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NAME	RBurrows	SAchten for BGarrett	LGersey via email	BKluklan NLO via Email	BVonTill	APersinko
DATE	6/27/13	7/9/13	7/17/13	6/27/13	7/24/13	7/21/13

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Safety Evaluation Report

License Amendment for the Crow Butte Resources North Trend Expansion Area ISR Facility Dawes County, Nebraska Materials License No. SUA-1534

Docket No. 40-8943
Crow Butte Resources, Inc.

U.S. Nuclear Regulatory Commission

Office of Federal and State Materials and Environmental Management Programs

July 2013

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ABBREVIATIONS AND ACRONYMS

byproduct material	Tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.
ac	acre
ACL	alternative concentration limit
ADAMS	Agencywide Documents Access and Management System
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
bgs	below ground surface
^{o}C	degrees Celsius
cfm	cubic feet per minute
CBR	Crow Butte Resources, Inc.
CFR	Code of Federal Regulations
cm	centimeter
cm/s	centimeters per second
CPP	central processing plant
DAC	derived air concentration
DOT	Department of Transportation
dpm	disintegrations per minute
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
^{o}F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FEN	Ferret Exploration Company of Nebraska, Inc.
FIRM	Flood Insurance Rate Map
ft	feet
ft msl	feet above mean sea level
ft/d	feet per day
ft/s	feet per second
ft^3/s	cubic feet per second
gal	gallon
gpm	gallons per minute
GMS	Ground water Modeling System
GPS	Global Positioning System

ha	hectares
HDPE	high density polyethylene
HPT	health physics technician
in	inches
IX	ion exchange
ISR	in situ recovery
kg	kilograms
km	kilometers
kPa/m	kilopascals per meter
L	liters
LC	license condition
lb	pound
Lpm	liters per minute
LSA	Low Specific Activity
m	meters
m^2/day	square meters per day
m^3	cubic meters
m^3/s	cubic meters per second
mg/L	milligrams/liter
mi	miles
MIT	Mechanical Integrity Test
ML	maximum likelihood
m msl	meters above mean sea level
MPa	megapascals
mR	milliRoentgen
mrem	millirems
MS	management system
µCi/ml	microcurie per milliliter
NAAQS	National Ambient Air Quality Standards
NaI	sodium iodide
NDEQ	Nebraska Department of Environmental Quality
NE	Nebraska or northeast
NOGCC	Nebraska Oil and Gas Conservation Commission
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NTEA	North Trend Expansion Area
OSHA	Occupational Safety and Health Administration
Pb-210	lead-210
pCi/L	picocurie per liter
Po-210	polonium-210

psi	pounds per square inch
psi/ft	pounds per square inch per foot
PV	pore volume
QAP	Quality Assurance Program
QA/QC	Quality Assurance/Quality Control
R	Roentgen
Ra-226	radium-226
RAI	Request for Additional Information
RCRA	Resource Conservation and Recovery Act
RO	reverse osmosis
RSO	Radiation Safety Officer
RWPs	radiation work permits
SD	South Dakota
SER	safety evaluation report
SERP	Safety and Environmental Review Panel
SHEQ	Safety, Health, Environment, and Quality
SOPs	standard operating procedures
SRWPs	standing radiation work permits
standard review plan	NUREG-1569 - Standard Review Plan for In Situ Leach Uranium Extraction License Applications
TDS	Total Dissolved Solids
Th-230	thorium-230
TEDE	Total Effective Dose Equivalent
TLD	thermoluminescent detector
TR	technical report
U_3O_8	uranium oxide
U-234	uranium-234
U-235	uranium-235
U-238	uranium-238
UCL	upper control limit
UIC	Underground Injection Control
WL	working levels
WSSR	weighted sum of the squared residuals
yr	year

INTRODUCTION

By letter dated May 30, 2007, Crow Butte Resources, Inc., d/b/a Cameco Resources (the applicant or CBR) submitted an application to U.S. Nuclear Regulatory Commission (NRC) to operate a satellite facility to be located at the North Trend Expansion Area (NTEA) (CBR, 2007). This application consisted of a Technical Report (TR) and an Environmental Report and constitutes a request to amend Materials License SUA-1534 (source and byproduct materials) to include the proposed construction and operation of the NTEA satellite facility. Licenses for source and byproduct material (from uranium recovery operations) are subject to safety requirements found in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material" and 10 CFR Part 20, "Standards for Protection Against Radiation."

NRC staff performed an acceptance review and formally accepted the application on August 28, 2007 (NRC, 2007). By letter dated November 17, 2008, NRC staff issued a request for additional information (NRC, 2008), to which the applicant responded by letter dated February 27, 2009 (CBR, 2009a). By letters dated November 12, 2009, and March 24, 2010, the staff transmitted a set of open issues to the applicant, the responses to which would allow the staff to complete its technical review (NRC, 2009, 2010). The applicant responded to these open issues by letter dated October 22, 2010 (CBR, 2010). Additional submittals from the applicant included missing attachments from the application (CBR, 2009b), and e-mails transmitting clarifications to its TR (CBR, 2011, 2012).

The Atomic Energy Act of 1954, as amended by the Uranium Mill Tailings Radiation Control Act of 1978, authorizes the NRC to issue licenses for the possession and use of source material and byproduct material. The NRC must license facilities, including in situ recovery (ISR) operations, in accordance with NRC regulatory requirements to protect public health and safety from radiological hazards. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," the NRC is required to make the following safety findings when issuing an ISR license:

- The application is for a purpose authorized by the Atomic Energy Act.
- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property.
- The applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property.
- The issuance of the license amendment will not be inimical to the common defense and security or to the health and safety of the public.

