CROW BUTTE RESOURCES, INC.

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January 2, 2003

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

Re: Docket No. 40-8943
License No. SUA-1534
Annual Report of Changes, Tests, or Experiments

Dear Mr. Gillen:

Crow Butte Resources, Inc. (CBR) is providing this annual report that summarizes the changes, tests or experiments made under License Condition 9.4 of SUA-1534. This report is made in accordance with the reporting requirements contained in License Condition 12.7.

CBR's source material license was renewed on March 4, 1998. The renewed license contained Performance Based License Conditions (PBLC). In a PBLC, CBR is allowed to make changes or conduct tests and experiments under certain conditions. These changes, test and experiments must be reviewed and approved by the CBR Safety and Environmental Review Panel (SERP). During 2002, the CBR SERP approved eight changes. One other SERP meeting was held to review appropriate responses to a loss-of-vacuum event with the vacuum yellowcake dryer.

The following materials are attached to provide the required summary information and documentation required by License Condition 12.7.

- SERP Evaluation Index, which summarizes each SERP Action and tracks any modifications to an approved action affected by subsequent SERP actions.

- A copy of the text of each approved SERP Evaluation. These evaluations describe the change or test approved and the safety and environmental evaluation performed by the SERP. Supporting documentation is maintained on site for NRC review.

NMSS01

- Highlighted versions of page changes made to the License Renewal Application (LRA) because of the SERP actions taken in 2002. These highlighted page changes use a strikethrough to denote deleted text and an underline to indicate new text.

- Page replacement versions of page changes for insertion in the updated NRC copy of the LRA. These pages have a revision date in the footer.

If you have any questions or require further information, please do not hesitate to contact me at (308) 665-2215.

Sincerely,
CROW BUTTE RESOURCES, INC.

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

Enclosures: As Stated

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

2002 SERP Evaluation Index

Safety and Environmental Review Panel

2002 Evaluation Index

SERP Evaluation Number	Date	Action Taken	Modifications to Previous SERP Actions
SERP 02-01	January 7, 2002	Replacement of Mine Unit 2 Baseline Restoration Well	None
SERP 02-02	February 6, 2002	Wellhouse 33 Approval	None
SERP 02-03	April 5, 2002	Wellhouse 27 Approval	None
SERP 02-04	June 5, 2002	Review of dryer loss of vacuum event	None
SERP 02-05	July 10, 2002	Review and approval of Mine Unit 8 baseline monitoring, restoration values and operational monitoring criteria (UCLs)	None
SERP 02-06	July 10, 2002	Wellhouse 34 Approval	None
SERP 02-07	August 8, 2002	Organizational Change	None
SERP 02-08	August 28, 2002	Review and Approve Changes to the Approved License Renewal Application	None
SERP 02-09	October 25, 2002	Wellhouse 35 Approval	None

SERP 02-01 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-01

Replacement of Mine Unit 2 Baseline Restoration Well

January 7, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review a proposal to replace a Mine Unit 2 baseline restoration well at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory/ Environmental Affairs
Mike Brost	Chief Geologist	Geology/Hydrology
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review a proposed replacement for a baseline restoration well in Mine Unit 2 with a nearby well. Specifically, well I-196-5 is a Mine Unit 2 baseline restoration well and is unusable for the intended purpose. Therefore, CBR would like to replace I-196-5 with monitor well CM1-6.

CBR is required by License Condition 10.3 and the Nebraska Department of Environmental Quality (NDEQ) UIC Permit, Part II.C to designate and baseline sample one injection or production well per 4 acres. This designation is made in the Notice of Intent submitted to NDEQ before placing a Mine Unit in operation. In addition, at the time that Mine Unit 2 was placed in operation, CBR was required to submit baseline sampling data and calculations of the monitor well upper control limits to NRC for approval. (The CBR SERP is now responsible for approving these requirements for new Mine Units under the Performance-Based License Condition).

In the request for approval submitted to NRC for Mine Unit 2 on January 23, 1992, CBR identified injection well I-196-5 as one of the twelve restoration wells for the Mine Unit. Baseline water quality data was submitted for these restoration wells and was used to calculate the proposed restoration criteria for the Mine Unit.

On March 29, 1996 during routine 5-year Mechanical Integrity Testing (MIT), well I-196-5 failed the MIT criteria. Subsequent investigation by CBR determined that the well casing had developed a leak at approximately 36 feet from the top of the casing. As required by permit condition, CBR repaired the casing by installing a ten foot long, 3-inch PVC sleeve with K packers at each end. Following installation of the sleeve, another MIT was conducted on November 18, 1996 and the well successfully met the test criteria. The well has not been used since the initial failure in 1996.

In early 2001, CBR performed the second 5-year MIT on well I-196-5. The well failed the MIT acceptance criteria. Subsequent testing indicated that the well is leaking at the sleeve that was installed to repair the well in 1996. Since the well has not been used since the initial failure in 1996, the MIT failure does not present an environmental concern. However, CBR must either repair or abandon wells that fail an MIT.

As a designated restoration well, CBR will be required to collect samples from I-196-5 following the completion of groundwater restoration activities in Mine Unit 2 that are now in progress. In accordance with the restoration requirements in License Condition 10.3, the UIC permit and CBR's Restoration Plan, restoration wells must be sampled for the restoration parameters during the stabilization phase of restoration. The data that results from this sampling is used to determine the effectiveness of restoration.

The requirement to obtain samples from I-196-5 at the completion of groundwater restoration presents CBR with practical difficulties that are not easy to address. It is difficult to obtain reliable pumping equipment that is sized to fit the 3-inch sleeve in I-196-5. The alternative of installing a larger pump with a packer seal on the drop pipe also presents problems.

Based on these practical concerns, CBR proposes to abandon well I-196-5 and to designate well CM1-6 as a replacement restoration well for Mine Unit 2. CBR believes that CM1-6 is an acceptable replacement for I-196-5 for this purpose based on the following reasons.

- Physical Proximity: Well CM1-6 is located approximately 35 feet northwest of I-196-5. A scale map depicting the location of both wells is attached.

- Screened Interval: Well CM1-6 is completed in the same zones of the Chadron Formation as I-196-5 when baseline sampling was performed. I-196-5 was originally

installed as a monitor well for the pilot plant operation (PM-8) in May 1985. The completion was as follows:

Telescope screen hung on K Packer	
K Packer depth:	621 ft.
Blank:	10 ft.
Screen:	10 ft. (631 ft. to 641 ft.)
Blank:	10 ft.
Screen:	10 ft. (651 ft. to 661 ft.)

In comparison, well CM1-6 was completed in September 1990 as a perimeter monitor well for Mine Unit 1. The completion was as follows:

Telescope screen hung on K Packer	
K Packer depth:	619 ft.
Blank:	10 ft.
Screen:	10 ft. (629 ft. to 639 ft.)
Blank:	10 ft.
Screen:	10 ft. (649 ft. to 659 ft.)

- Baseline Water Quality: As noted above, well I-196-5 was originally installed as a perimeter monitor well (PM-8) during the pilot testing at Crow Butte. The well had baseline sampling performed with 21 samples obtained between 1985 and 1990. In November 1992, PM-8 was recompleted in as an injection well for Mine Unit 2 and redesignated as I-196-5.

  Well CM1-6 was installed as a Mine Unit 1 perimeter monitor well in 1990. Baseline sampling comprised of 3 samples was performed between October and November 1990. Due to the physical proximity and similar screened interval as discussed above, the baseline analytical data for the two wells is very similar. The following table summarizes the baseline data from each well for the restoration parameters contained in License Condition 10.3B.

Parameter	Well I-196-5		Well CM1-6	
	Mean	Standard Deviation	Mean	Standard Deviation
Ammonia (mg/l)	0.414	0.022	0.31	0.02
Arsenic (mg/l)	<0.001	0	<0.001	0
Barium (mg/l)	<0.1	0	<0.1	0
Cadmium (mg/l)	<0.001	0	<0.01	0
Chloride (mg/l)	189	12	191	4
Copper (mg/l)	<0.01	0	<0.01	0
Fluoride (mg/l)	0.642	0.065	0.61	0.08
Iron (mg/l)	<0.03	0	<0.05	0
Mercury (mg/l)	<0.0002	0	<0.001	0
Manganese (mg/l)	0.008	0.002	<0.01	0
Molybdenum (mg/l)	0.02	0.005	<0.1	0
Nickel (mg/l)	<0.01	0	<0.05	0
Nitrate (mg/l)	0.022	0.015	0.02	0.02
Lead (mg/l)	<0.005	0	<0.05	0
Radium-226 (pCi/l)	88	27	16	3.3
Selenium (mg/l)	<0.001	0	<0.001	0
Sulfate (mg/l)	343	16	344	12
Uranium (mg/l)	0.029	0.011	0.005	0.002
Vanadium (mg/l)	<0.01	0	<0.1	0
Zinc (mg/l)	0.085	0.043	0.02	0.01
pH (S.U.)	8.16	0.18	8.41	0.11
Calcium (mg/l)	15.7	1.6	19.0	1.7
Total Carbonate (mg/l)	374	21	370	11
Potassium (mg/l)	11.8	0.9	11.7	0.6
Magnesium (mg/l)	3.9	0.4	4.8	0.2
Sodium (mg/l)	394	6.9	383	5.8
Total Dissolved Solids (mg/l)	1129	43	1157	33

As shown in the table, the baseline water quality of CM1-6 is comparable to I-196-5. CBR does not propose to change the restoration goals previously approved by NRC or NDEQ for Mine Unit 2. Copies of the Baseline Water Analysis Report for both wells are attached.

- Preoperational Sampling Requirements: The baseline sampling performed for CM1-6 exceeds the preoperational sampling requirements in License Condition 10.3

for restoration wells. This condition requires a minimum of three samples be obtained and analyzed for the parameters from License Condition 10.3B. CM1-6 had 3 samples obtained and analyzed during preoperational sampling.

Based on the similarities between the wells and the fact that CM1-6 meets the criteria to be selected as a baseline restoration well, CBR proposes to replace I-196-5 with CM1-6.

Summary of SERP Evaluation

The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the proposed change and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 11 dated June 26, 2001;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534,* Crow Butte Resources, Inc. December 1995;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534,* USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534,* USNRC February 1998.

License Condition 9.4 allows CBR to make changes that are not presented in the approved application if such changes:

- Do not conflict with any requirement specifically stated in the license or impair CBR's ability to meet all applicable NRC regulations;

- Do not degrade essential safety or environmental commitments in the application or reclamation plan; and

- Are consistent with the conclusions of action analyzed and selected in the Environmental Assessment (EA).

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to the proposed test.

License Condition 10.3(A) specifically states the requirements for designation of baseline restoration wells at the Crow Butte project:

"Three samples shall be collected from production and injection wells at a minimum density of one production or injection well per 4 acres. These samples shall be collected at least 14 days apart."

The designation of CM1-6 will continue to meet the requirements of this License Condition. A total of 21 baseline samples were obtained from CM1-6. These samples were analyzed for a parameter list that includes the parameters contained in License Condition 10.3(B).

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts. Section 3.3.2 of the EA addresses preoperational groundwater sampling and bases its conclusions on the designation of one restoration well per 4 acres. The proposed change will continue to implement this licensing basis.

Section 3.3.3 contains the well construction and testing requirements that were the basis of the EA. This section states that repeated failure of the integrity test will result in "...the well be plugged and abandoned by CBR in accordance with State requirements." The proposed change will allow CBR to proceed with proper abandonment of I-196-5.

Financial Surety

The proposed change to the Mine Unit 2 baseline restoration wells will have no affect on the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of the proposed change.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that environmental commitments made in the LRA and discussed in the EA would continue to be met with the proposed changes to the Mine Unit 2 baseline restoration wells. There will be no reduction in the number of wells or amount of sampling required during restoration of Mine Unit 2. This issue was discussed with the NRC Project Manager, Mr. Michael Layton, on November 20, 2001. A copy of a memorandum written to document this telephone conversation is attached.

Underground Injection Control Permit NE0122611

As noted in the Purpose section above, the Class III Underground Injection Control (UIC) permit issued by the NDEQ specifies similar requirements for designation and sampling of baseline restoration wells. On December 10, 2001, NDEQ approved the proposal to replace I-196-5 with CM1-6. A copy of the NDEQ approval letter is included as an attachment.

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves the proposed replacement of I-196-5 with CM1-6.

Approved this 7th day of January 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Mike Brost, Chief Geologist

Rhonda Grantham, Corporate Radiation Safety Officer

SERP 02-02 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-02

Wellhouse 33 Approval

February 6, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve operation of Wellhouse 33 in Mine Unit 7 at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Radiation Safety
Jim Stokey	Senior Engineer	Operations
Mike Brost	Chief Geologist	Well Construction
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve Wellhouse 33 for operation. The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the Wellhouse startup checklists and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 11 dated June 26, 2001;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534,* Crow Butte Resources, Inc. December 1995;

- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998.

License Condition 9.4 allows CBR to make changes that are not presented in the approved application if such changes:

- Do not conflict with any requirement specifically stated in the license or impair CBR's ability to meet all applicable NRC regulations;

- Do not degrade essential safety or environmental commitments in the application or reclamation plan; and

- Are consistent with the conclusions of action analyzed and selected in the Environmental Assessment (EA).

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to approval and operation of a wellhouse.

Mine Unit 7 was previously approved by the CBR SERP (see SERP 99-02). Therefore, no review of monitor well location or installation or baseline sampling and Upper Control Limit determination is required for Wellhouse 33.

License Condition 10.2: This License Condition requires that CBR construct all wells in accordance with the methods contained in the Section 3.1.2 of the approved License Renewal Application (LRA). License Condition 10.2 also requires that CBR perform mechanical integrity tests (MIT) for all injection and production wells.

The well construction methods in use for Wellhouse 33 are the same as those described in the LRA. All MIT data sheets were contained in the Notice of Intent to Operate submitted to the NDEQ for Wellhouse 33. The records indicate that the MITs performed in Wellhouse 33 met the requirements.

License Condition 9.3: This License Condition requires that CBR conduct operations in accordance with the representations contained in the LRA. Section 3.1.3 of

the LRA discusses construction materials, instrumentation, and monitoring requirements. Section 3.3 also discusses instrumentation, including wellhouse injection and production instrumentation and wet building alarms for wellhouses. Section 7.2.3 of the LRA requires that leak tests be performed on all wellfield piping before placing the system into production operations.

The SERP reviewed the Well House Start-up Checklist for Wellhouse 33. This checklist was developed by the Wellfield Construction staff to document completion of all required actions before initiating operations in a wellhouse. Some of these actions are required by regulatory and licensing requirements, while some were developed over the course of mining experience at Crow Butte. The Senior Engineer reviewed these items and stated that all had been completed and that the appropriate controls were in place.

A copy of the Well House Start-Up Checklist is attached to this SERP Evaluation. Supporting documentation in the form of pressure tests and ground continuity checks are also attached.

The SERP noted that Wellhouse 33 will require the installation of a booster pump. The booster pump is a submersible type pump that will be installed in a pump well pit located adjacent to the wellhouse. The piping well has been pressure tested as part of the wellhouse construction and testing. The pump well pit is protected with a wet building alarm that is common to the wellhouse wet building alarm. Following installation of the booster pump, the piping will be pressure tested at operating pressure in accordance with the SOPs. The SERP approved the addition of the booster pump for this wellhouse after wellhouse startup when additional injection pressure is required.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts.

Well construction and testing as described in the EA has been completed for the wells associated with Wellhouse 33.

Section 3.3.1 discusses leak testing of wellfield piping. The SERP reviewed the completion of pressure testing for piping systems associated with Wellhouse 33 and found that they meet the intent of the EA.

Financial Surety

The proposed change is covered in the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of Wellhouse 33.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA have been met and that startup of Wellhouse 33 in Mine Unit 7 will not degrade the safety and environmental commitments.

NDEQ Underground Injection Control Permit Requirements

The SERP noted that the final approval of the Notice of Intent by the NDEQ has been received. A copy of the approval of the Notice of Intent to Operate is attached.

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves startup and operation of Wellhouse 33 in Mine Unit 7.

CROW BUTTE RESOURCES, INC.

SERP 02-02

Approved this 6th day of February 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Jin Stokey, Senior Engineer

Mike Brost, Chief Geologist

Rhonda Grantham, Corporate Radiation Safety Officer

SERP 02-03 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-03

Wellhouse 27 Approval

April 5, 2001 2150

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve operation of Wellhouse 27 in Mine Unit 6 at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Environmental
Chuck Miller	Plant Manager	Operations
Jim Stokey	Senior Engineer	Construction
Mike Brost	Chief Geologist	Well Construction
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve Wellhouse 27 for operation. The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the Wellhouse startup checklists and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 11 dated June 26, 2001;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. December 1995;

- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998.

License Condition 9.4 allows CBR to make changes that are not presented in the approved application if such changes:

- Do not conflict with any requirement specifically stated in the license or impair CBR's ability to meet all applicable NRC regulations;

- Do not degrade essential safety or environmental commitments in the application or reclamation plan; and

- Are consistent with the conclusions of action analyzed and selected in the Environmental Assessment (EA).

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to approval and operation of a wellhouse.

Mine Unit 6 was previously approved by the CBR SERP (see SERP 98-1 dated March 4, 1998). Therefore, no review of monitor well location or installation or baseline sampling and Upper Control Limit determination is required for Wellhouse 27.

License Condition 10.2: This License Condition requires that CBR construct all wells in accordance with the methods contained in the Section 3.1.2 of the approved License Renewal Application (LRA). License Condition 10.2 also requires that CBR perform mechanical integrity tests (MIT) for all injection and production wells.

The well construction methods in use for Wellhouse 27 are the same as those described in the LRA. All MIT data sheets were contained in the Notice of Intent to Operate submitted to the NDEQ for Wellhouse 27 and were reviewed by the SERP. The records indicate that the MITs performed in Wellhouse 27 met the requirements.

License Condition 9.3: This License Condition requires that CBR conduct operations in accordance with the representations contained in the LRA. Section 3.1.3 of

the LRA discusses construction materials, instrumentation, and monitoring requirements. Section 3.3 also discusses instrumentation, including wellhouse injection and production instrumentation and wet building alarms for wellhouses. Section 7.2.3 of the LRA requires that leak tests be performed on all wellfield piping before placing the system into production operations.

The SERP reviewed the Well House Start-up Checklist for Wellhouse 27. This checklist was developed by the Wellfield Construction staff to document completion of all required actions before initiating operations in a wellhouse. Some of these actions are required by regulatory and licensing requirements, while some were developed over the course of mining experience at Crow Butte. The Senior Engineer reviewed these items and stated that all had been completed and the appropriate controls were in place.

A copy of the Well House Start-Up Checklist is attached to this SERP Evaluation. Supporting documentation in the form of pressure tests and ground continuity checks are also attached.

The SERP reviewed operational issues associated with the startup of Wellhouse 27.

- Due to the location of Wellhouse 27, CBR will need to reduce the pressure on the injection trunkline before injection is begun in Wellhouse 27.
- Wellhouse 27 was constructed to allow two alternate methods of oxygen addition to be tested. The north half of the wellfield uses the current CBR design. The south half of the wellfield uses the "Linde" system. CBR plans to monitor oxygen addition and contrast mining efficiencies between these two methods. The Plant Manager stated that the Standard Operating Procedures (SOPs) still contain instructions concerning the use of the Linde system. The Plant Manager and Senior Engineer will review the operating requirements for Wellhouse 27 with the Wellfield Operations and Plant Operations personnel before startup.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts.

