINE

MONTHLY RESTORATION REPORT

MONTH AND YEAR

MINE UNIT 4

1. RESTORATION ACTIVITY DURING MONTH:

	YES	NO	
a. Groundwater Transfer			(if yes, complete part 2)
b. Groundwater Sweep			(if yes, complete part 3)
c. Groundwater Treatment			IX treatment continues
d. Wellfield Recirculation			
e. Other (explain):			

2. LIST WELLS USED IN GROUNDWATER TRANSFER DURING THE MONTH:

3. LIST WELLS USED IN GROUNDWATER SWEEP DURING THE MONTH:

4. LIST WELLS SAMPLED DURING MONTH AND ASSAY RESULTS:

COPY

STATE OF NEBRASKA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Michael J. Linder
Director
Suite 400, The Atrium
1200 'N' Street
P.O. Box 98922
Lincoln, Nebraska 68509-8922
Phone (402) 471-2186
FAX (402) 471-2909

Mike Johanns
Governor

MAY 1 1 2004

Mr. Stephen Collings, President
Crow Butte Resources, Inc.
274 Union Blvd., Ste. 310
Lakewood, Colorado 80228

Dear Mr. Collings:

On March 1, 2004, the Nebraska Department of Environmental Quality (NDEQ) received Restoration Plans from Crow Butte Resources, Inc. for Mine Units 2, 3, and 4 of the Crow Butte Uranium Mine. The plans include projected activities and reporting requirements to be conducted in the Mine Units during restoration.

NDEQ staff have reviewed the Restoration Plans and determined that they are sufficient as proposed. The Department hereby approves the implementation of restoration activities in Mine Units 2, 3, and 4. Restoration values for parameters listed in Table 1 of the Restoration Plans will be those values approved for the restoration wells specified in each Notice of Intent to Operate.

If you have any questions or comments, please contact David Miesbach of my staff at (402) 471-4982.

Sincerely,

Michael J. Linder
Director

ML/dlm
data/word/dave/cbr/letter/rstrn3.doc