This Safety Evaluation Report (SER) documents the safety portion of the staff's review of the May 30, 2007 application, as amended by subsequent change pages and additional information, and includes an analysis to determine the applicant's compliance with these and other applicable 10 CFR Part 40 requirements, and applicable requirements set forth in Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content," to 10 CFR Part 40. This SER also evaluates the applicant's compliance with applicable requirements in 10 CFR Part 20, "Standards for Protection Against

Radiation." Furthermore, an environmental review is being conducted in parallel with the analysis as documented in this SER to address the environmental impacts associated with the proposed action.

The staff's safety review of the proposed NTEA satellite facility was performed using NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," (NRC, 2003) and is a comprehensive assessment of the applicants proposed ISR project. The regulations at 10 CFR Parts 20 and 40, and those in Appendix A to 10 CFR Part 40, contain the technical requirements for licensing an ISR project. This SER is organized following the organization of NUREG-1569 except that sections addressing environmental aspects are not included in the SER as they are addressed in the Environmental Assessment (EA).

The staff's review of the application for the proposed NTEA identified a number of facility-specific issues that require license conditions to ensure that the operation of the facility will be adequately protective of public health and safety. Table 1 includes the license condition language as well as the section of this SER where the need for the license condition was identified. These conditions are in addition to those that currently exist in Materials License SUA-1534 (NRC, 2012). The staff concludes that the findings described in succeeding sections of this SER, including the necessary license conditions, supports the issuance of a license authorizing the construction and operation of the facility. As such, the staff supports the issuance of the proposed license amendment authorizing the construction and operation of the NTEA satellite facility, provided that the conditions identified below are included in the license. By e-mail dated June 5, 2013, the applicant accepted all license conditions described in this SER (CBR, 2013).

Table I-1: License Conditions

SER Section	License Condition
2.2.4	Prior to commencement of operations, the licensee shall install a meteorological station within the NTEA license area and begin collecting meteorological data for a period of at least one year consistent with Regulatory Guide 3.63. The licensee shall continue to collect additional meteorological data on a continuous basis until the data collected is determined by the NRC with written verification to be representative of long-term meteorological conditions at the NTEA. Justification of the similarity or validity of the data shall include an analysis of the statistical data presented to illustrate confidence in the representativeness of the data. The meteorological data collected shall include wind speed, wind direction, temperature, precipitation, and humidity. The licensee shall also develop a relative frequency distribution for each stability class,sum all stability classes and format the stability classes consistent with Regulatory Guide 3.63. The applicant shall confirm and validate current onsite meteorological data against historical (May 1982 to April 1984) Crow Butte onsite

Table I-1: License Conditions	
	meteorological data and make appropriate changes to the environmental monitoring program if necessary. If changes to the environmental monitoring program are necessary, the licensee shall submit these changes to NRC staff for written verification.
2.4.4	The licensee shall minimize potential damage to infrastructure from peak flows by avoiding well installation within ephemeral drainage flood channel areas and within or near the White River flood channel areas at the NTEA. For wells installed within the high water marks of a 100-year flood plain in the Flood Insurance Rate Map issued by the Federal Emergency Management Agency, wellhead protection measures that are protective of the wells during flood conditions shall be provided to the NRC for review and written verification.
2.5.4, 2.6.4	Prior to major site construction, the licensee shall submit a preoperational radiological environmental monitoring program report for NRC review and written verification that will include air particulate, air radon, vegetation, food/crop, direct radiation, surface and subsurface soils, sediments, and surface water as described in Regulatory Guide 4.14 to comply with 10 CFR Part 40, Appendix A, Criterion 7. Surface soil samples shall include samples at 15 cm depth as described in NUREG-1569, Acceptance Criteria 2.9.3(2) for decommissioning purposes. Surface water samples shall also be analytically analyzed quarterly for the list of constituents in Table 2.7.3-1 of NUREG-1569. Sample analytical results shall be submitted to the NRC for written verification. If an alternate list of constituents tailored to the site, appropriate justification shall submitted to the NRC for review and approval before the sampling is implemented.
2.6.4	At least 60 days prior to the preoperational inspection, the licensee shall provide additional information to NRC for review and written verification for the justification and technical basis of the selection of the environmental air particulate sampling locations for AM-22, AM-23, AM-24 and AM-25 and how these sampling locations comport with Regulatory Guide 4.14.
2.6.4	At least 60 days prior to the preoperational inspection, the licensee shall provide justification that the location of sediment and surface water sampling location W-2 is consistent with Regulatory Guide 4.14 and identify the location of the other two sediment and surface water sampling locations (other than W-1 and W-2) for NRC review and written verification.
2.6.4	At least 60 days prior to the preoperational inspection, the licensee shall submit information on how its portable radiation survey technique (i.e., the sodium iodide readings) is consistent with the recommendations in Regulatory Guide 4.14 regarding gamma exposure rate measurements for