Well construction and testing as described in the EA has been completed for the wells associated with Wellhouse 27.

Section 3.3.1 discusses leak testing of wellfield piping. The SERP reviewed the completion of pressure testing for piping systems associated with Wellhouse 27 and found that they meet the intent of the EA.

Financial Surety

The proposed change is covered in the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of Wellhouse 27.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA have been met and that startup of Wellhouse 27 in Mine Unit 6 will not degrade the safety and environmental commitments.

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves startup and operation of Wellhouse 27 in Mine Unit 6.

Approved this 5th day of April 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Chuck Miller, Plant Manager

Jim Stokey, Senior Engineer

CROW BUTTE RESOURCES, INC.

SERP 02-03

Mike Brost, Chief Geologist

Rhonda Grantham, Corporate Radiation Safety Officer

SERP 02-04 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-04

Evaluation of Yellowcake Dryer Vacuum Loss

June 5, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review procedures followed after the yellowcake dryer lost vacuum.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Environmental
Chuck Miller	Plant Manager	Operations
Rhonda Grantham	Corporate RSO	Radiation Safety
Emil Daugherty	Plant Foreman	Operations

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review operational steps taken after the yellowcake dryer lost vacuum while drying yellowcake on May 10.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to the effluent control system for the dryer operation.

License Condition 10.8: This License Condition requires that if the yellowcake emission control equipment fails to operate within specifications that the dryer room be closed in as an airborne radioactivity area and that heating operations be suspended.

Contrary to this requirement, when the vacuum system failed and could not be restarted the decision was made to continue to heat the yellowcake to prevent it from setting up in the dryer.

Event Summary

During evening shift on May 10, 2002 the plant operators began experiencing problems with the yellowcake dryer. At approximately 2100 hrs, the dryer lost vacuum and the operators were unable to recover it. The dryer room was isolated as an airborne radioactivity area and the Lead Operator made appropriate notification. The decision was made by the Plant Foreman and Lead Operator to continue heating the yellowcake to prevent it from setting up in the dryer. During discussions between the CRSO and the Lead Operator the requirements of the SOP were reviewed and in accordance with the SOP the CRSO advised shutting down the heating unit. However, operations personnel decided to continue to heat the dryer. As a result of the continued heating, dried yellowcake dusted the dryer room. When the decision to leave the heat on was later reviewed, it was thought that the wording in the SOP requiring shut down of the heating system was ambiguous.

SERP Actions

As a result of the event, the SERP reviewed the actions taken and discussed potential implications of the event. The following topics were discussed:

- Requesting a license amendment to change the requirement for dryer shutdown in the event of a vacuum loss. After extensive discussion, it was decided that shutting down the dryer heat and auger systems could be done on a loss of vacuum with minimal damage. Therefore, the SERP determined that it was not necessary to request a license amendment to remove this requirement.

- Revising the SOP. It was decided that the SOP should be revised and the non-routine event section should be highlighted. In addition, the non-routine event section should be more detailed and give clear direction to the operators of actions to be taken for non-routine situations. These non-routine situations include loss of vacuum and apparent oil leakage into the dryer shell. The Plant Manager will prepare a detailed revision of the SOP.

- Maintenance items. The current condition of the dryer was reviewed and it was decided that the Plant Manager should review the design to determine if the dryer could be upgraded or if it needs to be replaced. It is possible that if a new dryer is purchased, the existing dryer could be used as a backup dryer. Additionally, a preventive maintenance program was discussed.

CROW BUTTE RESOURCES, INC.

SERP 02-04

Approved this 5th day of June 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Chuck Miller, Plant Manager

Rhonda Grantham, Corporate Radiation Safety Officer

Emil Daugherty, Plant Foreman

SERP 02-05 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-05

Mine Unit 8 Approval

July 10, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve Mine Unit 8 at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Environmental
Jim Stokey	Senior Engineer	Construction
Mike Brost	Chief Geologist	Well Construction
Chuck Miller	Plant Manager	Operations
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve Mine Unit 8 for operation. The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the Mine Unit 8 Notice of Intent to Operate and preoperational monitoring data and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 11 dated June 26, 2001;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534,* Crow Butte Resources, Inc. December 1995;

- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998.

In addition, the SERP evaluated compliance with the State of Nebraska Department of Environmental Quality (NDEQ) Underground Injection Control (UIC) Permit No. NE0122611.

License Condition 9.4 allows CBR to make changes that are not presented in the approved application if such changes:

- Do not conflict with any requirement specifically stated in the license or impair CBR's ability to meet all applicable NRC regulations;

- Do not degrade essential safety or environmental commitments in the application or reclamation plan; and

- Are consistent with the conclusions of action analyzed and selected in the Environmental Assessment (EA).

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to approval and operation of a new mine unit.

License Condition 9.5: This License Condition requires that CBR maintain an NRC-approved financial surety arrangement to cover reclamation of all existing operations and planned expansions for the upcoming year. If such expansion is not covered in the annual update to the existing surety arrangement, an updated surety must be provided to NRC at least 90 days before beginning construction.

The current surety arrangement approved by NRC and NDEQ includes the operation of the four wellhouses in Mine Unit 8 during 2002.

License Condition 9.10: This License Condition requires that CBR conduct operations within the permit area boundaries shown in the License Renewal Application (LRA), as amended.

Mine Unit 8 falls within this permit area boundary.

License Condition 10.2: This License Condition requires that all wells be constructed as described in the LRA and that Mechanical Integrity Tests (MITs) be conducted before the well can be utilized.

The well construction methods in use for Mine Unit 8 are the same as those described in the LRA. The SERP reviewed the MIT information contained in the Notice of Intent to Mine (NOI) submitted to the NDEQ. The package in the NOI included the MITs for required monitoring wells. MITs for future wellhouses in Mine Unit 8 cannot be reviewed since these wells have not been installed. Therefore, the SERP can only review baseline restoration wells and the monitoring wells of Mine Unit 8 for compliance with this License Condition. All MIT data sheets reviewed met the requirements.

License Condition 10.3: This License Conditions contain requirements for establishing pre-operational baseline groundwater quality including well density, sampling frequency and parameters, and determination of groundwater restoration goals.

10.3(A): A total of 30 injection or production wells are identified as baseline restoration wells for Mine Unit 8, which comprises 118.5 acres. The SERP reviewed the well placement. The wells meet the density requirement of this License Condition (i.e., 1 per every 4 acres) and are evenly spaced in the Mine Unit. Samples were collected at least 14 days apart.

10.3(B): The baseline samples were analyzed for all parameters listed in this portion of the License Condition.

10.3(C): Groundwater restoration goals were proposed for Mine Unit 8 that were based upon the mine unit average of all baseline restoration (BLR) wells. The goals are an arithmetic mean of the averages for the three samples taken for each of the 30 baseline restoration wells.

The SERP determined to insert a restoration goal table for Mine Unit 8 into the approved LRA to include all parameters required by License Condition 10.3(B).

License Condition 10.4: This License Condition contains requirements for determining Upper Control Limits (UCLs) for upper and perimeter monitor wells including well density, sampling schedule, analytes, and UCL calculational method.

10.4(A): A total of 30 shallow monitors and 25 perimeter monitor wells are identified for Mine Unit 8, which comprises 118.5 acres. The SERP reviewed the well placement. The wells meet the density requirement of this License Condition (i.e., 1 per

every 5 acres for shallow monitor wells) and are evenly spaced in the Mine Unit. Samples were collected at least 14 days apart.

10.4(B): The samples were analyzed for all parameters listed in this portion of the License Condition.

10.4(C): The proposed UCLs for each shallow and perimeter monitor well were calculated as required in this License Condition.

License Condition 10.16: This License Condition specifies the spacing for all perimeter monitor wells drilled after April 1999. All of the perimeter monitor wells for Mine Unit 8 meet the spacing requirements of the License.

The SERP concluded that all specific license requirements would continue to be met if this change is approved.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts.

Section 3.3 of the EA discusses wellfield design and construction. In 3.3.1 (page 20), the EA states that CBR analyzes the monitor wells for 35 parameters. This statement does not match License Condition 10.4(B), which requires that the monitor wells be sampled for the five excursion indicators only. In such a case, the License is the governing document, and the preoperational monitoring program complies with the license.

Well construction and testing as described in the EA has been completed for the baseline restoration wells, the shallow and perimeter monitor wells, and the wells associated with Wellhouse 34. This data was submitted to NDEQ with the NOI. Other wells that will be contained in Mine Unit 8 have not been drilled, constructed and/or tested and therefore cannot be approved by the SERP.

Section 3.3.1 discusses leak testing of wellfield piping. At the time that the SERP was held, final construction testing had not been completed on the Wellhouse 34 portion of Mine Unit 8 and other portions were in the design or construction phase. Therefore, the SERP could not review construction completion to approve startup of Wellhouse 34 or future wellhouses in Mine Unit 8.

Financial Surety

The proposed change is covered in the NRC-approved financial surety maintained by CBR. The approved surety for 2002 allows for operation of up to four wellhouses in Mine Unit 8.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of Mine Unit 8.

NDEQ UIC Permit

The SERP reviewed the requirements of the NDEQ UIC Permit they relate to startup of Mine Unit 8.

- The NOI was submitted as required on Page 4 of the permit and approved by the NDEQ (see attached letter).
- All monitor wells and restoration wells were installed and monitored as required by permit.
- All monitor wells were shown to be functionally operation as required.
- Restoration goals were determined for every parameter included in Table 1 as required.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA could not be confirmed at the time that the SERP met because the final testing and checks for Wellhouse 34 had not been completed. Therefore, the SERP could not approve startup of Wellhouse 34. When testing and final checks for Wellhouse 34 are completed, the SERP will review this information at that time and determine whether approval for startup of Wellhouse 34 of Mine Unit 8 will be granted. Future Wellhouses will be evaluated and approved before startup.

The SERP was satisfied that the well locations and preoperational monitoring performed for the baseline restoration wells, shallow monitor wells, and perimeter monitor wells had been completed as required in the licensing basis documents and the NDEQ permit. The restoration goals and UCLs had been properly determined and documented. Therefore,

the SERP approves the determination of restoration goals and excursion monitoring criteria for Mine Unit 8.

License Renewal Application Revision

License Condition 12.7 requires that CBR submit an annual report to NRC describing changes, tests, or experiments made under License Condition 9.4. As part of this report, CBR must submit changes made to the approved License Renewal Application (LRA) to reflect changes that are approved by the SERP.

The SERP reviewed proposed changes to Section 6.0 of the LRA. These changes are summarized as follows:

1. Table 6.1-8 was added, listing the groundwater standards, wellfield baseline averages, standard deviation, and restoration values for the restoration parameters in Mine Unit 8. These values were based on the data submitted to the NDEQ in the approved Notice of Intent.
2. The groundwater standard for cadmium was changed from 0.01 mg/L to 0.005 mg/L for Mine Units 2 through 7 (Tables 6.1-2 through 6.1-7). This change was made to reflect modifications made to CBR's Class III UIC permit dated March 9, 2001. The value for Mine Unit 1 was not changed since restoration is complete and approval has been received by NDEQ under the previous permit requirements.
3. The groundwater standard for selenium was changed from 0.01 mg/L to 0.05 mg/L for Mine Units 2 through 7. This change was made to reflect modifications made to CBR's Class III UIC permit dated March 9, 2001. The value for Mine Unit 1 was not changed since restoration is complete and approval has been received by NDEQ under the previous permit requirements.
4. Data for bicarbonate and carbonate was removed from Tables 6.1-2 through 6.1-7. The restoration requirement for these parameters is based on the total carbonate concentration. This change was made in Amendment 11 to SUA-1534.
5. The table headings were changed to delete reference to the "primary goal" and "secondary goal" in the Baseline and NDEQ Restoration Value columns since the basis for determining these goals is clearly described in the text in Section 6.1.3.

The SERP approved the proposed changes to the approved LRA.

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-06

Wellhouse 34 Approval to Operate

July 10, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve operation of Wellhouse 34 in Mine Unit 8 at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Manager of Operations	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Environmental
Jim Stokey	Senior Engineer	Construction
Mike Brost	Chief Geologist	Well Construction
Chuck Miller	Plant Manager	Operations
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve Wellhouse 34 for operation. The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the Wellhouse startup checklists and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 11 dated June 26, 2001;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. December 1995;

SERP 02-06 Evaluation

Approved this 10th day of July 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Jim Stokey, Senior Engineer

Mike Brost, Chief Geologist

Chuck Miller, Plant Manager

Rhonda Grantham, Corporate Radiation Safety Officer

- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998.

License Condition 9.4 allows CBR to make changes that are not presented in the approved application if such changes:

- Do not conflict with any requirement specifically stated in the license or impair CBR's ability to meet all applicable NRC regulations;

- Do not degrade essential safety or environmental commitments in the application or reclamation plan; and

- Are consistent with the conclusions of action analyzed and selected in the Environmental Assessment (EA).

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 11 to SUA-1534 dated June 26, 2001 was reviewed for specific requirements related to approval and operation of a wellhouse.

Mine Unit 8 was previously approved by the CBR SERP (see SERP 02-05 dated July 10, 2002). Therefore, no review of monitor well location, installation or baseline sampling and Upper Control Limit determination is required for approval of Wellhouse 34.

License Condition 10.2: This License Condition requires that CBR construct all wells in accordance with the methods contained in the Section 3.1.2 of the approved License Renewal Application (LRA). License Condition 10.2 also requires that CBR perform mechanical integrity tests (MIT) for all injection and production wells.

The well construction methods in use for Wellhouse 34 are the same as those described in the LRA. All MIT data sheets were contained in the Notice of Intent to Operate Mine Unit 8 that was submitted to the NDEQ for Wellhouse 34 and was reviewed by the SERP. The records indicate that the MITs performed in Wellhouse 34 met the requirements.

License Condition 9.3: This License Condition requires that CBR conduct operations in accordance with the representations contained in the LRA. Section 3.1.3 of

the LRA discusses construction materials, instrumentation, and monitoring requirements. Section 3.3 also discusses instrumentation, including wellhouse injection and production instrumentation and wet building alarms for wellhouses. Section 7.2.3 of the LRA requires that leak tests be performed on all wellfield piping before placing the system into production operations.

The SERP reviewed the Well House Start-up Checklist for Wellhouse 34. This checklist was developed by the Wellfield Construction staff to document completion of all required actions before initiating operations in a wellhouse. Some of these actions are required by regulatory and licensing requirements, while some were developed over the course of mining experience at Crow Butte. The Senior Engineer reviewed these items and stated that all had been completed and the appropriate controls were in place.

A copy of the Well House Start-Up Checklist is attached to this SERP Evaluation. Supporting documentation in the form of pressure tests and ground continuity checks are also attached.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts.

Well construction and testing as described in the EA has been completed for the wells associated with Wellhouse 34.

Section 3.3.1 discusses leak testing of wellfield piping. The SERP reviewed the completion of pressure testing for piping systems associated with Wellhouse 34 and found that they meet the intent of the EA.

Financial Surety

The proposed change is covered in the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of Wellhouse 34.

CROW BUTTE RESOURCES, INC.

SERP 02-06

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA have been met and that startup of Wellhouse 34 in Mine Unit 8 will not degrade the safety and environmental commitments.

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves startup and operation of Wellhouse 34 in Mine Unit 8.

Approved this 10th day of July 2002.

Steve Magnuson, Vice President, Manager of Operations
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Jim Stokey, Senior Engineer

Mike Brost, Chief Geologist

Chuck Miller, Plant Manager

Rhonda Grantham, Corporate Radiation Safety Officer

SERP 02-07 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-07

Organizational Change Evaluation

August 8, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met in accordance with USNRC Source Materials License SUA-1534 to review a proposed change to the corporate organization. License Condition 9.12 requires that Crow Butte follow the guidance set forth in USNRC Regulatory Guide 8.31, which discusses the health physics organization at uranium recovery facilities.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Engineering and Development	Management
Jim Stokey	Mine Manager	Operations
Mike Griffin	Manager of Health, Safety and Environmental Affairs	Regulatory Affairs
Rhonda Grantham	Corporate RSO	Radiation Safety

Mr. Magnuson is the SERP Chairman. Mr. Griffin was appointed SERP Secretary for this evaluation.

PURPOSE OF SERP EVALUATION

The purpose of the SERP evaluation was to review a proposed organizational change affecting the reporting responsibilities of the radiation safety staff. Specifically, the Corporate Radiation Safety Officer (CRSO) reports to the Manager of Health, Safety and Environmental Affairs as shown in the current organizational chart included as Figure 5.1-1 from the approved application (revised page dated April 6, 2001 attached). The Manager of Health, Safety, and Environmental Affairs reports to the Senior Vice President in the current organizational chart.

The proposed change is a result of reorganization of the Crow Butte site management. As discussed in the corporate announcement (attached), the current Vice President, Manager of Operations has been selected to direct other efforts in addition to the Crow Butte operation. Since this position previously directly managed operations at Crow Butte, a new position of Mine Manager has been created. In order to consolidate site management responsibilities, all site departments will report to the Mine Manager. This includes the environmental, health and safety department, which includes the health physics organization.

SOP C-2, *Safety and Environmental Review Panel* was followed in completing this evaluation.

Current NRC License Requirements

The SERP reviewed the requirements contained in Source Materials License SUA-1534, Amendment 12, dated July 24, 2002. License Condition 9.12 requires that CBR follow the guidance contained in Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable.* The corporate organization affecting the radiation safety staff must conform to the guidance contained in Regulatory Guide 8.31. This requirement is supported by the Safety Evaluation Report prepared by NRC (February 1998), which states that "...any organizational change that affects assignments or reporting responsibilities of the radiation safety staff conform to the (NRC) staff's recommendations in Regulatory Guide 8.31".

Section 2.1 of Regulatory Guide 8.31 states "generally, the RSO should report directly to the resident manager on matters of radiation safety." The proposed organizational change results in the CRSO and the radiation safety staff reporting to the Mine Manager through the Manager of Health, Safety, and Environmental Affairs.

Section 2.1 of Regulatory Guide 8.31 also recommends that the RSO have the authority and responsibility to "suspend, postpone or modify" work activities that are unsafe or may be a potential violation of regulations. Under the proposed organization, the CRSO will retain this authority and responsibility.

Impact on Regulations

There are no regulatory requirements impacted by the proposed change.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change caused substantive safety or environmental impacts. Organization of the radiation safety staff is not discussed in the EA and the SERP concluded that the proposed change is consistent with the NRC's conclusions in the EA.

Financial Surety

The proposed change will have no effect on the level of financial surety maintained by CBR.

Degradation of Essential Safety or Environmental Commitment

The CBR SERP believes that the proposed reorganization of the radiation safety staff will cause no degradation of CBR's commitment to worker safety and protection of the environment.

Conclusion

It was the conclusion of the SERP that the proposed change is allowed by License SUA-1534 and should be approved. The revised pages of the license application (pages 5-1 through 5-3) required in accordance with License Condition 9.4 were reviewed and approved and are attached to this evaluation.