Table I-1: License Conditions	
	NRC review and written verification.
3.1.4	If wellfield designs include a line drive(s), a demonstration of the containment of fluids injected at the line drive and a description of the associated monitoring program shall be provided to NRC for review and approval.
3.1.4	The licensee will obtain the necessary underground injection control (UIC) permit to construct a minimum of one deep disposal well prior to the commencement of operations of the NTEA. The licensee shall ensure the deep disposal well shall have enough capacity to handle the disposal of the total liquid effluent generation. The licensee shall ensure adequate deep well disposal capacity exists to dispose of liquids under normal operating conditions during production and restoration phases. If land application disposal is necessary in the future at the NTEA, a facility specific land application plan under a license amendment application shall be submitted to the NRC for review and approval six months prior to its construction.
3.1.4	The licensee shall identify the location, screen depth, and estimated pumping rate of any new ground water wells, or new use of an existing well, within the licensed area and within two kilometers of any production area. The licensee shall evaluate the impact of ISR operations to potential ground water users and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted as part of the semiannual reporting to the NRC specified under license condition 11.1 (D).
4.2.4	The satellite plant throughput shall not exceed a maximum flow rate of 4,500 gallons per minute, excluding restoration flow.
4.2.4	The licensee shall submit a license amendment application for the solar evaporation pond design and specifications to the NRC for review and approval at least six months before the applicant's planned commencement of NTEA operations. As part of this amendment application, the licensee shall use the Dawes County, Nebraska Flood Insurance Rate Map issued by the Federal Emergency Management Agency in June 2011 (as revised), to demonstrate whether the proposed location of the evaporation ponds in the NTEA will subject the ponds to potential flooding and erosion impacts. If a potential flood and erosion impact is identified or if the evaporation ponds are within a 100 year flood plain, the amendment application shall either include a flood and erosion protection design that will be maintained until the ponds are decommissioned or propose a new location for the evaporation ponds within the NTEA that will not pose flood and erosion impacts.
5.5.4	The licensee shall submit to NRC staff for written verification the

Table I-1: License Conditions	
	qualifications of a designee that will conduct radiation safety training. Until such verification is received by the licensee, only the radiation safety officer (RSO) shall conduct radiation safety training.
5.7.8.4	At least 60 days prior to the preoperational inspection, the licensee shall submit an operational radiological environmental monitoring program for NRC review and written verification that will include air particulate, air radon, direct radiation, soils, vegetation, food, fish, sediments, and surface water as described in Regulatory Guide 4.14 to comply with 10 CFR Part 40, Appendix A, Criterion 7. The report shall include the location of each sampling media, frequency of sampling, and frequency and type of analysis in accordance with Regulatory Guide 4.14. Sediment samples shall be analyzed for Th-230 in accordance with Regulatory Guide 4.14.
5.7.9.4	Prior to the preoperational inspection, the licensee shall submit monitoring results to the NRC for review and written verification of each well within two kilometers of the proposed NTEA production area monitoring well ring that is or could be used for drinking water, livestock, and crop irrigation. The minimum sampling frequency shall be quarterly. Samples shall be analyzed for the UCL parameters and for natural uranium and radium-226.
6.4.4	Prior to the preoperational inspection, the licensee shall submit a gamma action level to be used for soil cleanup related to Ra-226 and natural uranium for NRC staff review and written verification.

NRC finds that the license amendment application for the NTEA satellite facility complies with the standards and requirements of the Atomic Energy Act of 1954, as amended, and the Commission's regulations. Based on its review, as documented in this SER, the staff concludes that the application meets the applicable requirements in 10 CFR Parts 20 and 40. More specifically, in accordance with 10 CFR 40.32(b-c), the staff finds that the applicant is qualified by reason of training and experience to use source material for the purpose it requested and that the applicant's proposed equipment and procedures for use at its NTEA facility are adequate to protect public health and minimize danger to life or property. Therefore, in accordance with 10 CFR 40.32(d), staff finds that the amendment of the license to the applicant will not be inimical to the common defense and security or to the health and safety of the public.

References

10 CFR Part 40, Appendix A, "Criteria Relating to the Operation of Uranium Mills and to the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily from their Source Material Content."

10 CFR Part 20, "Standards for Protection Against Radiation."
Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011 et seq.

CBR, 2013. Crow Butte Resources, Inc., e-mail to NRC. Regarding Final Draft of the Crow Butte Resources, Inc.'s License, June 5, 2013, ADAMS Accession No. ML13170A403.

CBR, 2012. Crow Butte Resources, Inc., North Trend Expansion Area License Amendment Application Page Changes-NETA Disposal Well Track Changes and NTEA Disposal Well Clean Copy, e-mail dated June 10, 2012, ADAMS Accession No. ML12165A343.

CBR, 2011. Crow Butte Resources, Inc., Crow Butte North Trend Expansion Area Replacement Pages, e-mail dated July 15, 2011, ADAMS Accession No. ML11200A246.

CBR, 2010. Crow Butte Resources, Inc., Response to NRC Staff's Open Issues of November 12, 2009 and March 24, 2010, October 22, 2010, ADAMS Accession No. ML103010530.

CBR, 2009a. Crow Butte Resources, Inc., Response to NRC Staff's Request for Additional Information of November 17, 2008, February 27, 2009, ADAMS Accession No. ML090750430 (Package).

CBR, 2009b. Crow Butte Resources, Inc., Missing Attachments to the North Trend License Amendment, November 20, 2009, ADAMS Accession No. ML093520688.

CBR, 2007. Crow Butte Resources, Inc., Application for an Amendment to UNSRC Source Materials License SUA-1534 – North Trend Expansion Area, May 30, 2007, ADAMS Accession No. ML072540671.

NRC, 2012. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320362 (Package).

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NRC, 2008. Request for Additional Information, November 17, 2008, ADAMS Accession No. ML083170842.

NRC, 2007. Letter to CBR, Acceptance Review, License Amendment Application for the North Trend Expansion Area, Crow Butte Resources, Inc., Crawford, Nebraska, ADAMS Accession No. ML072390004.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June, 2003.

1.0 PROPOSED ACTIVITIES

1.1 REGULATORY REQUIREMENTS

The purpose of this section is to determine whether the applicant's summary of the proposed activities at the NTEA is in compliance with the applicable requirements in 10 CFR 40.31.

1.2 REGULATORY ACCEPTANCE CRITERIA

The application was reviewed for compliance with the applicable requirements of 10 CFR 40.31 using the acceptance criteria presented in Section 1.3 of NUREG-1569 (NRC, 2003).

1.3 STAFF REVIEW AND ANALYSIS

1.3.1 Facility Description

The applicant seeks to extract uranium from an ore body located in the NTEA using ISR methods (CBR, 2009). Uranium extracted from the NTEA will be processed at a satellite plant located within the NTEA (CBR, 2007). This plant will operate at a flow rate of 17,000 liters per minute (lpm) (4,500 gallons per minute (gpm)) with an expected annual production rate of 226,796 kilograms (kg) to 272,155 kg (500,000 pounds (lb) to 600,000 lb) uranium (CBR, 2007). Total reserves for the North Trend Expansion Area are not developed at this time; however, CBR has estimated recoverable resources at approximately 2,267,960 kg (5,000,000 lb) uranium (CBR, 2007).

The proposed NTEA encompasses approximately 854 hectares (ha) (2,110 acres (ac)) (CBR, 2007). The facility will consist of 9 mine units, and the total area of all mine units will occupy approximately 530 ha (1,310 ac) based on the applicant's current knowledge of available reserves. All of the surface and mineral rights are owned by private entities. The proposed NTEA is located in Sections 21, 22, 27, 28, 33, and 34 of Township 32 North, Range 52 West. Application Figure 1.3-1 shows the general location of the current license area and the proposed NTEA. Application Figure 1.3-2 shows the land ownership in the proposed NTEA. (CBR, 2007)

1.3.2 General Operations

In the NTEA, uranium will be recovered from the Chadron Sandstone (CBR, 2007). The depth in the NTEA ranges from 122 m to 244 m (400 ft to 800 ft). The width varies from 30.5 m to 305 m (100 ft to 1,000 ft). The ore body ranges in grade from less than 0.05% to greater than 0. 5% U_3O_8, with an average grade estimated at 0.20% uranium. The applicant is currently licensed to inject lixiviant that contains sodium carbonate or sodium bicarbonate and oxygen or hydrogen peroxide at the currently operating facility; this application does not request a different lixiviant composition (License SUA-1534 (NRC, 2010a)).

Uranium extracted from the NTEA will be loaded onto ion exchange (IX) resin at the satellite plant (CBR, 2007). The loaded IX resin will be transported, by tanker truck, to the currently licensed Crow Butte facility central processing plant (CPP) for elution, drying and packaging. Stripped resin will be returned to the NTEA satellite plant by tanker truck. (CBR, 2007)

The applicant stated that it will operate its wellfields using a barren lixiviant production bleed of 0.5 to 1.5 percent (CBR, 2007). By withdrawing slightly more lixiviant than is injected, an inward hydraulic gradient would be maintained in each wellfield. This inward hydraulic gradient is used to prevent excursions, which is the potential migration of production fluids away from the ore body (CBR, 2007).

In Section 1.8.1, the applicant stated that liquid waste will be disposed using evaporation ponds, deep disposal wells, or land application (CBR, 2007). The applicant identified locations for the evaporation ponds and the deep disposal well in the application; however, the applicant stated (Section 4.2.1.1) that it is not seeking to dispose of liquid waste by land application, at this time (CBR, 2007). Therefore, land application is not approved as part of this amendment. The applicant must submit a separate amendment request to use land application.

Regarding evaporation ponds, the applicant prepared an evaporation design report in April 1988 (Ferrett, 1988). The applicant constructed evaporation ponds based on this design report, and these ponds have been operated in a manner which was protective of the public health and safety (refer to Section 4.2.3.1.2 of NRC, 2012). NRC staff observes that the application does not address the solar evaporation pond design or the associated site evaluation for the pond. The applicant plans to develop a license amendment application for the design and specifications of the evaporation ponds using the requirements of their most current solar evaporation pond design and construction regulatory guides and a site geotechnical assessment of the pond site (CBR, 2009). The exact number and capacity of the ponds at the NTEA will depend upon on the performance of the proposed deep disposal well in terms of the waste disposal injection rate. The license amendment application will also include plans for pond monitor wells used to demonstrate compliance with 10 CFR 40, Appendix A, Criterion 7a (CBR, 2009). Evaporation ponds are further discussed in Section 4.2 of this SER.

1.3.3 Schedule

In Figure 1.7-3 of the application, the applicant presented schedules for extraction and restoration for each proposed mine unit (CBR, 2007). The applicant stated that extraction will occur over a three-year period, followed by three years of restoration. Past experience with restoration at the currently licensed Crow Butte facility indicates that restoration requires more than three years to complete. The staff observes that the applicant applied for and received approval for an alternate schedule for restoration because actual restoration required more time than originally stated in its application (NRC, 2010b). If restoration will require more than three years to complete, an alternate schedule must be requested per 10 CFR 40.42.

1.3.4 Description of Ground water Restoration and Decommissioning

The applicant will implement a ground water restoration program at the NTEA concurrent with and after uranium extraction (refer to Figure 3.1-5 of CBR, 2010). Restoration will include, at a maximum, the following steps:

Ground water transfer
Ground water sweep
Ground water treatment
Wellfield recirculation (refer to Section 6.1.4 of CBR, 2010)

The staff observes that at the currently licensed facility the applicant may elect not to perform all restoration phases, if the applicant determines that a certain phase is not necessary. Such discretion in restoration is acceptable to the staff because flexibility is important to efficiently accomplishing restoration. However, the applicant must submit for review and approval a modified ground water restoration plan if it elects to use restoration strategies other than those listed above.