Approved this 8th day of August 2002:

Steve Magnuson, Vice President, Engineering and Development
SERP Chairman

Jim Stokey, Mine Manager

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Rhonda Grantham, Corporate Radiation Safety Officer

SERP 02-08 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-08

License Renewal Application Page Revisions

August 28, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve revisions to the NRC-approved License Renewal Application.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Engineering and Development	Management
Mike Griffin	Manager of Health, Safety, and Environmental Affairs	Regulatory Affairs/ Environmental
Jim Stokey	Mine Manager	Operations
Rhonda Grantham	Corporate RSO	Radiation Safety
John Cash	Senior Environmental/Safety Coordinator	Regulatory Affairs

Mr. Magnuson is the SERP Chairman Mr. Griffin was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve proposed changes to the NRC-approved License Renewal Application (LRA) The revisions were required by issuance of Amendment 12 to SUA-1534 dated July 24, 2002 and to update various references.

License Condition 9.4 allows CBR to make changes in the facility or procedures or conduct tests or experiments that are not presented in the approved application if such changes do not:

i. Result in any appreciable increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in any appreciable increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the license application (as updated);
iii. Result in any appreciable increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in any appreciable increase in the consequences of a malfunction of an SSC previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type that any previously evaluated in the license application (as updated);
vi. Create a possibility for a malfunction of an SSC with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER) or the environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments.
viii. For the purposes of SERP evaluations, SSC means any SSC which has been referenced in a staff SER, TER, EA, or environmental impact statement (EIS) and supplements and amendments.

The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the proposed page changes and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 12 dated July 24, 2002;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. December 1995;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- Technical Evaluation Reports issued in support of amendments to SUA-1534.

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 12 to SUA-1534 dated July 24, 2002 was reviewed for specific requirements related to the proposed page changes.

License Condition 9.4 (E): This License Condition requires that CBR update the operations plan and the reclamation plan of the approved license application to reflect changes made by the SERP. The proposed changes to the license application are required to reflect changes made by NRC amendment. While updating the application to reflect license amendments is not specifically required by this License Condition, it is implied that the application should be updated. Approval of the proposed changes would meet this requirement.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed page changes could cause substantive safety or environmental impacts. The EA does not address the issue of updating the license renewal application.

Financial Surety

The proposed page changes have no affect on the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) in Section 1.0 discusses the authority and responsibility of the CBR SERP. The SER specifies that CBR will be required to submit any pages of the approved application that have been revised to reflect changes approved by the SERP. As discussed above, changes to the application pages to reflect changes made by amendment will meet the NRC goal of maintaining the application in a current status.

CROW BUTTE RESOURCES, INC.

SERP 02-08

Technical Evaluation Reports

The SERP reviewed the Technical Evaluation Reports (TERs) prepared by NRC staff to support amendments made to SUA-1534. None of the TERs prepared since license renewal directly address page changes in the approved application.

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves the proposed changes to the License Renewal Application.

Approved this 28th day of August 2002.

Steve Magnuson, Vice President, Engineering and Development
SERP Chairman

Mike Griffin, Manager of Health, Safety, and Environmental Affairs
SERP Secretary

Jim Stokey, Mine Manager

Rhonda Grantham, Corporate Radiation Safety Officer

John Cash, Senior Environmental/Safety Coordinator

Summary of License Renewal Application

Page Revisions

Section Number	Affected Pages	Summary of Proposed Change
5.3	5-6	Update reference to USNRC Regulatory Guide 8.31 to revision 1 dated May 2002.
5.5.1	5-9	Update reference to USNRC Regulatory Guide 8.31 to revision 1 dated May 2002.
5.7.1.2	5-16	Correct SOP reference for response to transportation accidents.
5.7.3.1	5-23	Add provisions for use of an equivalent primary calibration standard for air sampling pumps as an alternative to mass flow meters.
5.7.4.1	5-29	Update reference to USNRC Regulatory Guide 8.30 to revision 1 dated May 2002.
5.7.4.2	5-32	Update reference to USNRC Regulatory Guide 8.30 to revision 1 dated May 2002.
5.7.6	5-37	Update reference to USNRC Regulatory Guide 8.30 to revision 1 dated May 2002; remove outdated reference to License Condition 32.
5.7.7	5-39	Correct SOP reference for environmental radon sampling; correct outdated reference to License Condition 40.
5.7.7	5-40, 5-41	Clarify discussion of environmental air particulate monitoring frequency.
5.7.8	5-59	Correct SOP reference for routine groundwater monitoring.
5.7.8	5-59, 5-60	Clarify purging requirements for groundwater sampling.
5.7.8.2	5-67	Update reference to include Mine Unit 8.
5.7.8.2	5-67	Clarify reporting requirements for pond leaks to meet Amendment 12 of SUA-1534
5.7.10	5-69	Update reference to USNRC Regulatory Guide 8.30 to revision 1 dated May 2002.
6.1.4.1	6-17, 6-22	Update reference to include Mine Unit 8 restoration table.
6.2.5	6-30	Update reference to USNRC Regulatory Guide 8.30 to revision 1 dated May 2002.
6.4.1	6-33, Attachment 6.1	Remove bond calculation from 1995 and insert reference to annual submittal of surety update to NRC.
6.4.2	6-34	Update surety bond information to the approved 2002 bond.

SERP 02-09 Evaluation

Crow Butte Resources, Inc.

Safety and Environmental Review Panel

Evaluation Report – SERP 02-09

Wellhouse 35 Approval to Operate

October 29, 2002

The Crow Butte Resources, Inc. (CBR) Safety and Environmental Review Panel (SERP) met to review and approve operation of Wellhouse 35 in Mine Unit 8 at the Crow Butte Uranium Project.

The SERP appointed for this evaluation consisted of the following members:

Name	Title	Area of Expertise
Steve Magnuson	Vice President, Engineering and Development	Management
Jim Stokey	Mine Manager	Operations
Rhonda Grantham	Corporate RSO	Radiation Safety
John Cash	Senior Environmental/Safety Coordinator	Regulatory Affairs

Mr. Magnuson is the SERP Chairman. Mr. Cash was appointed SERP Secretary for this evaluation.

Purpose of SERP Evaluation

The purpose of this evaluation by the CBR SERP was to review and approve Wellhouse 35 for operation.

License Condition 9.4 allows CBR to make changes in the facility or procedures or conduct tests or experiments that are not presented in the approved application if such changes do not:

i. Result in any appreciable increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
ii. Result in any appreciable increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the license application (as updated);
iii. Result in any appreciable increase in the consequences of an accident previously evaluated in the license application (as updated);
iv. Result in any appreciable increase in the consequences of a malfunction of an SSC previously evaluated in the license application (as updated);
v. Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);
vi. Create a possibility for a malfunction of an SSC with a different result than previously evaluated in the license application (as updated);
vii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER) or the environmental assessment (EA) or the technical evaluation reports (TERs) or other analysis and evaluations for license amendments;
viii. For the purposes of SERP evaluations, SSC means any SSC which has been referenced in a staff SER, TER, EA, or environmental impact statement (EIS) and supplements and amendments.

The SERP evaluation was conducted in accordance with CBR Standard Operating Procedure (SOP) C-2, *Safety and Environmental Review Panel.* The SERP reviewed the Wellhouse startup checklists and supporting documentation and evaluated this information as compared with the requirements of the licensing basis, including the following documents:

- Title 10, Code of Federal Regulations;
- Source Materials License SUA-1534, Amendment No. 12 dated July 24, 2002;
- *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, Crow Butte Resources, Inc. December 1995;
- *Environmental Assessment for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- *Safety Evaluation Report for Renewal of Source Materials License No. SUA-1534*, USNRC February 1998;
- Technical Evaluation Reports issued in support of amendments to SUA-1534.

Title 10 Code of Federal Regulations

The proposed change will have no impact on CBR's ability to meet all applicable NRC regulations.

Source Materials License SUA-1534 Requirements

Amendment 12 to SUA-1534 dated July 24, 2002 was reviewed for specific requirements related to approval and operation of a wellhouse.

Mine Unit 8 was previously approved by the CBR SERP (see SERP 02-05 dated July 10, 2002). Therefore, no review of monitor well location, installation or baseline sampling and Upper Control Limit determination is required for approval of Wellhouse 35.

License Condition 10.2: This License Condition requires that CBR construct all wells in accordance with the methods contained in the Section 3.1.2 of the approved License Renewal Application (LRA). License Condition 10.2 also requires that CBR perform mechanical integrity tests (MIT) for all injection and production wells.

The well construction methods in use for Wellhouse 35 are the same as those described in the LRA. All MIT data sheets were contained in the Notice of Intent to Operate Wellhouse 35 that was submitted to the NDEQ and was reviewed by the SERP. The records indicate that the MITs performed in Wellhouse 35 met the requirements.

License Condition 9.3: This License Condition requires that CBR conduct operations in accordance with the representations contained in the LRA. Section 3.1.3 of the LRA discusses construction materials, instrumentation, and monitoring requirements. Section 3.3 also discusses instrumentation, including wellhouse injection and production instrumentation and wet building alarms for wellhouses. Section 7.2 3 of the LRA requires that leak tests be performed on all wellfield piping before placing the system into production operations.

The SERP reviewed the Well House Start-up Checklist for Wellhouse 35. This checklist was developed by the Wellfield Construction staff to document completion of all required actions before initiating operations in a wellhouse. Some of these actions are required by regulatory and licensing requirements, while some were developed over the course of mining experience at Crow Butte. The Mine Manager reviewed these items and stated that all had been completed and the appropriate controls were in place.

A copy of the Well House Start-Up Checklist is attached to this SERP Evaluation. Supporting documentation in the form of pressure tests and ground continuity checks are also attached.

Environmental Assessment

The SERP reviewed the contents of the Environmental Assessment (EA) prepared by NRC in February 1998 to determine whether the proposed change could cause substantive safety or environmental impacts.

Well construction and testing as described in the EA has been completed for the wells associated with Wellhouse 35.

Section 3.3.1 discusses leak testing of wellfield piping. The SERP reviewed the completion of pressure testing for piping systems associated with Wellhouse 35 and found that they meet the intent of the EA.

Financial Surety

The proposed change is covered in the NRC-approved financial surety maintained by CBR.

Safety Evaluation Report

The Safety Evaluation Report (SER) principally provides the basis for worker safety at Crow Butte and does not specifically address the issues related to approval of Wellhouse 35.

Technical Evaluation Reports

The SERP reviewed the Technical Evaluation Reports (TERs) prepared by NRC staff to support amendments made to SUA-1534. None of the TERs prepared since license renewal directly address issues related to approval of a new Wellhouse for operation.

Degradation of Essential Safety or Environmental Commitment

SUA-1534 allows CBR to make changes as long as they do not degrade the essential safety or environmental commitments made in the application. The SERP determined that safety commitments made in the LRA and discussed in the EA have been met and that startup of Wellhouse 35 in Mine Unit 8 will not degrade the safety and environmental commitments

Based upon this evaluation of the licensing basis, the CBR SERP hereby approves startup and operation of Wellhouse 35 in Mine Unit 8.

Approved this 29th day of October 2002.

CROW BUTTE RESOURCES, INC.

SERP 02-09

Steve Magnuson, Vice President, Engineering and Development
SERP Chairman

Jim Stokey, Mine Manager

Rhonda Grantham, Corporate Radiation Safety Officer

10/29/02
John Cash, Senior Environmental/Safety Coordinator

CROW BUTTE RESOURCES, INC.

License Renewal Application

Affected Pages (highlighted version)

2002 SERP Actions

5. OPERATIONS

Crow Butte Resources, Inc. (CBR) operates a commercial scale in-situ leach uranium mine (the Crow Butte Uranium Project) near Crawford, Nebraska. CBR maintains a headquarters in Denver, Colorado where site-licensing actions originate. All CBR operations, including the Crow Butte Uranium Project operations, are conducted in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement CBRs policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1. CORPORATE ORGANIZATION/ADMINISTRATIVE PROCEDURES

The CBR organizational chart as it pertains to the responsibility for radiation safety and environmental protection at the Crow Butte Uranium Project facility is given as Figure 5.1-1. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. Specific responsibilities of the organization are provided below.

5.1.1. SENIOR VICE PRESIDENT - OPERATIONS

The overall responsibility for the radiation, environmental, and safety activities of the Crow Butte Facility rests with the Senior Vice President - Operations of CBR. ~~In addition, the Senior Vice President – Operations of CBR is responsible for all Crow Butte commercial production facilities, reporting directly to the President of CBR.~~ The Senior Vice President - Operations is also responsible for license development and license modifications. The Vice President, Engineering and Development will, in the absence or disability of the Senior Vice President - Operations, perform the duties of the Senior Vice President - Operations.

5.1.2. VICE PRESIDENT, ~~MANAGER OF OPERATIONS~~ENGINEERING AND DEVELOPMENT

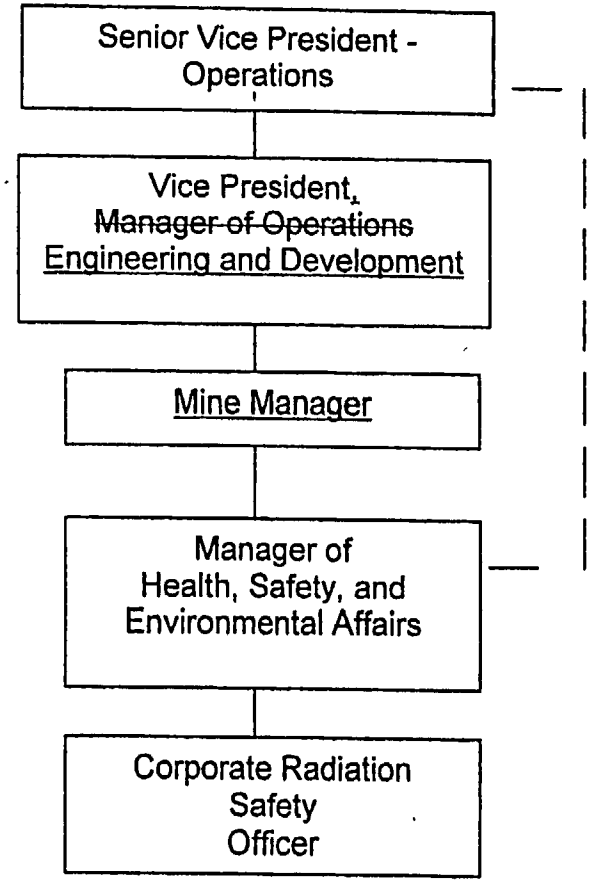
The Vice President, Engineering and Development is responsible for all Crow Butte commercial production facilities, reporting directly to the Senior Vice President-Operations

~~The Vice President, Manager of Operations is responsible for all uranium production activity at the project site. The Vice President, Manager of Operations is also responsible for implementing any safety and/or monitoring programs associated with operations, including yellowcake-handling procedures. The Vice President, Manager of Operations is authorized to immediately implement any action to correct or prevent radiation safety hazards. The Vice President, Manager of Operations reports directly to the Senior Vice President – Operations.~~

5.1.3. MINE MANAGER

The Mine Manager is responsible for all uranium production activity at the project site. The Mine Manager is also responsible for implementing any safety and/or monitoring programs associated with operations, including yellowcake-handling procedures. The Mine Manager is authorized to immediately implement any action to correct or prevent radiation safety hazards. The Mine Manager reports directly to the Vice President, Engineering and Development.

Figure 5.1-1: Crow Butte Resources Organizational Chart



~~5.1.3.~~5.1.4. MANAGER OF HEALTH, SAFETY, AND ENVIRONMENTAL AFFAIRS

The Manager of Health, Safety, and Environmental Affairs is responsible for ensuring that CBR complies with all applicable regulatory requirements including those involving environmental protection and radiation safety. The Manager of Health, Safety, and Environmental Affairs reports directly to the ~~Senior Vice President - Operations of CBR~~Mine Manager and supervises the CRSO to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. The Manager of Health, Safety, and Environmental Affairs has no production-related responsibilities. The Manager of Health, Safety, and Environmental Affairs also has the responsibility to advise the Senior Vice President - Operations on matters involving radiation safety and to implement changes and/or corrective actions involving radiation safety authorized by the Senior Vice President - Operations.

~~5.1.4.PLANT MANAGER~~

~~The Plant Manager has direct oversight of the facility operations including yellowcake handling procedures. The Plant Manager is responsible for carrying out any procedures or actions implemented by the Corporate Radiation Safety Officer (CRSO) or Vice President, Manager of Operations to correct or prevent radiation safety hazards. The Plant Manager reports directly to the Vice President, Manager of Operations.~~

5.1.5. CORPORATE RADIATION SAFETY OFFICER

The CRSO is responsible for the development, administration and enforcement of all radiation safety programs. The CRSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The CRSO is responsible for the implementation of all on-site environmental programs, including emergency procedures. The CRSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The CRSO works closely with all supervisory personnel to insure that established programs are maintained. The CRSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The CRSO makes recommendations to improve any and all radiological safety related controls The CRSO has no production-related responsibilities. The CRSO will report to the Manager of Health, Safety, and Environmental Affairs

Weekly

The CRSO and the Plant Manager or their qualified designees conduct a weekly inspection of the plant to observe general radiation safety practices and to review required changes in equipment and procedures. The results of these weekly inspections are documented.

Monthly

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

Quarterly

Quarterly inspections are performed of the evaporation ponds in accordance with the guidance contained in USNRC Regulatory Guide 3.11.1, "Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings".

Annually

On an annual basis, an audit of the radiation protection and ALARA program is conducted in accordance with USNRC Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium ~~Mills~~Recovery Facilities Will Be As Low As Reasonably Achievable", Revision 1. A written report of the results is submitted to corporate management. The auditor may be the Manager of Health, Safety, and Environmental Affairs or an outside radiation safety auditor as identified in Figure 5.1-1 and discussed in Section 5.1-8. The CRSO may accompany the auditor, but may not participate in the conclusions.

The annual ALARA audit report summarizes the following data:

1. Employee exposure records

2. Bioassay results

3. Inspection log entries and summary reports of daily mine and process inspections

5.5. TRAINING

All site employees, and contracted personnel when present, at the Crow Butte Uranium Project are administered a training program based upon the CBR Radiation Safety Training Plan covering radioactive material handling and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines. The technical content of the training program is under the direction of the CRSO. The CRSO or a qualified designee conducts training.

5.5.1. TRAINING PROGRAM CONTENT

Visitors

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

Contractors

Any contractors having work assignments at the facility are given appropriate training and safety instruction. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of permanent workers.

Permanent Employees

The CBR Radiation Safety Training Program incorporates the following topics discussed in USNRC Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium ~~Mills~~Recovery Facilities Will Be As Low As Reasonably Achievable", Revision 1:

Fundamentals of health protection

- The radiological and toxic hazards of exposure to uranium and its daughters.
- How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration.
- Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

- **Transportation accidents** - Standard Operating Procedure ~~P-18~~C-21 provides the CBR emergency action plan for responding to a transportation accident involving a yellowcake shipment. The SOP provides instructions for proper packaging, documentation, driver emergency and accident response procedures and cleanup and recovery actions. Spill response is specifically addressed in SOP C-19, ~~*Solution*~~*Radioactive Materials Spills*.