Once the restoration values are reached and maintained, restoration is deemed complete. Results are documented in a Restoration Report and submitted to the Nebraska Department of Environmental Quality (NDEQ) and the NRC for approval (CBR, 2007).

At the completion of mine life and after ground water restoration has been completed, all injection and recovery wells will be plugged and the site decommissioned (CBR, 2007). Decommissioning will include satellite plant disassembly and disposal, pond reclamation, and land reclamation of all disturbed areas. Appropriate NRC Regulatory Guidelines will be followed as required. (CBR, 2007)

1.3.5 Financial Assurance

The applicant maintains an NRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation activities. The applicant maintains an Irrevocable Standby Letter of Credit issued by the Royal Bank of Canada in favor of the State of Nebraska in the present amount of $35,398,802. The surety amount is revised annually in accordance with the requirements of SUA- 1534. The surety amount will be revised to reflect the estimated costs of reclamation activities for the NTEA as development activities proceed.

1.4 EVALUATION FINDINGS

The staff reviewed the proposed activities at the NTEA in accordance with review procedures in Section 1.3 of the standard review plan. Information contained in the application described the proposed activities at the NTEA facility, including: (1) the corporate entities involved (discussed in Introduction), (2) the location of the facility, (3) land ownership, (4) ore-body locations, (5) the proposed recovery process, (6) operating plans and design throughput, (7) schedules for construction, startup, and duration of operations, (8) waste management and disposal plans, and (9) financial assurance.

Based upon the review conducted by the staff as indicated above, the information provided in the application meets the applicable acceptance criteria of Section 1.3 of the standard review plan and the requirements of 10 CFR 40.31.

1.5 REFERENCES

Cameco, 2011. Cameco Resources, Crow Butte Operation, Class III UIC Permit NE0122611 April 2011 Monthly Restoration Report, May 18, 2011, ADAMS Accession No. ML11146A015.

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CBR, 2007. Crow Butte Resources, Inc., Application for an Amendment to UNSRC Source Materials License SUA-1534 – North Trend Expansion Area, May 30, 2007, ADAMS Accession No. ML072540671.

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NRC, 2010a. Materials License Amendment No. 25, ADAMS Accession No. ML100830012.

NRC, 2010b. Request for Alternate Decommission (Ground water Restoration) Schedule. February 18, 2010, ADAMS Accession No. ML092510030.

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2.0 SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

2.1.1 Regulatory Requirements

The staff determines if the applicant has adequately identified the site location in accordance with the requirements of 10 CFR 40.31(g)(2).

2.1.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR 40 using the acceptance criteria presented in Section 2.1.3 of NUREG-1569 (NRC, 2003).

2.1.3 Staff Review and Analysis

Except where noted, information in the SER section is derived from Section 2.1 of the application (CBR, 2007). The NTEA is located near the City of Crawford, Dawes County, in northwestern Nebraska. Crawford is the principal town in the area and is approximately 6.4 kilometers (km) (4 miles (mi)) northwest of the currently licensed Crow Butte central processing plant. Crawford is approximately 40 km (25 mi) west of Chadron, Nebraska, and 113 km (70 mi) north of Scottsbluff, Nebraska. Also, Crawford is 34 km (21 mi) south of the South Dakota state line and 53 km (33 mi) east of the Wyoming state line. The topography consists of low rolling hills dominated by the Pine Ridge south and west of the project area. (CBR, 2007)

The NTEA is located approximately 0.80 km (0.5 mi) due north of the City of Crawford, Dawes County, Nebraska, and the specific township and range locations are as follows: Sections 21, 22, 27, 28, 33, and 34 of Township 32 North, Range 52 West. The NTEA is also approximately 3.2 km (2 mi) northwest of the western edge of the currently licensed Crow Butte facility permit boundary. Application Figure 2.1-1 (CBR, 2007) shows the general location of the proposed NTEA and the 3.2-km (2.0-mi) review area associated with the NTEA. All of the minerals leased in the NTEA are on private lands, as depicted in application Figure 1.3-2 (CBR, 2007).

Application Figure 2.1-3 (CBR, 2009) presents the NTEA topography and layout with the proposed location of the satellite plant, wellfields, evaporation pond, and control area boundaries. The staff's review of this figure indicates that land surface generally slopes from west to east at a 2 percent grade. Highest elevation occurs along the western boundary near Mine Unit 6 at 1,149 meters above mean sea level (m msl) [3,770 feet above mean sea level (ft msl)]. Lowest elevations occur in the southeast corner of the site near Mine Unit 7 at 1,107 m msl) (3,630 ft msl).

Application Figure 2.1-4 (CBR, 2009) presents the project location with topographical features, drainage and surface water features, nearby population centers and political boundaries as well as principal highways, railroads, transmission lines, and waterways. The staff's review of this figure indicates that the NTEA is located approximately 0.80 km (0.5 mi) northeast of the Fort Robinson State Park Boundary. A review of aerial photographs indicates that the NTEA is located approximately 8 km (5 mi) northwest of the Nebraska National Forest – Pine Ridge

Ranger District (Google Earth, 2011). Major transportation links include US Highway 20, Nebraska State Routes 2/71, and the Dakota, Minnesota, and Eastern Railroad.

Application Table 2.2-9 presents the distance between the center of the site and the nearest neighbors for the each of the 16 cardinal directions (CBR, 2007). The staff's review of this table indicates that the nearest neighbor to the site is 1,036 m (3,400 ft) east-southeast of the site. No residences were identified in the north, west-southwest, and west-northwest directions.

Application Table 2.2-12 provides well depths of private wells in the vicinity of the NTEA. Staff observes the table does not indicate the unit of measurement for well depths. Staff finds that the unit of measurement is necessary for clarity of well depths. Therefore, NRC staff is imposing a license condition requiring the licensee to submit application replacement pages for Table 2.2-12 with the unit of measurement for well depths. This license condition is presented in SER Section 2.1.4.

2.1.4 Evaluation Findings

The staff has reviewed the site location and layout of the NTEA in accordance with the review procedures in Section 2.1.2, and the acceptance criteria in Section 2.1.3, of the standard review plan (NRC, 2003). The applicant has described the site location and layout with appropriately scaled and labeled maps showing the site layout, principal facilities and structures, boundaries, and topography.

The staff observes that Table 2.2-12 of the application does not indicate the unit of measurement for well depths. Staff finds that the unit of measurement is necessary for clarity of well depths. Therefore, the staff is imposing the following license condition:

> At least 60 days prior to the preoperational inspection, the licensee shall submit application replacement pages for Table 2.2-12 with well depth units.

Based upon the review conducted by staff as indicated above, the information provided in the application is consistent with the applicable acceptance criteria of Section 2.1.3 of the standard review plan (NRC, 2003) and meets the requirements of 10 CFR 40.31(g)(2).

2.1.5 References

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, "Domestic Licensing of Source Material," U.S. Government Printing Office, Washington, DC.

CBR, 2009. Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession No. ML090750430 (Package).

CBR, 2007. Crow Butte Resources, Inc., Application for an Amendment to UNSRC Source Materials License SUA-1534 – North Trend Expansion Area, May 20, 2007 (ADAMS Accession No. ML072540671)

Google Earth, 2011. Program can be downloaded at http://www.google.com/earth/index.html Accessed March 28, 2011.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June, 2003.

2.2 METEOROLOGY

This section discusses the meteorological conditions of the region surrounding and including the North Trend facility. Meteorological data is used for the selection of environmental monitoring locations, the assessment of the impact of operations on the environmental, and the performance of radiological dose assessments.

2.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the meteorology program, which is part of the site monitoring programs required by Criterion 7 of Appendix A to 10 CFR Part 40, is sufficiently complete to allow for estimating doses to workers and members of the public.

2.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed to ensure that the facility will continue to operate so as to protect health and safety and the environment using the acceptance criteria presented in Section 2.5.3 of NUREG-1569 (NRC, 2003).

2.2.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the meteorological conditions at the North Trend Facility. Aspects reviewed in the following sections include; general site conditions, meteorological data acquisition, wind, and air quality. The information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007) and as updated.

2.2.3.1 General Site Conditions

The NTEA (NTEA) is located in Dawes County, NE and is located several kilometers north of the city of Crawford, NE. The NTEA site is approximately 3 miles west and 5 miles north of the current process plant (CBR, 2010). Other cities within the region of the NTEA site are Chadron, NE and Rapid City, SD. The average annual temperatures range from23.5 °C (74.3 °F high) to -4.9°C,(23.2 degrees Fahrenheit [°F], low) . The staff observed that July was the warmest month recorded at the Chadron station and the average maximum and minimum warmest daily temperatures measured were 31.8°C (89.2°F) and 2°C (35.6°F), respectively. The staff observed that December was the coldest month recorded at the Chadron station; average maximum and minimum coldest daily temperatures measured were -15.2°C and -11.8°C (59.4°F and 10.8°F), respectively.

The applicant provided mean and maximum precipitation data for Chadron, NE from 1948 to 2003 in Table 2.5-3 of the TR (CBR, 2010) and precipitation events from 1982 to 1990 for Scottsbluff, NE and Rapid City, SD in Table 2.5-4 of the TR (CBR, 2010). NRC staff observed in Table 2.5-3 of the TR (CBR, 2010) that the annual mean precipitation was 40.79 cm (16.05 inches) for water (rain) and 107.44 cm (42.3 inches) for snow.
The applicant compared rainfall for spring and summer at Crawford and Chadron in 1999 in Table 2.5-5 of the TR (CBR, 2010) and showed that the total rainfall for the period of April to August was 37.9 cm (14.93 inches) and 37.3 cm (14.69 inches), respectively.

In addition to the precipitation data, the applicant provided percent relative humidity data from 1982 to 1990 for Scottsbluff, NE and Rapid City, SD in Table 2.5-6 of the TR (CBR, 2010).The applicant compared relative humidity between Chadron, NE, Scottsbluff, NE, and Rapid City, SD in Figure 2.5-3 of the TR (CBR, 2009). The 30-day averages of the humidity data shown in this figure indicate the highest relative humidity in April for all three locations and the lowest relative humidity in August for Rapid City and Chadron while Scottsbluff is approximately equally low in August and December.

2.2.3.2 Meteorological Data Acquisition

According to Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting," (NRC, 1988), an onsite meteorological measurement program should employ instrument systems physically located on or near the site that are capable of measuring meteorological information representative of the site vicinity. Meteorological measurements should be made in locations that can provide data representative of the atmospheric conditions into which material will be released and transported. The information is used to estimate the maximum potential annual radiation dose to the public and the environmental impact resulting from the routine release of radioactive materials in gaseous and particulate effluents.

The applicant, however, did not collect onsite meteorological data at the NTEA. With that said, as discussed in SER Section 2.2.3.3 below, the applicant has committed to install and operate a meteorological tower to verify that the data from the currently licensed facility accurately represents meteorological conditions at the NTEA. Based on the applicant's analysis of meteorological data in the vicinity of the NTEA, including data previously collected by the applicant and accepted by NRC staff, and the information that will be collected in accordance with the license condition presented in SER Section 2.2.4 to verify this data, NRC staff has reasonable assurance that the applicant's onsite meteorological data will be consistent with acceptance criteria NUREG-1569 2.5.3(1) (NRC, 2003).