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

  At the Crow Butte Uranium Project site, an undetected excursion is highly unlikely. All wellfields are surrounded by a ring of monitor wells located no further than 300 feet from the wellfield and screened in the ore-bearing Chadron aquifer. Additionally, monitor wells are placed in the first overlying aquifer above each wellfield segment. Sampling of these wells is done on a biweekly basis. Past experience at in-situ leach mining facilities has shown that this monitoring system is effective in detecting leachate migration. The total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and over-production of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

  Migration of fluids to overlying aquifers has also been considered. Several controls are in place to prevent this. First, CBR has plugged all exploration holes to prevent co-mingling of Brule and Chadron aquifers and to isolate the mineralized zone. Successful plugging was tested by conducting two hydrologic tests prior to mining. Results indicated that no leakage or communication exists between the mineralized zone and overlying aquifers. In addition, prior to start of production a well integrity test is performed on all injection/recovery wells. This requirement of the Nebraska Underground Injection Control Regulations insures that all wells are constructed properly and capable of maintaining pressure without leakage. Lastly, monitor wells completed in the overlying aquifer are also sampled on a regular basis for the presence of leach solution.

  Seepage of solutions from the evaporation ponds into ground or surface water is also a potential pollution source. However, this has not been nor should it be a problem at the Crow Butte site.

Proposed Beta and Gamma Survey Program

CBR proposes to institute the same gamma exposure-monitoring program of worker occupied stations and areas likely to have significant gamma exposure rates at the Crow Butte Uranium Project that has been performed to date with the following changes.

- Gamma survey instruments will be calibrated annually or at the manufacturers recommended frequency, whichever is more frequent.

Gamma exposure rate surveys will be performed in accordance with the instructions currently contained in Standard Operating Procedure C-13, "Gamma Surveys". Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions.

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake will be performed as discussed in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities," Section 1.4. Beta evaluations may be substituted for surveys using radiation survey instruments. Surveys or evaluations will be performed whenever a change in equipment or procedures has occurred that may significantly affect worker exposures.

5.7.3. IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

5.7.3.1. IN-PLANT AIRBORNE URANIUM PARTICULATE MONITORING

Program Description

Airborne particulate levels at solution mines which ship slurry yellowcake product are normally very low since the product is wet. Yellowcake drying operations began in 1993. Monitoring for airborne uranium was performed routinely at Crow Butte Uranium Project through the use of area sampling and breathing zone sampling. The monitoring programs are described below.

Area Sampling

Area samples are collected monthly at the four specified sample locations in the plant. Additionally, samples are taken in the dryer room during dryer operations and for the issuance of an RWP. Area samples are taken in accordance with the instructions currently contained in SOP C-12, "Survey for Airborne Uranium". Samples are taken with a glass fiber filter and a regulated air sampler such as an Eberline RAS-1 or equivalent. Sample volume is adequate to achieve the lower limits of detection (LLD) for uranium in air. Samplers are calibrated every six months using a digital mass flowmeter or equivalent primary calibration standard.

Measurement of airborne uranium is performed by gross alpha counting of the air filters using an alpha scaler such as an Eberline MS-3 or equivalent. The Maximum Permissible Concentration (MPC) value for natural uranium of 1 E-10 μCi/ml from Appendix B to 10 CFR §§ 20.1 - 20.601 was applied to the gross alpha counting results. After implementation of the new 10 CFR 20 on January 1, 1994, the Derived Air Concentration (DAC) for soluble (D classification) natural uranium of 5 E-10 μCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 was used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230) which are alpha emitters. An action level of 25% of the MPC (DAC since 1994) for soluble natural uranium was established at the Crow Butte Uranium Project facilities. If an airborne uranium sample exceeded the MPC (DAC), an investigation was performed. The only area at the Crow Butte Uranium Project which has met the definition of an Airborne Radioactivity Area as contained in 10 CFR § 20.1003 is the dryer room during yellowcake packaging operations.

5.7.4.1. NATURAL URANIUM EXPOSURE

Exposure calculations for airborne natural uranium are carried out using the intake method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities~~,~~", Revision 1, Section 2. The intake is calculated using the following equation:

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

where:

I_u	=	uranium intake, μg or μCi
t_i	=	time that the worker is exposed to concentrations X_i (hr)
X_i	=	average concentration of uranium in breathing zone, μg/m^3, μCi/m^3
b	=	breathing rate, 1.2 m^3/hr
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the week or quarter

The intake for uranium is calculated on Time Weighted Exposure (TWE) forms. The intakes are totaled and entered onto each employee's Occupational Exposure Record.

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

Time of Exposure Determination

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

5.7.4.2. RADON DAUGHTER EXPOSURE

Exposure calculations for airborne radon daughters are carried out using the intake method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities~~,~~", Revision 1, ~~-~~Section 2. The radon daughter intake is calculated using the following equation:

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

where:

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

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

Time of Exposure Determination

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

accordance with the guidance contained in USNRC Regulatory Guide 8.22, "Bioassay in Uranium Mills, Revision 1" and with the instructions currently contained in Standard Operating Procedure C-10, "Bioassay Sampling."

5.7.6. CONTAMINATION CONTROL PROGRAM

CBRs contamination control program at Crow Butte Uranium Project consists of the following elements:

Surveys For Surface Contamination

CBR performs surveys for surface contamination in operating and clean areas of the Crow Butte Uranium Project facilities in accordance with the guidelines contained in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities", Revision 1. Surveys for alpha contamination in clean areas such as lunchrooms change rooms and offices are conducted weekly. An action level of 25% of the limits from USNRC Regulatory Guide 8.30 is used for clean areas.

Surveys For Contamination of Skin and Personal Clothing

~~Condition 32 of License SUA-1534 requires that all employees who do not shower prior to leaving the restricted area monitor themselves with an alpha survey instrument.~~ All personnel leaving the restricted area are required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields are required to monitor themselves prior to leaving the area. All personnel receive training in the performance of surveys for skin and personal contamination. Personnel are also allowed to conduct contamination monitoring of small, hand-carried items as long as all surfaces can be reached with the instrument probe and the item does not originate in yellowcake areas. All other items are surveyed as described in the next Section.

As recommended in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities" Revision 1, CBR conducts quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. A spot check of the employees assigned to the mine site is conducted, concentrating on plant operators and maintenance personnel. The purpose of the surveys is to ensure that employees are adequately surveying and decontaminating themselves prior to exiting the restricted areas.

Surveys of Equipment Prior to Release to an Unrestricted Area

instructions contained in Standard Operating Procedure C-14, "Equipment Release and Disposal."

- Personnel monitoring will be performed in accordance with the instructions contained in Standard Operating Procedure C-17, "Entering and Leaving Restricted Areas."

5.7.7. AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Program Description and Historical Monitoring Results

The airborne effluent and environmental monitoring programs are designed to monitor the release of airborne radioactive effluents from the Crow Butte Uranium Project facilities. To evaluate the effectiveness of the effluent control systems, the results of the monitoring program are compared with the background levels and with regulatory limits. Table 5.7-6 provides the sampling locations, types, frequency, methods and parameters for the Crow Butte Uranium Project facilities. CBR performs environmental sampling and gamma exposure monitoring as indicated in Table 5.7-6.

Radon

The radon gas effluent released to the environment is monitored at seven locations (AM-1 through AM-6 and AM-8). Monitoring is performed using Track-Etch radon cups provided by Landauer Corporation. The cups are exchanged on a quarterly basis. CBR received approval from the NRC and has changed the sampling frequency for environmental radon to semiannually effective March 1998. Standard Operating Procedure ~~C-2, "Radon Sampling and Analysis"~~E-10, "Environmental Radon Sampling and Gamma Exposure Rate Measurement" currently provides the instructions for radon gas monitoring. In addition to the manufacturer's Quality Assurance program, CBR exposes two duplicate radon Track Etch cups per each monitoring period at locations AB-3 and AB-6. Table 5.7-7 contains the results of radon monitoring for the Crow Butte Uranium Project facility since 1991.

In addition to the environmental monitoring performed at the Crow Butte Uranium Project, release of radon from process operations is estimated and reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1534 Condition Number ~~40~~12.1. Table 5.7-8 contains annual calculated radon releases from the Crow Butte Uranium Project Facility since 1991.

Air Particulate

CBR performs low volume air particulate sampling at the seven environmental monitoring stations for a minimum of two weeks per month during dryer operations. Filters are collected ~~for two weeks~~ and then composited for analysis on a quarterly basis. The results of air particulate sampling performed since 1991 are shown in Table 5.7-9.

Surface Soil

Surface soil has been sampled as described in Table 5.7-6. Surface soil samples will be taken at the air monitoring locations following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Subsurface Soil

Subsurface soil has been sampled at the plant as described in Table 5.7-6. Subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Vegetation

Vegetation samples from Crow Butte Uranium Project were collected on an annual basis in animal grazing areas in the direction of the prevailing wind as described in Table 5.7-6. Sampling was normally performed during the summer months. The samples were collected using the following procedures:

- A minimum of one pound of vegetation was composited on three occasions during the grazing season. The materials collected were primarily the seed/flower head and leafy portions of grasses and forbes along with young shoots of shrubs. Vegetation was analyzed for natural uranium, radium-226, thorium-230, lead-210 and polonium-210. The results of annual vegetation sampling at the Crow Butte Uranium Project facility are presented in Table 5.7-10.

Table 5.7-6: Operational Environmental and Effluent Monitoring Program

Sample Type	Location	Type	Number	Frequency	Analyses
Air (Radon)	Nearest residences and in the prevalent wind direction	Continuous	6	Semiannually	Rn-222
	Environmental control station near Crawford, NE.		1		
Air (particulate)	Same locations as radon air monitoring	Continuous	7	A minimum of 2 weeks per month when dryer is in use	U-nat Ra-226 Pb-210
Surface Soil (top 5 cm)	Plant site before topsoil removal	Grab	2	Once	U-nat Ra-226
	Plant site after topsoil removal	Grab	2	Once	U-nat Ra-226
	Evaporation ponds before excavation	Grab	2	Once	U-nat Ra-226
	Air sampling stations	Grab	7	Once	U-nat Ra-226
Subsurface soil	Plant site	1/3 meter composites to one meter	1	Once	U-nat Ra-226
Groundwater	Water supply wells within 1 km of area wellfield	Grab	1	Quarterly	U-nat Ra-226

5.7.8. GROUNDWATER/SURFACE WATER MONITORING PROGRAM

Program Description

During operations at the Crow Butte Uranium Project facilities, a detailed water-sampling program is conducted to identify any potential impacts to water resources of the area. CBRs operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis. An overview of the groundwater and surface water monitoring programs at the Crow Butte Uranium Project can be found in Table 5.7-6.

5.7.8.1. GROUNDWATER MONITORING

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

All private wells and surface waters within one kilometer of the wellfield area boundary are sampled on a quarterly basis. Surface water samples are taken in accordance with the instructions contained in Standard Operating Procedure ~~E-6, "Surface Water Sampling."~~E-5, "Routine Groundwater Monitoring." Samples are analyzed for natural uranium and radium-226. The results of this sampling since 1991 for uranium are shown in Table 5.7-13 and for radium in Table 5.7-14.

Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed approximately 300 feet from the wellfield boundary. After completion, wells are washed out and developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appear stable and consistent with the anticipated quality of the area. After development, wells are sampled to obtain baseline water quality. For baseline sampling, ~~a minimum of one casing displacement is evacuated prior to sample collections~~all wells are purged until field parameters are stable. Quarterly monitor well results are shown for uranium in Table 5.7-15 and for radium in Table 5.7-16. All monitor wells including ore zone and overlying monitor wells are sampled three times at least 14 days apart. The first, second and third samples are analyzed for the excursion indicator parameters (sodium, chloride, sulfate, conductivity, and alkalinity). CBR analyzes one sample for the baseline parameters shown in Table 5.7-17.

Results from the samples are averaged arithmetically to obtain a baseline value as well as an average value for determine upper control limits for excursion detection.

Upper Control Limits and Excursion Monitoring

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

Operational monitoring consists of sampling the monitor wells no more than 14 days apart and analyzing the samples for the excursion indicators chloride, conductivity, sodium, sulfate and total alkalinity. In special circumstances including inclement weather, wellhead mechanical failure, conditions which place an employee at risk while sampling, and conditions which could cause damage to the environment if sampling was performed, the sampling could be delayed by a period not to exceed 5 days. The circumstances requiring postponement of the sampling will be documented.

Excursion Verification and Corrective Action

During routine sampling, if two of the five UCL values are exceeded in a monitor well, or if one UCL value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample is taken within 48.

5.7.8.2. SURFACE WATER MONITORING

The pre-operational water quality-monitoring program assessed water quality and quantity for Squaw Creek. CBR samples two surface water locations for Squaw Creek. The CBR SERP approved mine Unit 6 on March 6, 1998. This expansion required that the downstream Squaw Creek monitoring location be relocated The new sample point was designated as S-5. Sampling at the previous downstream location, S-3 was discontinued.

With the approval of Mine Unit 6, operational surface water sampling was also begun at the English Creek upstream and downstream locations. The upstream sample is a composite of the springs that are the sources of English Creek and were identified as E-1 and E-2 during the preoperational monitoring program. Preoperational monitoring location E-3 was not used for downstream monitoring since its location is well beyond the Mine Unit 6 wellfield. Instead, a new downstream location designated E-4 was chosen immediately outside the Mine Unit boundary and sampling was begun. Additionally, the expansion to Mine Unit ~~6~~8 will require sampling of the impoundment identified as I-3 in the preoperational monitoring program when it is located within the wellfield. Samples from all locations are obtained quarterly. Surface water samples are analyzed for the parameters given in Table 5.7-6. Surface monitoring results are submitted in the semi-annual activity and monitoring reports submitted to NRC. A summary table of regional surface water monitoring results can be found in Table 5.7-13 and Table 5.7-14.

5.7.8.3. EVAPORATION POND LEAK DETECTION MONITORING

The evaporation ponds are lined and equipped with a leak detection system. During operations, the leak detection standpipes are checked for evidence of leakage. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard are also performed during normal operations. A minimum freeboard of 5 feet is allowed for the commercial ponds during normal operations. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, it is analyzed for specific conductivity. Should the analyses indicate that the liner is leaking (by comparison to chemical analyses of pond water), the following actions are taken:

- The USNRC Project Manager is notified by telephone within 48 hours of leak verification
- The level of the leaking pond is lowered by transferring its contents into an adjacent pond. While lowering the water level in the pond, inspections of the liner are made to determine the cause and location

The Standard Operating Procedures developed by CBR are a critical step to insuring that quality assurance objectives are met. Current SOPs exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.
7. Laboratory procedures.

5.7.10. MONITORING PROGRAM SUMMARY

Section 5.7 of this renewal application has reviewed the radiological monitoring data produced at Crow Butte Uranium Project for the years of 1990 through 1994. Each Section has discussed the historical results of the data with an emphasis on regulatory compliance and trend analysis to determine whether CBRs ALARA goals are being met. Where the data indicated that some adjustments in the monitoring program were indicated, CBR has noted those changes in the "Proposed Program" portion of each Section. In order to aid the reviewer in comparing the elements of the current monitoring program with those of the proposed program, Table 5.7-18 provides a tabular summary of both programs as well as the regulatory guidance provided in USNRC Regulatory Guide 8.30, "Health Physics Surveys In Uranium ~~Mills~~Recovery Facilities", Revision 1.

mobilized. As the plant is operated in the pH range of 6.5 to 9.0, mobilization of the organics and coloring of the leach solution is avoided.

6.1.3 RESTORATION GOALS

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to baseline values on a mine unit average. The secondary goal is to return the groundwater to a quality consistent with premining use or uses. The restoration values set by the Nebraska Department of Environmental Quality (NDEQ) in the UIC Permit are these secondary goals. Restoration values~~, secondary goal,~~ for each mine unit have been specified by the NDEQ for groundwater restoration efforts. Prior to mining in each mine unit, baseline groundwater quality is determined. This data is established in each mine unit at the minimum density of one production or injection well per four acres.

The baseline data support establishment of the upper control limits and restoration standards for each mine unit. The upper control limits and restoration standards for each Mine Unit, beginning with Mine Unit 6, are determined by the Safety and Environmental Review Panel (SERP) during the approval process for the new Mine Unit. The NDEQ restoration values are established as the average plus two standard deviations for any parameter that exceeds the applicable drinking water standard. If a drinking water standard exists for a parameter, and baseline is below that standard, the drinking water standard is used to establish the restoration value. If there is no drinking water standard for an element, for example vanadium, the restoration value will be based on best practicable technology. The restoration value for the major cations (Ca, Mg, K, Na) should allow for the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criteria should allow for the total carbonate to be less than 50% of the TDS. The TDS restoration value is set at the average plus one standard deviation.

Mine unit averages and secondary goals for Mine Units 1 through 5 are given in Tables 6.1-1 through 6.1-5. These restoration values were approved by NRC based on submittals before operation of the Mine Unit. The mine unit average and NDEQ restoration values for Mine Unit 6 are given in Table 6.1-6. The CBR SERP determined these restoration values on March 4, 1998. The mine unit average and NDEQ restoration values for Mine Unit 7 are given in Table 6.1-7. The CBR SERP determined these restoration values on July 9, 1999. The mine unit average and NDEQ restoration values for Mine Unit 8 are given in Table 6.1-8. The CBR SERP determined these restoration values on July 10, 2002. NDEQ Permit Number NE0122611 requires that a Mine Unit be returned to a wellfield average of these restoration values. These concentrations were approved by the NDEQ with the Notice of Intent to Operate submittals. Post mining water quality for Mine Unit 1 can be found in Table 6.1-8.

Crow Butte Resources operated a R&D Pilot Facility starting in July 1986 and initiated restoration activities of its Wellfield No. 2 in February 1987. Wellfield No. 1 was incorporated into Mine Unit 1, thus no restoration took place in that area. The techniques used during that program are the basis for the commercial restoration program outlined in this section. Crow Butte Resources will utilize ion exchange columns, a reverse osmosis unit and reductant addition equipment similar to those used in the R&D restoration during commercial restoration operations.

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

- Groundwater transfer;
- Groundwater sweep;
- Groundwater treatment; and
- Wellfield recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

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 phase, Crow Butte Resources will make a request to the appropriate regulatory agencies that the wellfield is restored.

Table 6.1-1: Baseline and Restoration Values for Mine Unit 1

Parameter	Groundwater Standard	MU-1 Baseline ~~(Primary Goal)~~	MU-1 Standard Deviation	MU-1 NDEQ Restoration Value ~~(Secondary Goal)~~
Ammonium (mg/l)	10 0	<0.372		10.0
Arsenic (mg/l)	0.05	<0.00214		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0 01	<0 00644		0.005[1]
Chloride (mg/l)	250.0	203.9	38	250.0
Copper (mg/l)	1.0	<0 017		1.0
Fluoride (mg/l)	4.0	0.686	0.04	4.0
Iron (mg/l)	0.3	<0.0441		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.011		0.05
Molybdenum (mg/l)	1.0	<0.0689		1.0
Nickel (mg/l)	0.15	<0 0340		0.15
Nitrate (mg/l)	10 0	<0.050		10.0
Lead (mg/l)	0.05	0 0315		0.05
Radium (pCi/L)	5.0	229.7	177.1	584.0
Selenium (mg/l)	0.01	<0 00323		0.05
Sodium (mg/l)	N/A	412	19 2	4120
Sulfate (mg/l)	250.0	356.2	9 4	375
Uranium (mg/l)	5.0	0 0922	0.089	5.0
Vanadium (mg/l)	0.2	<0 0663		0 2
Zinc (mg/l)	5.0	<0 036		5.0
pH (Std. Units)	6 5 - 8.5	8 46	0 2	6.5 – 8.5
Calcium (mg/l)	N/A	12.5	3.2	125.0
Total Carbonate (mg/l)	N/A	351	31.1	585
Potassium (mg/l)	N/A	12.5	1.5	125.0
Magnesium (mg/l)	N/A	3.2	0.8	32.0
TDS (mg/l)	N/A	1170.2	47.6	1170.2

[1] Standard for Cadmium lowered in modification to UIC permit dated March 9, 2001 following NDEQ approval of Mine Unit 1 restoration

Table 6.1-2: Baseline and Restoration Values for Mine Unit 2

Parameter	Groundwater Standard	MU-2 Baseline ~~(Primary Goal)~~	MU-2 Standard Deviation	MU-2 NDEQ Restoration Value ~~(Secondary Goal)~~
Ammonium (mg/l)	10.0	0.37	0 07	10.0
Arsenic (mg/l)	0.05	<0.001		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	~~0.010~~ 0.005	<0.007		0.005
Chloride (mg/l)	250.0	208.6	30.8	250.0
Copper (mg/l)	1.0	<0.013		1.0
Fluoride (mg/l)	4.0	0.67	0.04	4.0
Iron (mg/l)	0.3	<0.045		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.01		0.05
Molybdenum (mg/l)	1.0	<0.073		1.0
Nickel (mg/l)	0.15	<0.037		0.15
Nitrate (mg/l)	10.0	<0.039		10.0
Lead (mg/l)	0 05	<0.035		0.05
Radium (pCi/L)	5 0	234.5	411.8	1058.0
Selenium (mg/l)	~~0 010~~ 0.05	<0.001		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		0.2
Zinc (mg/l)	5 0	<0 026		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

Table 6.1-3: Baseline and Restoration Values for Mine Unit 3

Parameter	Groundwater Standard	MU-3 Baseline ~~(Primary Goal)~~	MU-3 Standard Deviation	MU-3 NDEQ Restoration Value ~~(Secondary Goal)~~
Ammonium (mg/l)	10.0	<0.329		10.0
Arsenic (mg/l)	0.05	<0.001		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0 005~~0 01~~	<0.01		0.005
Chloride (mg/l)	250 0	197.6	16.7	250.0
Copper (mg/l)	1.0	<0.0108		1.0
Fluoride (mg/l)	4.0	0.719	0.05	4.0
Iron (mg/l)	0.3	<0.05		0.3
Mercury (mg/l)	0 002	<0.001		0.002
Manganese (mg/l)	0 05	<0.01		0.05
Molybdenum (mg/l)	1.0	<0.1		1.0
Nickel (mg/l)	0.15	<0.05		0.15
Nitrate (mg/l)	10.0	<0.0728		10.0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5 0	165	222.5	611.0
Selenium (mg/l)	0 05~~0 01~~	<0.00115		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		0.2
Zinc (mg/l)	5.0	<0.0131		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

Table 6.1-4: Baseline and Restoration Values for Mine Unit 4

Parameter	Groundwater Standard	MU-4 Baseline ~~(Primary Goal)~~	MU-4 Standard Deviation	MU-4 NDEQ Restoration Value ~~(Secondary Goal)~~
Ammonium (mg/l)	10 0	0 288	0 08	10.0
Arsenic (mg/l)	0.05	<0.00209		0.05
Barium (mg/l)	1 0	<0.1		1.0
Cadmium (mg/l)	0 005~~0 01~~	<0.01		0 005
Chloride (mg/l)	250.0	217.5	34.9	250.0
Copper (mg/l)	1.0	<0.0114		1.0
Fluoride (mg/l)	4 0	0.745	0.05	4.0
Iron (mg/l)	0.3	<0.0504		0.3
Mercury (mg/l)	0 002	<0.001		0.002
Manganese (mg/l)	0.05	<0 01		0.05
Molybdenum (mg/l)	1.0	<0.1		1.0
Nickel (mg/l)	0 15	<0 05		0.15
Nitrate (mg/l)	10.0	<0.114		10.0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5.0	154.3	171.5	496.0
Selenium (mg/l)	0 05~~0 01~~	<0.00244		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		5.0
Vanadium (mg/l)	0.2	<0.0984		0 2
Zinc (mg/l)	5.0	<0.0143		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

Table 6.1-5: Baseline and Restoration Values for Mine Unit 5

Parameter	Groundwater Standard	MU-5 Baseline ~~(Primary Goal)~~	MU-5 Standard Deviation	MU-5 NDEQ Restoration Value ~~(Secondary Goal)~~
Ammonium (mg/l)	10 0	0 28	0 05	10 0
Arsenic (mg/l)	0 05	<0.001		0 05
Barium (mg/l)	1.0	<0.10		1.0
Cadmium (mg/l)	0 005~~0 01~~	<0.01		0 005
Chloride (mg/l)	250.0	191.9	7.9	250.0
Copper (mg/l)	1.0	<0 01		1.0
Fluoride (mg/l)	4.0	0.64	0.07	4.0
Iron (mg/l)	0.3	<0.05		0.3
Mercury (mg/l)	0.002	<0.001		0 002
Manganese (mg/l)	0.05	<0.01		0 05
Molybdenum (mg/l)	1.0	<0.10		1.0
Nickel (mg/l)	0 15	<0 05		0.15
Nitrate (mg/l)	10.0	<0.1		10.0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5 0	166 0	184.6	535.0
Selenium (mg/l)	0 05~~0 01~~	<0 002		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		0.2
Zinc (mg/l)	5 0	<0.02		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

Table 6.1-6: Baseline and Restoration Values for Mine Unit 6

Parameter	Groundwater Standard	MU-6 Baseline	MU-6 Standard Deviation	MU-6 NDEQ Restoration Value
Ammonium (mg/l)	10.0	0.32	0.05	10.0
Arsenic (mg/l)	0.05	0.002		0.05
Barium (mg/l)	1.0	0.100		1.0
Cadmium (mg/l)	0 005~~0.01~~	0.009		0 005
Chloride (mg/l)	250.0	206	15.4	250 0
Copper (mg/l)	1.0	0.012		1.0
Fluoride (mg/l)	4.0	0 65	0.03	4.0
Iron (mg/l)	0.3	0 050		0 3
Mercury (mg/l)	0.002	0.001		0.002
Manganese (mg/l)	0.05	0 010		0.05
Molybdenum (mg/l)	1.0	0 102		1.0
Nickel (mg/l)	0.15	0 050		0.15
Nitrate (mg/l)	10.0	0.1		10.0
Lead (mg/l)	0.05	0.050		0 05
Radium (pCi/L)	5.0	80.6	121.9	325
Selenium (mg/l)	0.05~~0.01~~	0 001		0.05
Sodium (mg/l)	N/A	400	12.8	4000
Sulfate (mg/l)	250.0	361	14.6	390
Uranium (mg/l)	5 0	0.133	0.212	5.0
Vanadium (mg/l)	0 2	0.098		0 2
Zinc (mg/l)	5 0	0.011		5 0
pH (Std. Units)	6 5 - 8.5	8 6	0.2	6.5 – 9 0
Calcium (mg/l)	N/A	12.8	2.3	128
Total Carbonate (mg/l)	N/A	367.1	22.9	596
Potassium (mg/l)	N/A	11.9	1.7	119
Magnesium (mg/l)	N/A	3.2	0 7	32
TDS (mg/l)	N/A	1192	28.1	1220

Table 6.1-7: Baseline and Restoration Values for Mine Unit 7

Parameter	Groundwater Standard	MU-7 Baseline	MU-7 Standard Deviation	MU-7 NDEQ Restoration Value
Ammonium (mg/l)	10.0	0.42	0.08	10.0
Arsenic (mg/l)	0.05	0 001		0.05
Barium (mg/l)	1.0	0.10		1.0
Cadmium (mg/l)	0 005~~0.01~~	0.007		0.005
Chloride (mg/l)	250.0	198	22 6	250.0
Copper (mg/l)	1.0	0.01		1.0
Fluoride (mg/l)	4.0	0.70	0.05	4.0
Iron (mg/l)	0.30	0.05		0.30
Mercury (mg/l)	0.002	0.001		0.002
Manganese (mg/l)	0.05	0.01		0.05
Molybdenum (mg/l)	1.00	0.10		1.00
Nickel (mg/l)	0.15	0.05		0.15
Nitrate (mg/l)	10.0	0 1		10 0
Lead (mg/l)	0.05	0 05		0.05
Radium (pCi/L)	5 0	142	148.0	438
Selenium (mg/l)	0 05~~0 01~~	0.004		0.05
Sodium (mg/l)	N/A	387	21.6	3,870
Sulfate (mg/l)	250.0	346	20.1	386
Uranium (mg/l)	5.0	0.110	0.138	5.0
Vanadium (mg/l)	0.2	0.10		0.2
Zinc (mg/l)	5.0	0.01		5.0
pH (Std. Units)	6.5 - 8 5	8 6	0.3	6.5 – 9.2
Calcium (mg/l)	N/A	12.2	2.6	122
Total Carbonate (mg/l)	N/A	356		588
Potassium (mg/l)	N/A	12.9	3.0	129
Magnesium (mg/l)	N/A	3.2	0.7	32
TDS (mg/l)	N/A	1,176	40.7	1,217

Table 6.1-8: Baseline and Restoration Values for Mine Unit 8

Parameter	Groundwater Standard	MU-8 Baseline	MU-8 Standard Deviation	MU-8 NDEQ Restoration Value
Ammonium (mg/l)	10 0	0 682	0 222	10.0
Arsenic (mg/l)	0 05	0.002	0 001	0.05
Barium (mg/l)	1.0	0 099	0 005	1.0
Cadmium (mg/l)	0 005	0 005		0 005
Chloride (mg/l)	250	196	53.8	250
Copper (mg/l)	1.0	0 01		1 0
Fluoride (mg/l)	4 0	0.638	0 048	4 0
Iron (mg/l)	0 30	0.135	0 086	0 30
Mercury (mg/l)	0 002	0 001		0 002
Manganese (mg/l)	0 05	0 01		0 05
Molybdenum (mg/l)	1 0	0 093	0.023	1 00
Nickel (mg/l)	0 15	0 049	0 003	0.15
Nitrate (mg/l)	10 0	0.2		10 0
Lead (mg/l)	0 05	0 049	0 003	0 05
Radium (pCi/L)	5 0	124 4	151.8	428
Selenium (mg/l)	0 05	0.004		0 05
Sodium (mg/l)	N/A	416.8	41.8	4,168
Sulfate (mg/l)	250	312	33	378
Uranium (mg/l)	5 0	0 188	0 140	5 0
Vanadium (mg/l)	0 2	0 127	0 122	0 2
Zinc (mg/l)	5 0	0 013	0 008	5 0
pH (Std Units)	6 5 - 8 5	8 67	0 37	6 5 – 9 41
Calcium (mg/l)	N/A	12 3	3 5	123
Total Carbonate (mg/l)	N/A	377	15 6	569
Potassium (mg/l)	N/A	11.8	3 2	117.8
Magnesium (mg/l)	N/A	2 7	0.92	27.1
TDS (mg/l)	N/A	1,137	97 4	1,234

6.1.4 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. Crow Butte Resources will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional techniques are necessary.

6.1.4.1 GROUNDWATER TRANSFER

Prior to commencing restoration activities, the regulatory agencies will be notified that mining has ceased in a given mine unit and Crow Butte Resources will proceed to establish post mining water quality data for all of the required parameters listed in Table 6.1-1 through ~~6.1-7~~6.1-8.

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

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

The advantage of using the groundwater transfer technique is that it reduces the amount of water that must be ultimately be sent to the waste disposal system during restoration activities.

6.1.4.2 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 that 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

6.1.6 REPORTING

During the restoration process, Crow Butte Resources will perform daily, weekly, and monthly analysis as needed to track restoration progress. These analyses will be provided to NDEQ in Monthly Restoration Reports and the USNRC in the Semiannual Radiological Effluent and Environmental Monitoring Report. This information will also be included in the final restoration report.

Upon completion of restoration activities and prior to stabilization, all designated restoration wells in the mine unit will be sampled for the required constituents listed in Tables 6.1-1 through ~~6.1-7~~6.1-8. These samples may be split with NDEQ if required. Assay results will be submitted to NDEQ and USNRC as required. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the regulatory agencies, Crow Butte Resources will notify the regulatory agencies it is commencing the stabilization phase of restoration.

During stabilization all designated restoration wells will be sampled monthly for the required constituents listed in Table 6.1-1 through ~~6.1-7~~6.1-8. At the end of a six month stabilization period Crow Butte Resources will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. At that time, Crow Butte Resources would request that the mine unit be declared restored.

and opportunity to split soil samples. After approval of the soil contamination removal program, revegetation will commence.

The objective of site soil surveys during decommissioning will be to identify and remove to a licensed disposal facility any earthen materials which exceed EPA 40 CFR Part 192.32 standards or other applicable standards at the time of decommissioning. These standards presently require that radium concentrations in surface soils, averaged over areas of 100 square meters, do not exceed background levels by more than 5 pCi/g averaged over the first 15 cm below the surface and 15 pCi/g averaged over any 15 cm thick layer more than 15 cm below the surface.

Three general types of site soil surveys will be conducted on the site during decommissioning:

- Areas of potential surface contamination will be identified using a gross gamma survey on an adequately spaced grid.
- Spot-checks of areas around the site of potentially contaminated areas.
- The final soil background survey on areas which have been prepared for surface reclamation using a grid spacing adequate for confirming clean up to applicable standards.

Contaminated soils that are removed from site surfaces will be transported to a licensed disposal site. The primary areas for potential soil contamination include well field surfaces, evaporation pond bottoms and berms, process building areas, storage yards and transportation routes over which product or contaminants have been moved.

6.2.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will document decommissioning processes and ensure that occupational radiation exposure levels are kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee by way of specialized training, will be on site during any decommissioning activities where a potential radiation exposure hazard exists.

Health physics survey conducted during decommissioning will be guided by applicable sections of 10 CFR 20 and USNRC Regulatory Guide No 8.30 entitled "*Health Physics Surveys in Uranium ~~Mills~~Recovery Facilities*", Revision 1 or other applicable standards at the time.

6.3.3 CONTOURING OF AFFECTED AREAS

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

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

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

6.4 BONDING ASSESSMENT

6.4.1 BOND CALCULATIONS

Cost estimates for the purpose of bond calculations were made for the Crow Butte Project site. The cost assessment includes groundwater restoration, decontamination and decommissioning and surface reclamation costs for all areas to be affected by the installation and operation of the proposed mine plan. The detailed calculation utilized in determining the bonding requirements for the Crow Butte Project ~~are enclosed on Attachment 6-1~~is submitted annually to the NDEQ and the NRC and are maintained on file at the project office.

6.4.2 FINAL SURETY ARRANGEMENTS

Crow Butte Resources maintains a NRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation activities. Crow Butte maintains an Irrevocable Letter of Credit No. ~~745040~~748/S17668 issued by ~~First Bank N.A.~~the Royal Bank of Canada during ~~1995~~2002 in favor of the State of Nebraska in the present amount of $~~5,543,958~~12,355,260.

~~ATTACHMENT 6.1~~

CROW BUTTE RESOURCES, INC.

License Renewal Application

Affected Pages (replacement pages)

2002 SERP Actions

5. OPERATIONS

Crow Butte Resources, Inc. (CBR) operates a commercial scale in-situ leach uranium mine (the Crow Butte Uranium Project) near Crawford, Nebraska. CBR maintains a headquarters in Denver, Colorado where site-licensing actions originate. All CBR operations, including the Crow Butte Uranium Project operations, are conducted in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to both ensure compliance and further implement CBRs policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1. CORPORATE ORGANIZATION/ADMINISTRATIVE PROCEDURES

The CBR organizational chart as it pertains to the responsibility for radiation safety and environmental protection at the Crow Butte Uranium Project facility is given as Figure 5.1-1. The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, radiation safety programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. Specific responsibilities of the organization are provided below.

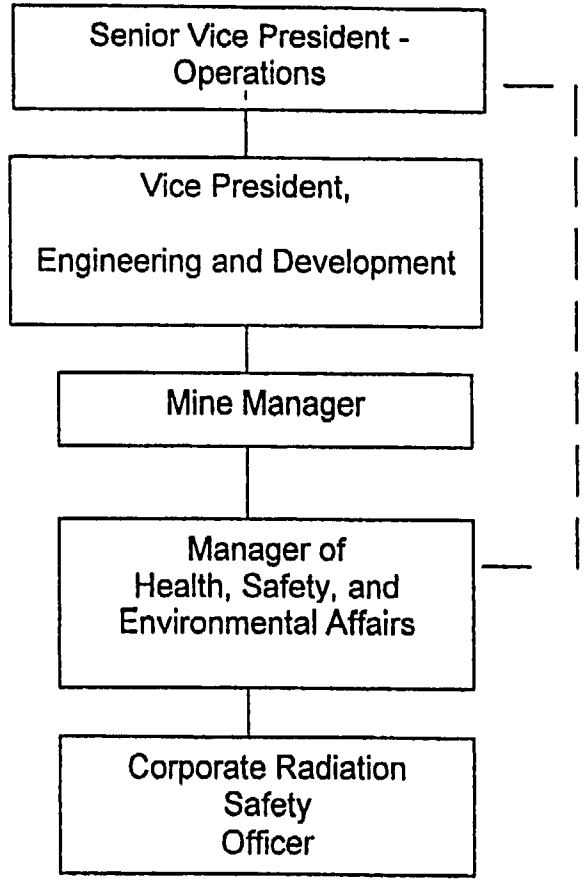
5.1.1. SENIOR VICE PRESIDENT - OPERATIONS

The overall responsibility for the radiation, environmental, and safety activities of the Crow Butte Facility rests with the Senior Vice President - Operations of CBR. The Senior Vice President - Operations is also responsible for license development and license modifications. The Vice President, Engineering and Development will, in the absence or disability of the Senior Vice President - Operations, perform the duties of the Senior Vice President - Operations.

5.1.2. VICE PRESIDENT, ENGINEERING AND DEVELOPMENT

The Vice President, Engineering and Development is responsible for all Crow Butte commercial production facilities, reporting directly to the Senior Vice President-Operations.

Figure 5.1-1: Crow Butte Resources Organizational Chart



5.1.3. MINE MANAGER

The Mine Manager is responsible for all uranium production activity at the project site. The Mine Manager is also responsible for implementing any safety and/or monitoring programs associated with operations, including yellowcake-handling procedures. The Mine Manager is authorized to immediately implement any action to correct or prevent radiation safety hazards. The Mine Manager reports directly to the Vice President, Engineering and Development.

5.1.4. MANAGER OF HEALTH, SAFETY, AND ENVIRONMENTAL AFFAIRS

The Manager of Health, Safety, and Environmental Affairs is responsible for ensuring that CBR complies with all applicable regulatory requirements including those involving environmental protection and radiation safety. The Manager of Health, Safety, and Environmental Affairs reports directly to the Mine Manager and supervises the CRSO to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. The Manager of Health, Safety, and Environmental Affairs has no production-related responsibilities. The Manager of Health, Safety, and Environmental Affairs also has the responsibility to advise the Senior Vice President - Operations on matters involving radiation safety and to implement changes and/or corrective actions involving radiation safety authorized by the Senior Vice President - Operations.