2.2.3.3 Wind

In Section 2.5.5 of the TR (CBR, 2010), the applicant provided wind roses from Scottsbluff, NE, and Rapid City, SD and these wind roses show the dominant wind directions for each location. In addition to these two sites, the applicant also provided (Figure 2.5-6 of CBR, 2010) a wind rose for the Crow Butte facility, located southeast of the proposed satellite facility, collected from May 1982 to 1984.

In Section 2.5.5 of the TR (CBR, 2010), the applicant stated that they considered the two year Crow Butte site wind record to continue to be the most representative of the long-term wind conditions at the NTEA. To demonstrate the validity of this statement, the applicant compared short-term wind data from 1984 to 1990 for Scottsbluff, NE and Rapid City, SD to longer-term wind data (1961-2003) for these same locations. In Section 2.5 of the TR, (CBR, 2010) the applicant stated that these comparisons showed that while wind patterns differ from location to location, wind patterns at a specific site do not change significantly from year to year.

As indicated in SER Section 2.2.3.2 above, the applicant did not collect onsite meteorological data at the NTEA. Based on previously evaluated data, NRC staff has reasonable assurance that the meteorological data collected at the main facility will not be significantly different from the meteorological conditions at the proposed NTEA site. In addition, NRC staff has reviewed previous meteorological data and stability class from the currently licensed facility and found no technical reason for invalidating previous wind data. However, the applicant did not provide objective evidence that the meteorological data from the currently licensed facility are representative of long-term conditions at the proposed NTEA site.

In Section 2.5.5 of the TR (CBR, 2010), the applicant stated that at the outset of operations, it will install, and for one year, will operate a meteorological tower at the proposed facility to verify the representativeness of the historic Crow Butte data used in the proposed license amendment application. NRC staff is capturing this commitment with a license condition requiring the installation of a meteorological station at the NTEA. This license condition is presented in SER Section 2.2.4.

In Section 2.5.5 of the TR (CBR, 2010), the applicant stated that a description of how the stability classes were calculated could not be found in CBR's archived records. The applicant stated that based on the type of meteorological data collected onsite, it may be assumed the stability classes were calculated using the Sigma Theta Method. This method was the most common method historically used to calculate stability class, because all that was required was wind speed and wind direction. This method was also used in a number of standard air modeling programs. It is very likely that the CBR stability class data generated historically was calculated this way since there was not a lot of other data available beyond wind speed and wind direction (CBR, 2010). Staff uses joint frequency distribution data to assess annual public doses. The applicant provided frequency of winds by direction and speed for each class including a summary of all stability classes (Class A thru F) as shown in Table 2.5-7 thru 2.5-13 in the TR (CBR, 2010). NRC staff observes that the frequency distributions are defined by each of the sixteen wind directions and wind speed intervals, as well as the average or mean wind speed for the Crow Butte site from May 1982 to April 1984.

The applicant also provided joint frequency distribution data, which is expressed as a decimal frequency in Table 2.5-14 of the TR (CBR, 2010) for each stability class (Class A through Class F) and represents a summary of the meteorological conditions at the meteorological station location for a two-year period (May 1982 to April 1984). NRC staff summed all the stability classes (Class A through F) and observes that the results represent 99.91% of the frequency distribution.

The applicant indicated in Section 2.5.5 of the TR (CBR, 2010) that the nearest national weather station to NTEA that reports mixing height values is located in North Platte, NE. This station is approximately 274 kilometers (170 miles) southeast of the City of Crawford. The applicant stated that due to the distance, the data are not considered representative of the NTEA and that mixing height data were not available for the Crow Butte meteorological station.

Due to the unavailability of relevant mixing height data, the applicant utilized a mixing height default value of 100 meters (m). The applicant indicated that the default value of 100 m (328 ft) was from NUREG/CR-2011 (NRC, 1981). Staff observes that the default value in NUREG/CR-2011 is 1000 m (3281 ft), not 100 m (328 ft). NRC staff reviewed the annual mixing heights

(morning and afternoon) for North Platte, NE in Table B.1 of a U.S. EPA study (1972) and found that the annual mixing heights for morning and afternoon were 329 m (1079 ft) and 1509 m (4951 ft), respectively. This was the only mixing height value for Nebraska in the U.S. Environmental Protection Agency (EPA) study (1972). The EPA (1972) mixing height values for N. Platte, NE are much higher than the default mixing height used in MILDOS (Yuan, 1989). To determine if the applicant's default mixing height was reasonable, NRC staff computed annual radiation doses, expressed in mrem/yr, using MILDOS with different mixing heights at 50 m (164 ft), 100 m (328 ft), 1000 m (3281 ft), and 1500 m (4921 ft), as well as the annual mixing heights identified by U.S. EPA (1972) for N. Platte, NE and using a hypothetical release rate of 1000 Curies of Radon-222.