5.1.5. CORPORATE RADIATION SAFETY OFFICER

The CRSO is responsible for the development, administration and enforcement of all radiation safety programs. The CRSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The CRSO is responsible for the implementation of all on-site environmental programs, including emergency procedures. The CRSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The CRSO works closely with all supervisory personnel to insure that established programs are maintained. The CRSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The CRSO makes recommendations to improve any and all radiological safety related controls. The CRSO has no production-related responsibilities. The CRSO will report to the Manager of Health, Safety, and Environmental Affairs

Weekly

The CRSO and the Plant Manager or their qualified designees conduct a weekly inspection of the plant to observe general radiation safety practices and to review required changes in equipment and procedures. The results of these weekly inspections are documented.

Monthly

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

Quarterly

Quarterly inspections are performed of the evaporation ponds in accordance with the guidance contained in USNRC Regulatory Guide 3.11.1, "Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings".

Annually

On an annual basis, an audit of the radiation protection and ALARA program is conducted in accordance with USNRC Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable", Revision 1. A written report of the results is submitted to corporate management. The auditor may be the Manager of Health, Safety, and Environmental Affairs or an outside radiation safety auditor as identified in Figure 5.1-1 and discussed in Section 5.1-8. The CRSO may accompany the auditor, but may not participate in the conclusions.

The annual ALARA audit report summarizes the following data:

1. Employee exposure records
2. Bioassay results
3. Inspection log entries and summary reports of daily mine and process inspections
4. Documented training program activities

5.5. TRAINING

All site employees, and contracted personnel when present, at the Crow Butte Uranium Project are administered a training program based upon the CBR Radiation Safety Training Plan covering radioactive material handling and radiological emergency procedures. This training program is administered in keeping with standard radiological protection guidelines. The technical content of the training program is under the direction of the CRSO. The CRSO or a qualified designee conducts training.

5.5.1. TRAINING PROGRAM CONTENT

Visitors

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

Contractors

Any contractors having work assignments at the facility are given appropriate training and safety instruction. Contract workers who will be performing work on heavily contaminated equipment receive the same training normally required of permanent workers.

Permanent Employees

The CBR Radiation Safety Training Program incorporates the following topics discussed in USNRC Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable", Revision 1:

Fundamentals of health protection

- The radiological and toxic hazards of exposure to uranium and its daughters.
- How uranium and its daughters enter the body (inhalation, ingestion, and skin penetration.
- Why exposures to uranium and its daughters should be kept as low as reasonably achievable (ALARA).

- Review of past incidents of spills.
- Coordination of all departments in carrying out goals of containing potential spills.
- Establishment of employee emergency response training programs.
- Responsibility for program implementation and subsequent review and updating.
- Review of new construction and process changes relative to spill prevention and control.

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

Engineering and administrative controls are in place to prevent both surface and subsurface releases to the environment and to mitigate the effects should a release occur.

- **Surface Releases** - The most common form of surface release from in-situ mining operations occurs from breaks, leaks, or separations within the piping that transfers mining fluids between the process plant and the wellfield. These are generally classified as small releases.

  In general, piping from the plant to and within the wellfield is constructed of PVC, high-density polyethylene pipe with butt-welded joints or equivalent. All pipelines are pressure tested at operating pressures prior to operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines are protected from a major cause of potential failure - that of vehicles driving over the lines causing breaks. The only exposed pipes are at the process plant, the wellheads, at temporary transfer lines and in the control house in the wellfield. Trunkline flows and wellhead pressures are monitored each shift for process control. One section of underground piping that passes beneath Squaw Creek is double contained for additional protection.

- **Transportation accidents** - Standard Operating Procedure C-21 provides the CBR emergency action plan for responding to a transportation accident involving a yellowcake shipment. The SOP provides instructions for proper packaging, documentation, driver

emergency and accident response procedures, and cleanup and recovery actions. Spill response is specifically addressed in SOP C-19, *Radioactive Materials Spills.*

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

  At the Crow Butte Uranium Project site, an undetected excursion is highly unlikely. All wellfields are surrounded by a ring of monitor wells located no further than 300 feet from the wellfield and screened in the ore-bearing Chadron aquifer. Additionally, monitor wells are placed in the first overlying aquifer above each wellfield segment. Sampling of these wells is done on a biweekly basis. Past experience at in-situ leach mining facilities has shown that this monitoring system is effective in detecting leachate migration. The total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and over-production of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

  Migration of fluids to overlying aquifers has also been considered. Several controls are in place to prevent this. First, CBR has plugged all exploration holes to prevent co-mingling of Brule and Chadron aquifers and to isolate the mineralized zone. Successful plugging was tested by conducting two hydrologic tests prior to mining. Results indicated that no leakage or communication exists between the mineralized zone and overlying aquifers. In addition, prior to start of production a well integrity test is performed on all injection/recovery wells. This requirement of the Nebraska Underground Injection Control Regulations insures that all wells are constructed properly and capable of maintaining pressure without leakage. Lastly, monitor wells completed in the overlying aquifer are also sampled on a regular basis for the presence of leach solution.

  Seepage of solutions from the evaporation ponds into ground or surface water is also a potential pollution source. However, this has not been nor should it be a problem at the Crow Butte site. Construction and operational safeguards have been implemented to insure maximum competency of the synthetic liner and earthen embankments. The underdrain leak detection system allows sampling that would detect a leak. The pond soil foundation has a low ambient moisture due to its elevation, soil type and preparation, thus should the unlikely event

occur of pond fluids seeping into the compacted subsoil, the liquid would be quickly absorbed and would not migrate. Pond monitor wells are also located downstream of the evaporation ponds to detect leaks into the uppermost aquifer.

In addition to the spills described above, the accumulation of sediment or erosion of existing soils can lead to potential releases of pollutants. The likelihood of significant sediment or erosion problems is greatest during construction activities, which are completed at this time. Future construction activities could include additional wellfield development, or additional pond construction. During construction, there is a possibility that sediment load may increase in Squaw Creek. If rain, producing runoff, occurs during construction, a small amount of the fill may be carried into the creek. Significant precipitation during pond construction and plant facilities might also produce the same effect. Plant cover for erosion control will be established as soon as possible on exposed areas. Little additional suspendable material should be produced during mining operations and restoration activities. Site reclamation in the future with backfilling of ponds, grading the plant site, and replacing the topsoil will also expose unsecured soil for suspension in runoff waters. The increased sediment load as a result of precipitation during future construction or reclamation activities should not significantly effect the quality of Squaw Creek as the more sensitive areas of the stream are located upstream form the point of entry of the tributary.

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

Proposed Beta and Gamma Survey Program

CBR proposes to institute the same gamma exposure-monitoring program of worker occupied stations and areas likely to have significant gamma exposure rates at the Crow Butte Uranium Project that has been performed to date with the following changes.

- Gamma survey instruments will be calibrated annually or at the manufacturers recommended frequency, whichever is more frequent.

Gamma exposure rate surveys will be performed in accordance with the instructions currently contained in Standard Operating Procedure C-13, "Gamma Surveys". Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions.

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake will be performed as discussed in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities," Section 1.4. Beta evaluations may be substituted for surveys using radiation survey instruments. Surveys or evaluations will be performed whenever a change in equipment or procedures has occurred that may significantly affect worker exposures.

5.7.3. IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

5.7.3.1. IN-PLANT AIRBORNE URANIUM PARTICULATE MONITORING

Program Description

Airborne particulate levels at solution mines which ship slurry yellowcake product are normally very low since the product is wet. Yellowcake drying operations began in 1993. Monitoring for airborne uranium was performed routinely at Crow Butte Uranium Project through the use of area sampling and breathing zone sampling. The monitoring programs are described below.

Area Sampling

Area samples are collected monthly at the four specified sample locations in the plant. Additionally, samples are taken in the dryer room during dryer operations and for the issuance of an RWP. Area samples are taken in accordance with the instructions currently contained in SOP C-12, "Survey for Airborne Uranium". Samples are taken with a glass fiber filter and a regulated air sampler such as an Eberline RAS-1 or equivalent. Sample volume is adequate to achieve the lower limits of detection (LLD) for uranium in air. Samplers are calibrated every six months using a digital mass flowmeter or equivalent primary calibration standard.

Measurement of airborne uranium is performed by gross alpha counting of the air filters using an alpha scaler such as an Eberline MS-3 or equivalent. The Maximum Permissible Concentration (MPC) value for natural uranium of 1 E-10 μCi/ml from Appendix B to 10 CFR §§ 20.1 - 20.601 was applied to the gross alpha counting results. After implementation of the new 10 CFR 20 on January 1, 1994, the Derived Air Concentration (DAC) for soluble (D classification) natural uranium of 5 E-10 μCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 was used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230), which are alpha emitters. An action level of 25% of the MPC (DAC since 1994) for soluble natural uranium was established at the Crow Butte Uranium Project facilities. If an airborne uranium sample exceeded the MPC (DAC), an investigation was performed. The only area at the Crow Butte Uranium Project which has met the definition of an Airborne Radioactivity Area as contained in 10 CFR § 20.1003 is the dryer room during yellowcake packaging operations.

5.7.4.1. NATURAL URANIUM EXPOSURE

Exposure calculations for airborne natural uranium are carried out using the intake method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities", Revision 1, Section 2. The intake is calculated using the following equation:

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

where:

I_u	=	uranium intake, μg or μCi
t_i	=	time that the worker is exposed to concentrations X_i (hr)
X_i	=	average concentration of uranium in breathing zone, μg/m^3, μCi/m^3
b	=	breathing rate, 1.2 m^3/hr
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the week or quarter

The intake for uranium is calculated on Time Weighted Exposure (TWE) forms. The intakes are totaled and entered onto each employee's Occupational Exposure Record.

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

Time of Exposure Determination

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

5.7.4.2. RADON DAUGHTER EXPOSURE

Exposure calculations for airborne radon daughters are carried out using the intake method from USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities", Revision 1, Section 2. The radon daughter intake is calculated using the following equation:

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

where:

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

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

Time of Exposure Determination

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

accordance with the guidance contained in USNRC Regulatory Guide 8.22, "Bioassay in Uranium Mills, Revision 1" and with the instructions currently contained in Standard Operating Procedure C-10, "Bioassay Sampling."

5.7.6. CONTAMINATION CONTROL PROGRAM

CBRs contamination control program at Crow Butte Uranium Project consists of the following elements:

Surveys For Surface Contamination

CBR performs surveys for surface contamination in operating and clean areas of the Crow Butte Uranium Project facilities in accordance with the guidelines contained in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities", Revision 1. Surveys for alpha contamination in clean areas such as lunchrooms change rooms and offices are conducted weekly. An action level of 25% of the limits from USNRC Regulatory Guide 8.30 is used for clean areas.

Surveys For Contamination of Skin and Personal Clothing

All personnel leaving the restricted area are required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields are required to monitor themselves prior to leaving the area. All personnel receive training in the performance of surveys for skin and personal contamination. Personnel are also allowed to conduct contamination monitoring of small, hand-carried items as long as all surfaces can be reached with the instrument probe and the item does not originate in yellowcake areas. All other items are surveyed as described in the next Section.

As recommended in USNRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Recovery Facilities" Revision 1, CBR conducts quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. A spot check of the employees assigned to the mine site is conducted, concentrating on plant operators and maintenance personnel. The purpose of the surveys is to ensure that employees are adequately surveying and decontaminating themselves prior to exiting the restricted areas.

instructions contained in Standard Operating Procedure C-14, "Equipment Release and Disposal."

- Personnel monitoring will be performed in accordance with the instructions contained in Standard Operating Procedure C-17, "Entering and Leaving Restricted Areas."

5.7.7. AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Program Description and Historical Monitoring Results

The airborne effluent and environmental monitoring programs are designed to monitor the release of airborne radioactive effluents from the Crow Butte Uranium Project facilities. To evaluate the effectiveness of the effluent control systems, the results of the monitoring program are compared with the background levels and with regulatory limits. Table 5.7-6 provides the sampling locations, types, frequency, methods, and parameters for the Crow Butte Uranium Project facilities. CBR performs environmental sampling and gamma exposure monitoring as indicated in Table 5.7-6.

Radon

The radon gas effluent released to the environment is monitored at seven locations (AM-1 through AM-6 and AM-8). Monitoring is performed using Track-Etch radon cups provided by Landauer Corporation. The cups are exchanged on a quarterly basis. CBR received approval from the NRC and has changed the sampling frequency for environmental radon to semiannually effective March 1998. Standard Operating Procedure E-10, "Environmental Radon Sampling and Gamma Exposure Rate Measurement" currently provides the instructions for radon gas monitoring. In addition to the manufacturer's Quality Assurance program, CBR exposes two duplicate radon Track Etch cups per each monitoring period at locations AB-3 and AB-6. Table 5.7-7 contains the results of radon monitoring for the Crow Butte Uranium Project facility since 1991.

In addition to the environmental monitoring performed at the Crow Butte Uranium Project, release of radon from process operations is estimated and reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1534 Condition Number 12.1. Table 5.7-8 contains annual calculated radon releases from the Crow Butte Uranium Project Facility since 1991.

Air Particulate

CBR performs low volume air particulate sampling at the seven environmental monitoring stations for a minimum of two weeks per month during dryer operations. Filters are collected and then composited for analysis on a quarterly basis. The results of air particulate sampling performed since 1991 are shown in Table 5.7-9.

Surface Soil

Surface soil has been sampled as described in Table 5.7-6. Surface soil samples will be taken at the air monitoring locations following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Subsurface Soil

Subsurface soil has been sampled at the plant as described in Table 5.7-6. Subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Vegetation

Vegetation samples from Crow Butte Uranium Project were collected on an annual basis in animal grazing areas in the direction of the prevailing wind as described in Table 5.7-6. Sampling was normally performed during the summer months. The samples were collected using the following procedures:

- A minimum of one pound of vegetation was composited on three occasions during the grazing season. The materials collected were primarily the seed/flower head and leafy portions of grasses and forbes along with young shoots of shrubs. Vegetation was analyzed for natural uranium, radium-226, thorium-230, lead-210 and polonium-210. The results of annual vegetation sampling at the Crow Butte Uranium Project facility are presented in Table 5.7-10.

Table 5.7-6: Operational Environmental and Effluent Monitoring Program

Sample Type	Location	Type	Number	Frequency	Analyses
Air (Radon)	Nearest residences and in the prevalent wind direction	Continuous	6	Semiannually	Rn-222
	Environmental control station near Crawford, NE.		1		
Air (particulate)	Same locations as radon air monitoring	Continuous	7	A minimum of 2 weeks per month when dryer is in use	U-nat Ra-226 Pb-210
Surface Soil (top 5 cm)	Plant site before topsoil removal	Grab	2	Once	U-nat Ra-226
	Plant site after topsoil removal	Grab	2	Once	U-nat Ra-226
	Evaporation ponds before excavation	Grab	2	Once	U-nat Ra-226
	Air sampling stations	Grab	7	Once	U-nat Ra-226
Subsurface soil	Plant site	1/3 meter composites to one meter	1	Once	U-nat Ra-226
Groundwater	Water supply wells within 1 km of area wellfield	Grab	1	Quarterly	U-nat Ra-226

5.7.8. GROUNDWATER/SURFACE WATER MONITORING PROGRAM

Program Description

During operations at the Crow Butte Uranium Project facilities, a detailed water-sampling program is conducted to identify any potential impacts to water resources of the area. CBRs operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis. An overview of the groundwater and surface water monitoring programs at the Crow Butte Uranium Project can be found in Table 5.7-6.

5.7.8.1. GROUNDWATER MONITORING

The groundwater excursion-monitoring program is designed to detect excursions of lixiviant into the ore zone aquifer outside of the wellfield being leached and into the overlying water bearing strata. The Pierre Shale below the ore zone is over 1200 feet thick and contains no water bearing strata. Therefore, it is not necessary to monitor any water bearing strata below the ore zone.
All private wells and surface waters within one kilometer of the wellfield area boundary are sampled on a quarterly basis. Surface water samples are taken in accordance with the instructions contained in Standard Operating Procedure E-5, "Routine Groundwater Monitoring." Samples are analyzed for natural uranium and radium-226. The results of this sampling since 1991 for uranium are shown in Table 5.7-13 and for radium in Table 5.7-14.

Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed approximately 300 feet from the wellfield boundary. After completion, wells are washed out and developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appear stable and consistent with the anticipated quality of the area. After development, wells are sampled to obtain baseline water quality. For baseline sampling, all wells are purged until field parameters are stable. Quarterly monitor well results are shown for uranium in Table 5.7-15 and for radium in Table 5.7-16. All monitor wells including ore zone and overlying monitor wells are sampled three times at least 14 days apart. The first, second and third samples are analyzed for the excursion indicator parameters (sodium, chloride, sulfate, conductivity, and alkalinity). CBR analyzes one sample for the baseline parameters shown in Table 5.7-17.

Results from the samples are averaged arithmetically to obtain a baseline value as well as an average value for determine upper control limits for excursion detection.

Upper Control Limits and Excursion Monitoring

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

Operational monitoring consists of sampling the monitor wells no more than 14 days apart and analyzing the samples for the excursion indicators chloride, conductivity, sodium, sulfate and total alkalinity. In special circumstances including inclement weather, wellhead mechanical failure, conditions which place an employee at risk while sampling, and conditions which could cause damage to the environment if sampling was performed, the sampling could be delayed by a period not to exceed 5 days. The circumstances requiring postponement of the sampling will be documented.

Excursion Verification and Corrective Action

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

5.7.8.2. SURFACE WATER MONITORING

The pre-operational water quality-monitoring program assessed water quality and quantity for Squaw Creek. CBR samples two surface water locations for Squaw Creek. The CBR SERP approved Mine Unit 6 on March 6, 1998. This expansion required that the downstream Squaw Creek monitoring location be relocated. The new sample point was designated as S-5. Sampling at the previous downstream location, S-3 was discontinued.

With the approval of Mine Unit 6, operational surface water sampling was also begun at the English Creek upstream and downstream locations. The upstream sample is a composite of the springs that are the sources of English Creek and were identified as E-1 and E-2 during the preoperational monitoring program. Preoperational monitoring location E-3 was not used for downstream monitoring since its location is well beyond the Mine Unit 6 wellfield. Instead, a new downstream location designated E-4 was chosen immediately outside the Mine Unit boundary and sampling was begun. Additionally, the expansion to Mine Unit 8 will require sampling of the impoundment identified as I-3 in the preoperational monitoring program when it is located within the wellfield. Samples from all locations are obtained quarterly. Surface water samples are analyzed for the parameters given in Table 5.7-6. Surface monitoring results are submitted in the semi-annual activity and monitoring reports submitted to NRC. A summary table of regional surface water monitoring results can be found in Table 5.7-13 and Table 5.7-14.

5.7.8.3. EVAPORATION POND LEAK DETECTION MONITORING

The evaporation ponds are lined and equipped with a leak detection system. During operations, the leak detection standpipes are checked for evidence of leakage. Visual inspection of the pond embankments, fences, and liners and the measurement of pond freeboard are also performed during normal operations. A minimum freeboard of 5 feet is allowed for the commercial ponds during normal operations. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, it is analyzed for specific conductivity. Should the analyses indicate that the liner is leaking (by comparison to chemical analyses of pond water), the following actions are taken:

- The USNRC Project Manager is notified by telephone within 48 hours of leak verification.

- The level of the leaking pond is lowered by transferring its contents into an adjacent pond. While lowering the water level in the pond, inspections of the liner are made to determine the cause and location

The Standard Operating Procedures developed by CBR are a critical step to insuring that quality assurance objectives are met. Current SOPs exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.
7. Laboratory procedures.

5.7.10. MONITORING PROGRAM SUMMARY

Section 5.7 of this renewal application has reviewed the radiological monitoring data produced at Crow Butte Uranium Project for the years of 1990 through 1994. Each Section has discussed the historical results of the data with an emphasis on regulatory compliance and trend analysis to determine whether CBRs ALARA goals are being met. Where the data indicated that some adjustments in the monitoring program were indicated, CBR has noted those changes in the "Proposed Program" portion of each Section. In order to aid the reviewer in comparing the elements of the current monitoring program with those of the proposed program, Table 5.7-18 provides a tabular summary of both programs as well as the regulatory guidance provided in USNRC Regulatory Guide 8.30, "Health Physics Surveys In Uranium Recovery Facilities", Revision 1.

mobilized. As the plant is operated in the pH range of 6.5 to 9.0, mobilization of the organics and coloring of the leach solution is avoided.

6.1.3 RESTORATION GOALS

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to baseline values on a mine unit average. The secondary goal is to return the groundwater to a quality consistent with premining use or uses. The restoration values set by the Nebraska Department of Environmental Quality (NDEQ) in the UIC Permit are these secondary goals. Restoration values for each mine unit have been specified by the NDEQ for groundwater restoration efforts. Prior to mining in each mine unit, baseline groundwater quality is determined. This data is established in each mine unit at the minimum density of one production or injection well per four acres.

The baseline data support establishment of the upper control limits and restoration standards for each mine unit. The upper control limits and restoration standards for each Mine Unit, beginning with Mine Unit 6, are determined by the Safety and Environmental Review Panel (SERP) during the approval process for the new Mine Unit. The NDEQ restoration values are established as the average plus two standard deviations for any parameter that exceeds the applicable drinking water standard. If a drinking water standard exists for a parameter, and baseline is below that standard, the drinking water standard is used to establish the restoration value. If there is no drinking water standard for an element, for example vanadium, the restoration value will be based on best practicable technology. The restoration value for the major cations (Ca, Mg, K, Na) should allow for the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criteria should allow for the total carbonate to be less than 50% of the TDS. The TDS restoration value is set at the average plus one standard deviation.

Mine unit averages and secondary goals for Mine Units 1 through 5 are given in Tables 6.1-1 through 6.1-5. These restoration values were approved by NRC based on submittals before operation of the Mine Unit. The mine unit average and NDEQ restoration values for Mine Unit 6 are given in Table 6.1-6. The CBR SERP determined these restoration values on March 4, 1998. The mine unit average and NDEQ restoration values for Mine Unit 7 are given in Table 6.1-7. The CBR SERP determined these restoration values on July 9, 1999. The mine unit average and NDEQ restoration values for Mine Unit 8 are given in Table 6.1-8. The CBR SERP determined these restoration values on July 10, 2002. NDEQ Permit Number NE0122611 requires that a Mine Unit be returned to a wellfield average of these restoration values. These concentrations were approved by the NDEQ with the Notice of Intent to Operate submittals. Post mining water quality for Mine Unit 1 can be found in Table 6.1-8.

Crow Butte Resources operated a R&D Pilot Facility starting in July 1986 and initiated restoration activities of its Wellfield No. 2 in February 1987. Wellfield No. 1 was incorporated into Mine Unit 1, thus no restoration took place in that area. The techniques used during that program are the basis for the commercial restoration program outlined in this section. Crow Butte Resources will utilize ion exchange columns, a reverse osmosis unit and reductant addition equipment similar to those used in the R&D restoration during commercial restoration operations.

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

- Groundwater transfer;
- Groundwater sweep;
- Groundwater treatment; and
- Wellfield recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

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 phase, Crow Butte Resources will make a request to the appropriate regulatory agencies that the wellfield is restored.

Table 6.1-1: Baseline and Restoration Values for Mine Unit 1

Parameter	Groundwater Standard	MU-1 Baseline	MU-1 Standard Deviation	MU-1 NDEQ Restoration Value
Ammonium (mg/l)	10.0	<0.372		10.0
Arsenic (mg/l)	0.05	<0.00214		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0.01	<0.00644		0.005[1]
Chloride (mg/l)	250.0	203.9	38	250.0
Copper (mg/l)	1.0	<0.017		1.0
Fluoride (mg/l)	4.0	0.686	0.04	4.0
Iron (mg/l)	0.3	<0.0441		0.3
Mercury (mg/l)	0 002	<0.001		0.002
Manganese (mg/l)	0.05	<0.011		0 05
Molybdenum (mg/l)	1.0	<0 0689		1.0
Nickel (mg/l)	0.15	<0.0340		0.15
Nitrate (mg/l)	10.0	<0 050		10.0
Lead (mg/l)	0.05	0.0315		0.05
Radium (pCi/L)	5.0	229.7	177.1	584.0
Selenium (mg/l)	0.01	<0.00323		0.05
Sodium (mg/l)	N/A	412	19.2	4120
Sulfate (mg/l)	250.0	356.2	9.4	375
Uranium (mg/l)	5.0	0.0922	0.089	5.0
Vanadium (mg/l)	0.2	<0.0663		0.2
Zinc (mg/l)	5.0	<0.036		5.0
pH (Std Units)	6.5 - 8 5	8.46	0.2	6.5 – 8.5
Calcium (mg/l)	N/A	12.5	3 2	125.0
Total Carbonate (mg/l)	N/A	351	31.1	585
Potassium (mg/l)	N/A	12 5	1.5	125.0
Magnesium (mg/l)	N/A	3.2	0 8	32.0
TDS (mg/l)	N/A	1170 2	47.6	1170 2

[1] Standard for Cadmium lowered in modification to UIC permit dated March 9, 2001 following NDEQ approval of Mine Unit 1 restoration

Table 6.1-2: Baseline and Restoration Values for Mine Unit 2

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		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0 005	<0.007		0.005
Chloride (mg/l)	250 0	208.6	30.8	250.0
Copper (mg/l)	1.0	<0.013		1.0
Fluoride (mg/l)	4 0	0.67	0.04	4.0
Iron (mg/l)	0 3	<0.045		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0 05	<0.01		0.05
Molybdenum (mg/l)	1.0	<0.073		1.0
Nickel (mg/l)	0 15	<0.037		0 15
Nitrate (mg/l)	10 0	<0.039		10.0
Lead (mg/l)	0 05	<0.035		0.05
Radium (pCi/L)	5.0	234.5	411.8	1058.0
Selenium (mg/l)	0.05	<0.001		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		0.2
Zinc (mg/l)	5.0	<0.026		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

Table 6.1-3: Baseline and Restoration Values for Mine Unit 3

Parameter	Groundwater Standard	MU-3 Baseline	MU-3 Standard Deviation	MU-3 NDEQ Restoration Value
Ammonium (mg/l)	10.0	<0.329		10.0
Arsenic (mg/l)	0.05	<0.001		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0.005	<0.01		0.005
Chloride (mg/l)	250.0	197.6	16 7	250.0
Copper (mg/l)	1.0	<0.0108		1.0
Fluoride (mg/l)	4.0	0 719	0.05	4.0
Iron (mg/l)	0 3	<0.05		0 3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.01		0.05
Molybdenum (mg/l)	1.0	<0 1		1.0
Nickel (mg/l)	0.15	<0.05		0.15
Nitrate (mg/l)	10 0	<0.0728		10 0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5 0	165	222.5	611.0
Selenium (mg/l)	0 05	<0 00115		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		0.2
Zinc (mg/l)	5 0	<0 0131		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

Table 6.1-4: Baseline and Restoration Values for Mine Unit 4

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		0.05
Barium (mg/l)	1.0	<0.1		1.0
Cadmium (mg/l)	0.005	<0.01		0 005
Chloride (mg/l)	250.0	217.5	34.9	250.0
Copper (mg/l)	1.0	<0 0114		1.0
Fluoride (mg/l)	4 0	0.745	0.05	4.0
Iron (mg/l)	0 3	<0.0504		0.3
Mercury (mg/l)	0 002	<0.001		0.002
Manganese (mg/l)	0 05	<0 01		0.05
Molybdenum (mg/l)	1.0	<0 1		1.0
Nickel (mg/l)	0 15	<0.05		0.15
Nitrate (mg/l)	10 0	<0.114		10.0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5.0	154 3	171.5	496.0
Selenium (mg/l)	0.05	<0.00244		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		5.0
Vanadium (mg/l)	0.2	<0.0984		0 2
Zinc (mg/l)	5 0	<0.0143		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

Table 6.1-5: Baseline and Restoration Values for Mine Unit 5

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		0.05
Barium (mg/l)	1.0	<0.10		1.0
Cadmium (mg/l)	0.005	<0.01		0.005
Chloride (mg/l)	250 0	191.9	7.9	250 0
Copper (mg/l)	1.0	<0.01		1.0
Fluoride (mg/l)	4 0	0.64	0.07	4 0
Iron (mg/l)	0 3	<0.05		0 3
Mercury (mg/l)	0.002	<0 001		0 002
Manganese (mg/l)	0.05	<0.01		0.05
Molybdenum (mg/l)	1.0	<0.10		1.0
Nickel (mg/l)	0.15	<0.05		0.15
Nitrate (mg/l)	10.0	<0.1		10.0
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5.0	166.0	184.6	535 0
Selenium (mg/l)	0.05	<0.002		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		0.2
Zinc (mg/l)	5 0	<0.02		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

Table 6.1-6: Baseline and Restoration Values for Mine Unit 6

Parameter	Groundwater Standard	MU-6 Baseline	MU-6 Standard Deviation	MU-6 NDEQ Restoration Value
Ammonium (mg/l)	10.0	0.32	0.05	10.0
Arsenic (mg/l)	0 05	0.002		0.05
Barium (mg/l)	1.0	0 100		1.0
Cadmium (mg/l)	0 005	0 009		0.005
Chloride (mg/l)	250.0	206	15.4	250.0
Copper (mg/l)	1.0	0 012		1.0
Fluoride (mg/l)	4.0	0.65	0 03	4.0
Iron (mg/l)	0.3	0.050		0.3
Mercury (mg/l)	0.002	0.001		0.002
Manganese (mg/l)	0.05	0.010		0.05
Molybdenum (mg/l)	1.0	0.102		1.0
Nickel (mg/l)	0.15	0.050		0.15
Nitrate (mg/l)	10 0	0 1		10 0
Lead (mg/l)	0.05	0.050		0 05
Radium (pCi/L)	5 0	80 6	121.9	325
Selenium (mg/l)	0.05	0.001		0.05
Sodium (mg/l)	N/A	400	12.8	4000
Sulfate (mg/l)	250 0	361	14.6	390
Uranium (mg/l)	5 0	0.133	0 212	5.0
Vanadium (mg/l)	0 2	0.098		0.2
Zinc (mg/l)	5.0	0 011		5.0
pH (Std. Units)	6 5 - 8 5	8.6	0 2	6.5 – 9.0
Calcium (mg/l)	N/A	12.8	2.3	128
Total Carbonate (mg/l)	N/A	367.1	22.9	596
Potassium (mg/l)	N/A	11.9	1.7	119
Magnesium (mg/l)	N/A	3 2	0.7	32
TDS (mg/l)	N/A	1192	28.1	1220

Table 6.1-7: Baseline and Restoration Values for Mine Unit 7

Parameter	Groundwater Standard	MU-7 Baseline	MU-7 Standard Deviation	MU-7 NDEQ Restoration Value
Ammonium (mg/l)	10.0	0.42	0.08	10.0
Arsenic (mg/l)	0.05	0.001		0.05
Barium (mg/l)	1.0	0.10		1.0
Cadmium (mg/l)	0 005	0.007		0.005
Chloride (mg/l)	250.0	198	22.6	250.0
Copper (mg/l)	1.0	0.01		1.0
Fluoride (mg/l)	4.0	0.70	0 05	4.0
Iron (mg/l)	0 30	0.05		0.30
Mercury (mg/l)	0 002	0.001		0.002
Manganese (mg/l)	0.05	0.01		0.05
Molybdenum (mg/l)	1.00	0.10		1.00
Nickel (mg/l)	0.15	0.05		0.15
Nitrate (mg/l)	10 0	0.1		10.0
Lead (mg/l)	0.05	0.05		0.05
Radium (pCi/L)	5 0	142	148 0	438
Selenium (mg/l)	0.05	0.004		0.05
Sodium (mg/l)	N/A	387	21.6	3,870
Sulfate (mg/l)	250.0	346	20.1	386
Uranium (mg/l)	5.0	0.110	0.138	5.0
Vanadium (mg/l)	0.2	0.10		0.2
Zinc (mg/l)	5 0	0.01		5.0
pH (Std. Units)	6 5 - 8.5	8.6	0.3	6 5 – 9 2
Calcium (mg/l)	N/A	12.2	2.6	122
Total Carbonate (mg/l)	N/A	356		588
Potassium (mg/l)	N/A	12 9	3.0	129
Magnesium (mg/l)	N/A	3 2	0.7	32
TDS (mg/l)	N/A	1,176	40.7	1,217

Table 6.1-8: Baseline and Restoration Values for Mine Unit 8

Parameter	Groundwater Standard	MU-8 Baseline	MU-8 Standard Deviation	MU-8 NDEQ Restoration Value
Ammonium (mg/l)	10.0	0.682	0.222	10.0
Arsenic (mg/l)	0 05	0.002	0.001	0.05
Barium (mg/l)	1.0	0.099	0.005	1.0
Cadmium (mg/l)	0.005	0.005		0.005
Chloride (mg/l)	250	196	53.8	250
Copper (mg/l)	1.0	0.01		1.0
Fluoride (mg/l)	4.0	0.638	0.048	4.0
Iron (mg/l)	0 30	0.135	0.086	0.30
Mercury (mg/l)	0.002	0.001		0.002
Manganese (mg/l)	0.05	0 01		0.05
Molybdenum (mg/l)	1.0	0 093	0 023	1.00
Nickel (mg/l)	0.15	0.049	0.003	0.15
Nitrate (mg/l)	10.0	0.2		10.0
Lead (mg/l)	0 05	0.049	0.003	0.05
Radium (pCi/L)	5.0	124.4	151.8	428
Selenium (mg/l)	0.05	0.004		0.05
Sodium (mg/l)	N/A	416.8	41.8	4,168
Sulfate (mg/l)	250	312	33	378
Uranium (mg/l)	5.0	0.188	0.140	5.0
Vanadium (mg/l)	0 2	0.127	0.122	0.2
Zinc (mg/l)	5.0	0.013	0.008	5.0
pH (Std. Units)	6.5 - 8 5	8.67	0.37	6.5 – 9 41
Calcium (mg/l)	N/A	12.3	3.5	123
Total Carbonate (mg/l)	N/A	377	15 6	569
Potassium (mg/l)	N/A	11.8	3.2	117.8
Magnesium (mg/l)	N/A	2.7	0 92	27.1
TDS (mg/l)	N/A	1,137	97.4	1,234

Table 6.1-8: Post Mining Water Quality for Mine Unit 1 Restoration Well Sampling

	PM-1	PM-4	PM-5	PT-5	IJ-6	IJ-13	IJ-25	IJ-28	IJ-45	PR-8	PR-15	PR-19
Ca (mg/l)	87.9	87.1	80.8	87.9	87.6	93.9	89.4	89.6	89.9	85.4	86.7	98.3
Mg (mg/l)	22.6	20.6	22.7	23.8	21.4	23.9	22.5	23.1	24.8	23.2	23.1	23.8
Na (mg/l)	1154	942	1054	1144	1054	1174	1177	1182	1126	1144	1172	1083
K (mg/l)	32.7	26.3	30	30	27.2	31.3	30	31.3	32.7	30	30	28.6
CO_3 (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0
HCO_3 (mg/l)	1099	900	972	981	1057	1086	1111	1207	1104	1170	1170	959
SO_4 (mg/l)	1109	959	1115	1240	1031	1209	1119	1112	1134	1115	1115	1283
Cl (mg/l)	598	455	586	594	544	598	594	619	607	603	603	590
NH_4 (mg/l)	0.33	0.67	0.14	0.33	0.44	0.07	< 0.05	< 0.05	0.33	0.27	0.15	0.49
NO_2 (mg/l)	< 0.01	0.02	0.09	< 0.01	0.11	< 0.01	< 0.01	< 0.01	0.04	0.05	< 0.01	0.05
NO_3 (mg/l)	1.06	< 0.1	0.97	0.99	1.29	0.74	0.86	1.3	1.25	1.46	1.6	0.46
F (mg/l)	0.37	0.26	0.54	0.45	0.45	0.37	0.38	0.45	0.43	0.43	0.4	0.35
SiO_2 (mg/l)	25.7	18.2	35.3	24.7	33.3	34.3	26.4	31.6	28.3	33.2	30	22.2
TDS (mg/l)	3694	3121	3756	3851	3515	3899	3751	3886	3873	3820	3807	3765
Cond (µmho/cm)	5843	4841	5590	5964	5445	6012	5807	6025	5916	5819	5940	5819
$CaCO_3$ (mg/l)	901	738	797	804	866	890	911	989	905	959	959	786
pH (Std. units)	7.65	6.87	6.85	7.28	7.16	7.35	7.65	7.81	7.37	7.46	7.78	6.92
Trace Metals												
Al (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.29
As (mg/l)	0.018	0.007	0.018	0.017	0.031	0.028	0.02	0.028	0.023	0.028	0.024	0.011
Ba (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
B (mg/l)	1.17	1.44	1.09	1.36	1.06	1.26	1.13	1.19	1.15	1.23	1.25	1.17

Table 6.1-8: Post Mining Water Quality for Mine Unit 1 Restoration Well Sampling

	PM-1	PM-4	PM-5	PT-5	IJ-6	IJ-13	IJ-25	IJ-28	IJ-45	PR-8	PR-15	PR-19
Cd (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cr (mg/l)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cu (mg/l)	< 0.01	< 0.01	0.05	< 0.01	0.02	< 0.01	< 0.01	< 1	< 0.01	< 0.01	< 0.01	< 0.01
Fe (mg/l)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.38
Pb (mg/l)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Mn (mg/l)	0.02	0.11	0.05	0.04	0.14	0.15	0.08	0.06	0.06	0.02	< 0.01	0.16
Hg (mg/l)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mo (mg/l)	0.6	0.2	0.42	0.53	0.47	0.5	0.56	0.54	0.53	0.59	0.53	0.37
Ni (mg/l)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.12	0.12	0.12	< 0.05	< 0.05	< 0.05	< 0.05
Se (mg/l)	0.139	0.012	0.129	0.24	0.112	0.122	0.1	0.138	0.149	0.154	0.148	0.041
V (mg/l)	1	0.1	0.38	1.15	1.12	1.18	1.03	1.24	1.29	1.23	1.56	0.28
Zn (mg/l)	< 0.01	0.14	0.11	0.01	0.11	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radionuclides												
U (mg/l)	8.63	6.29	54.52	9.3	13.9	9.31	9.9	2.52	14.83	5.24	5.18	6.78
Ra-226 (pCi/l)	370	126	329	1139	1113	1558	1258	1147	681	417	109	1182

6.1.4 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. Crow Butte Resources will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional techniques are necessary.

6.1.4.1 GROUNDWATER TRANSFER

Prior to commencing restoration activities, the regulatory agencies will be notified that mining has ceased in a given mine unit and Crow Butte Resources will proceed to establish post mining water quality data for all of the required parameters listed in Table 6.1-1 through 6.1-8.

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

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

The advantage of using the groundwater transfer technique is that it reduces the amount of water that must be ultimately be sent to the waste disposal system during restoration activities.

6.1.4.2 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 that 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 mine unit.

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

6.1.4.3 GROUNDWATER TREATMENT

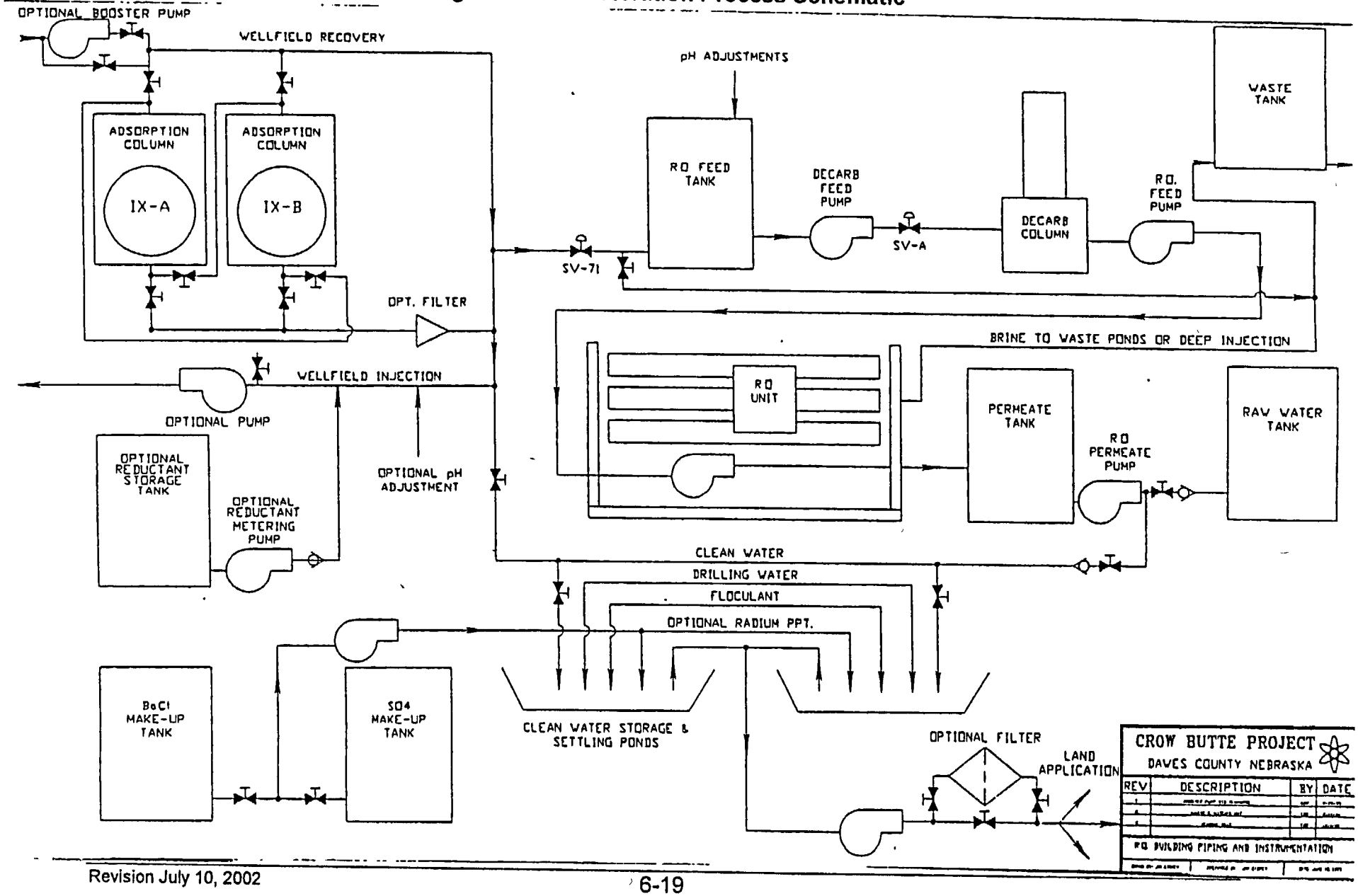
Following the groundwater sweep step water is pumped from production wells to treatment equipment and then reinjected into the wellfield. Ion exchange and reverse osmosis treatment equipment is utilized during this stage as shown in Figure 6.1-1. Depending upon the final configuration of the main plant following the capacity increase to 5,000 gpm, the ion exchange step may utilize the existing fixed bed downflow columns located at the main plant, or may be relocated.

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

A portion of the restoration recovery water can be sent to the reverse osmosis unit. The use of a reverse osmosis unit has several effects:

- 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.

Figure 6.1-1: Restoration Process Schematic



Before the water can be processed by the reverse osmosis unit, the soluble uranium must be removed by the ion exchange system. The water is then filtered, the pH lowered for decarbonation to prevent calcium carbonate plugging of the membranes, and then pressurized by a pump. The reverse osmosis unit contains membranes which 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 membrane. Table 6.1-9 shows typical manufacturers specification data for removal of ion constituents. The clean water, called permeate, will be re-injected, sent to storage for use in the mining process, or sent to the waste disposal system. The twenty-five to forty percent of water that is rejected, referred to as the brine, contains the majority of dissolved salts that contaminate the groundwater and is sent for disposal in the wastewater system.

The sulfide reductant that may be added to the injection stream during this stage will 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. A comprehensive safety plan regarding reductant use will be implemented should it be utilized.

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

6.1.5 STABILIZATION PHASE

Upon completion of restoration, a groundwater stabilization monitoring program will begin in which the restoration wells and any monitor wells on excursion status during the mining operations will be sampled and assayed. Sampling frequency will be one sample per month for a period of six months, and if all six samples show that restoration values for all wells are maintained during the stabilization period, restoration shall be deemed complete.

Table 6.1-9: Typical Membrane Rejection
Source: Osmonics, Inc.

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

6.1.6 REPORTING

During the restoration process, Crow Butte Resources will perform daily, weekly, and monthly analysis as needed to track restoration progress. These analyses will be provided to NDEQ in Monthly Restoration Reports and the USNRC in the Semiannual Radiological Effluent and Environmental Monitoring Report. This information will also be included in the final restoration report.

Upon completion of restoration activities and prior to stabilization, all designated restoration wells in the mine unit will be sampled for the required constituents listed in Tables 6.1-1 through 6.1-8. These samples may be split with NDEQ if required. Assay results will be submitted to NDEQ and USNRC as required. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the regulatory agencies, Crow Butte Resources will notify the regulatory agencies it is commencing the stabilization phase of restoration.

During stabilization all designated restoration wells will be sampled monthly for the required constituents listed in Table 6.1-1 through 6.1-8. At the end of a six month stabilization period Crow Butte Resources will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. At that time, Crow Butte Resources would request that the mine unit be declared restored.

6.2 DECONTAMINATION AND DECOMMISSIONING

The following sections address the final decommissioning of process facilities, evaporation ponds, wellfields and equipment that will be used on the Crow Butte site. It discusses general procedures to be used, both during final decommissioning, as well as the decommissioning of a particular phase or production unit area.

Decommissioning of wellfields and process facilities, once their usefulness has been completed in an area will be scheduled after agency approval of groundwater restoration and stability. It will be accomplished in accordance with an approved decommissioning plan and the most current applicable NDEQ and USNRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed per Section 6.2.3.
- Radiological surveys and sampling of all facilities, process related equipment and materials presently on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation.
- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of U.S. Nuclear Regulatory Commission.
- Survey excavated areas for earthen contamination and remove same to a licensed disposal facility.
- Backfill and recontour all disturbed areas.
- Perform final site soil radiation background surveys.
- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the Crow Butte facilities. Crow Butte Resources will, prior to final decommissioning of an area, submit to the USNRC and NDEQ a detailed plan for their review and approval.

6.2.1 PROCESS BUILDINGS AND EQUIPMENT

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to identify any potential hazards. The survey will also support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed below.

6.2.1.1 REMOVAL AND DISPOSAL ALTERNATIVES

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

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

It is most likely that process buildings will be dismantled and moved to another location or to a permanent licensed disposal facility. Cement foundation pads and footing will be broken up and trucked to disposal site or a licensed facility if contaminated. The landowners, however, could request that a building or other structures be left on site for his use. In this case, the building will be decontaminated to meet unrestricted use criteria.

6.2.1.1.1 DISPOSAL AT A LICENSED FACILITY

If a piece of process equipment is to be moved to another licensed area the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the

equipment will be washed down and decontaminated to permit safe handling.

- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.

- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in plastic lined covered dump trucks or drummed in barrels for delivery to the receiving facility.

- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

- All other miscellaneous contaminated material will be transported to a licensed disposal facility.

6.2.1.1.2 DISPOSAL TO UNRESTRICTED USE

If a piece of equipment is to be released for unrestricted use it will be appropriately surveyed before leaving the licensed area. Both interior and exterior surfaces will be surveyed to detect potential contamination. Appropriate decontamination procedures will be used to clean any contaminated areas and the equipment resurveyed and documentation of the final survey retained to show that unrestricted use criteria were met prior to releasing the equipment or materials from the site. Criteria to be used for release to unrestricted use will be USNRCs *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials"* May 1987 Revision (Annex B) or the most current standards for decontamination at that time.

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

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

be resurveyed to ensure removal of all contamination to appropriate levels.

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

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

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

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

6.2.2 EVAPORATION POND DECOMMISSIONING

6.2.2.1 DISPOSAL OF POND WATER

The volume of water remaining in the lined evaporation ponds after restoration as well as its chemical and radiological characteristics will be considered to determine the most practical disposal program. Disposal options for the pond liquid include evaporation, treatment and disposal or transportation to another licensed facility or disposal site. The pond water from the later stages of groundwater restoration may be treatable to within discharge limits; if this can be accomplished, the water will be treated and discharged under an appropriate NPDES permit. Evaporation of the remaining water may be enhanced by use of sprinkler systems, etc.

6.2.2.2 POND SLUDGE AND SEDIMENTS

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

USNRC licensed disposal facility. All equipment and personnel working on sludge and liner removal will be checked prior to leaving the work area to prevent the tracking of sludge into uncontaminated locations.

6.2.2.3 DISPOSAL OF POND LINERS AND LEAK DETECTION SYSTEMS

Pond liners will be kept washed down and intact as much as practical during sludge removal so as to confine sludges and sediments to the pond bottom. Pond liners will be cut into strips and transported to a USNRC licensed disposal facility or will be decontaminated for release to an unrestricted area. After removal of the pond liners, the pond leak detection system piping will be removed. Materials involved in the leak detection system will be surveyed and released for unrestricted use if not contaminated or transported to a USNRC licensed facility for disposal. The earthen material in the pond bottom and leak detection system trenches will be surveyed for soil contamination; any contaminated soil in excess of limits defined in 10 CFR 40, Appendix A, will be removed.

Following the removal of all pond materials and the disposal of any contaminated soils, surface preparation will take place prior to reclamation. Pond surface reclamation will be performed in accordance with the surface reclamation plan, Section 6.3. An additional radiation background survey will be conducted on the recontoured area prior to topsoiling.

6.2.2.4 ON SITE BURIAL

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

6.2.3 WELLFIELD DECOMMISSIONING

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, electrical conduit, well boxes, and wellhead equipment. All of the lines are above ground surface

lines that will not require excavation for removal. Wellhead equipment such as valves, meters or control fixtures will be salvaged.

- Removal of buried well field piping.
- Wells will be plugged and abandoned according to the procedures described below.
- The well field area may be recontoured, if necessary, and a final background gamma survey conducted over the entire well field area to identify any contaminated earthen materials requiring removal to disposal.
- Final surface reclamation of the well field areas will be conducted according to the surface reclamation plan described in Section 6.3.
- All piping, boxes and wellhead equipment will be surveyed for contamination prior to release in accordance with the USNRC guidelines for decommissioning.

It is estimated that a significant portion of the equipment will meet releasable limits that will allow disposal at an unrestricted area landfill. Other materials which are contaminated will be acid washed or cleansed with other methods until they are releasable. If the equipment still does not meet releasable limits, it will be disposed of at a facility licensed to accept by-product material.

After the Crow Butte aquifer restoration and post-restoration stabilization has been completed and accepted in writing as successful by both the NDEQ and USNRC, the decommissioning of the mine unit wellfields will commence.

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

6.2.3.1 WELL PLUGGING AND ABANDONMENT

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

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

The plugging method will be as follows:

- An approved abandonment mud (a mud-polymer mix) will be mixed in a cement unit and pumped down a hose, which is lowered to the bottom of the well casing using a reel.
- When the hose is removed, the casing is topped off and a cement plug placed on top.
- A hole is then dug around the well, and, at a minimum, the top three feet of casing removed.
- The hole is backfilled and the area revegetated.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning.

6.2.3.2 BURIED TRUNKLINES, PIPES AND EQUIPMENT

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

6.2.4 DECONTAMINATION

After all surface equipment is removed and all wells are properly plugged and abandoned, a gamma survey of the wellfield surfaces will be conducted. Any areas with elevated gamma readings that indicate radium-226 levels in excess of limits in 10 CFR 40, Appendix A, will be resurveyed. Soil samples will be collected from confirmed contaminated locations for the analysis of radium-226 and uranium. Based upon the soil sampling and additional gamma radiation readings, contaminated soil will be removed and transferred to a site licensed to accept by-product materials. Gamma survey results and soil sampling results will be submitted to the USNRC for their review, approval

and opportunity to split soil samples. After approval of the soil contamination removal program, revegetation will commence.

The objective of site soil surveys during decommissioning will be to identify and remove to a licensed disposal facility any earthen materials which exceed EPA 40 CFR Part 192.32 standards or other applicable standards at the time of decommissioning. These standards presently require that radium concentrations in surface soils, averaged over areas of 100 square meters, do not exceed background levels by more than 5 pCi/g averaged over the first 15 cm below the surface and 15 pCi/g averaged over any 15 cm thick layer more than 15 cm below the surface.

Three general types of site soil surveys will be conducted on the site during decommissioning:

- Areas of potential surface contamination will be identified using a gross gamma survey on an adequately spaced grid.
- Spot-checks of areas around the site of potentially contaminated areas.
- The final soil background survey on areas which have been prepared for surface reclamation using a grid spacing adequate for confirming clean up to applicable standards.

Contaminated soils that are removed from site surfaces will be transported to a licensed disposal site. The primary areas for potential soil contamination include well field surfaces, evaporation pond bottoms and berms, process building areas, storage yards and transportation routes over which product or contaminants have been moved.

6.2.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will document decommissioning processes and ensure that occupational radiation exposure levels are kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee by way of specialized training, will be on site during any decommissioning activities where a potential radiation exposure hazard exists.

Health physics survey conducted during decommissioning will be guided by applicable sections of 10 CFR 20 and USNRC Regulatory Guide No. 8.30 entitled "*Health Physics Surveys in Uranium Recovery Facilities*", Revision 1 or other applicable standards at the time.

6.2.6 EQUIPMENT AND MATERIAL SURVEYS

Any site equipment to be released for unrestricted use will be surveyed for alpha contamination and beta gamma as necessary to document levels for release, according to USNRC *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials"*, May 1987 Revision (Annex B) or the most current standards for decontamination at that time.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation and U.S. Nuclear Regulatory Commission Regulations (49 CFR 173.389)(10 CFR 71).

6.2.7 RECORDS AND REPORTING PROCEDURES

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

6.3 SURFACE RECLAMATION

The following reclamation plan provides procedural techniques for surface reclamation of all disturbances contained in the Crow Butte Resources mine plan. Provided are reclamation procedures for the process plant facilities, evaporation ponds, wellfield production units, access and haul roads. Reclamation techniques and procedures for subsequent satellite facilities, additional ponds and wellfields will follow the same concepts as presented below. Reclamation schedules for wellfield production units will be discussed separately because they are dependent upon the progress of mining and the successful completion of groundwater restoration. Cost estimates for bonding calculations include all activities which are anticipated to complete groundwater restoration, decontamination, decommissioning and surface reclamation of wellfield and satellite plant facilities installed to operate for one year of mining activity.

The principal objective of the surface reclamation plan is to return disturbed lands to production, compatible with the post mining land use, of equal or better quality than its premining condition. The reclaimed lands should therefore be capable of supporting livestock grazing and provided stable habitat for native wildlife species. Soils, vegetation, wildlife and radiological

baseline data will be used as guidelines for the design, completion and evaluation of surface reclamation. Final surface reclamation will blend affected areas with adjacent undisturbed lands so as to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind and water, sedimentation and re-establish natural through drainage patterns.

6.3.1 WELLFIELD RECLAMATION

Surface reclamation in the wellfield production units will vary in accordance with the development sequence, mining/reclamation timetable. Final surface reclamation of each wellfield production units will be after approval of groundwater restoration stability and the completion of well abandonment and decommissioning activities specified in Section 6.2. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape. The seed bed will be prepared and reseeded with assistance from the U.S. Soil Conservation Service.

6.3.2 PROCESS FACILITIES RECLAMATION

Subsoils and stockpiled topsoil will be replaced on the disturbances from which they were removed during construction, within practical limits. Areas to be backfilled will be scarified or ripped prior to backfilling to create an uneven surface for application of backfill. This will provide a more cohesive surface to eliminate slipping and slumping. The less suitable subsoil and unsuitable topsoil, if any, will be backfilled first so as to place them in the deepest part of the excavation to be covered with more suitable reclamation materials. Subsoils will be replaced using paddle wheel scrapers, push-cats or other appropriate equipment to transfer the earth from stockpile locations or areas of use and to spread it evenly on the ripped disturbances. Grader blades may be used to even the spread of backfill materials. Backfill compacting will be accomplished by movement of the equipment over the fill area. Topsoil replacement will commence as soon as practical after a given disturbed surface has been prepared. Topsoil will be picked up from storage locations by paddle wheel scrapers or other appropriate equipment and distributed evenly over the disturbed areas. The final grading of topsoil materials will be done so as to establish adequate drainage and the final prepared surface will be left in a roughened condition. There will be no topsoil used for construction of any kind; topsoil will have been salvaged and stockpiled.

6.3.3 CONTOURING OF AFFECTED AREAS

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

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

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

6.4 BONDING ASSESSMENT

6.4.1 BOND CALCULATIONS

Cost estimates for the purpose of bond calculations were made for the Crow Butte Project site. The cost assessment includes groundwater restoration, decontamination and decommissioning and surface reclamation costs for all areas to be affected by the installation and operation of the proposed mine plan. The detailed calculation utilized in determining the bonding requirements for the Crow Butte Project is submitted annually to the NDEQ and the NRC and are maintained on file at the project office.

6.4.2 FINAL SURETY ARRANGEMENTS

Crow Butte Resources maintains a NRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation activities. Crow Butte maintains an Irrevocable Letter of Credit No. 0748/S17668 issued by the Royal Bank of Canada during 2002 in favor of the State of Nebraska in the present amount of $12,355,260.