Table 2.2-1: Effect of Mixing Height on Annual Dose

Mixing Ht (m)	Mixing Ht (m)	Receptor Points (x,y) in Km	Receptor Points (x,y) in Km	Receptor Points (x,y) in Km	Receptor Points (x,y) in Km	Receptor Points (x,y) in Km	Receptor Points (x,y) in Km
AM	PM	(1,0)	(2,0)	(3,0)	(0,1)	(0,2)	(0,3)
		mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr	mrem/yr
50	50	2.47	0.903	0.543	12.2	4.29	2.54
100	100	2.29	0.764	0.427	11.8	3.83	2.1
1000	1000	2.23	0.704	0.379	11.7	3.71	1.99
1500	1500	2.23	0.704	0.378	11.7	3.71	1.99
329	1509	2.23	0.703	0.378	11.7	3.71	1.99

The computation used several hypothetical receptor points and the results showed that the annual radiation dose decreases as the mixing height increases at each receptor point. The annual dose at the N. Platte, NE receptor point did not differ from the hypothetical receptor point at 1000 m (3281 ft) and 1500 m (4921 ft). NRC staff has determined that the default mixing heights (morning and afternoon) used in the applicant's MILDOS computation resulted in a higher and more conservative estimated annual dose than had the applicant used the annual average mixing heights (morning and afternoon) from the EPA study (1972) for N. Platte, NE or the actual default value of 1000 m (3281 ft) in NUREG/CR-2011. Therefore, NRC staff accepts the default mixing height of 100 m (328 ft) as used in the MILDOS computation by the applicant and has reasonable assurance that its use is protective of health and safety.

2.2.3.4 Air Quality

In Section 2.5.6 of the TR, (CBR, 2010), the applicant presented updated data on the existing air quality in nearby areas that they determined to be geographically similar to the proposed facility. Non-radiological air concentrations for particulate matter with diameters less than 0.001 cm (0.00039 inches) were presented for a rural area near Rapid City, SD, and the Badlands National Park in South Dakota (CBR, 2010). The reported concentrations were obtained from the United EPA air quality monitoring database and were below the National Ambient Air Quality Standards (NAAQS) for maximum 24 hour average concentrations and annual average concentrations (CBR, 2010). NRC staff finds this information acceptable as it comes from an authoritative reference source. In addition, NRC staff finds the results acceptable for characterizing the air quality at the applicant's site as it is consistent with previous staff

conclusions on ISR activity, in general, for both operations and restoration in the Nebraska-South Dakota-Wyoming Uranium Milling Region (NRC, 2009).

The applicant also stated that all counties within 80 km (50 mi) of the project are in attainment of NAAQS. NRC staff independently verified this statement by sampling EPA's database (EPA, 2012) for several air pollutants and therefore finds the information the applicant provided on air quality acceptable.

2.2.4 Evaluation Findings

NRC staff reviewed the meteorological data submitted by the applicant for the proposed NTEA facility in accordance with Section 2.5.3 and Appendix A of NUREG-1569 (NRC, 2003). NRC staff reviewed general site conditions, meteorological data acquisition, wind, and air quality. NRC staff has determined that the applicant provided sufficient information consistent with the regulatory guidance and acceptance criteria as identified in the above sections with the exception of the installation of an onsite meteorological station. The applicant stated that at the outset of operations it will install, and for one year will operate, a meteorological tower at the proposed NTEA facility to verify the representativeness of the historic Crow Butte Central Processing Plant data used in the proposed NTEA facility license amendment application. NRC staff is imposing the following license condition to ensure compliance with 10 CFR Parts 20 and 40:

> Prior to commencement of operations, the licensee shall install a meteorological station within the NTEA license area and begin collecting meteorological data for a period of at least one year consistent with Regulatory Guide 3.63. The licensee shall continue to collect additional meteorological data on a continuous basis until the data collected is determined by the NRC with written verification to be representative of long-term meteorological conditions at the NTEA. Justification of the similarity or validity of the data shall include an analysis of the statistical data presented to illustrate confidence in the representativeness of the data.
>
> The meteorological data collected shall include wind speed, wind direction, temperature, precipitation, and humidity. The licensee shall also develop a relative frequency distribution for each stability class and sum all stability classes and format the stability classes consistent with Regulatory Guide 3.63.
>
> The applicant shall confirm and validate current onsite meteorological data against historical (May 1982 to April 1984) Crow Butte onsite meteorological data and make appropriate changes to the environmental monitoring program if necessary. If changes to the environmental monitoring program are necessary, the licensee shall submit these changes to NRC staff for written verification.

Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented by information to be collected and verified in accordance with the noted license condition, meets the applicable acceptance criteria of Section 2.5.3 of the Standard Review Plan (NRC, 2003) and the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.2.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, Appendix A, "Criteria Relating to the Operation of Uranium Mills and to the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily from their Source Material Content."

CBR, 2010. Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Radioactive Source Material License no. SUA-1534, Crow Butte Resources Inc., October 22, 2010, ADAMS Accession No. ML103010525

CBR, 2009. Crow Butte's Response to NRC Request for Additional Information Technical Report North Trend Expansion Area, February 28, 2009, ADAMS Accession No. ML090750429.

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML073480264 (Package).

EPA, 2012. Nonattainment Areas Map-Criteria Air Pollutants, AirData website located at: http://www.epa.gov/air/data/reports.html, accessed February 2012.

NRC, 2009. NUREG-1910, Vol. 1, "Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, Chapter 1 through Chapter 4, Final Report," May 2009.

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications-Final Report." June 2003.

NRC, 1981. MILDOS-A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations, NUREG/CR-2011 PNL-3767, April 1981.

NRC, 1988. Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities Data Acquisition and Reporting", March 1988.

USEPA, 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States. EPA/AP-101, Document # 450R72102, U.S. Environmental Protection Agency, Washington, D.C.

Yuan, 1989. Yuan, Y.C., J.H.C. Wang, and A.J. Zielen, 1989. ANL/ES-161, "MILDOS-AREA: an Enhanced Version of MILDOS for Large-Area Sources," Argonne National Laboratory, Argonne, IL, June 1989.

2.3 GEOLOGY AND SEISMOLOGY

2.3.1 Regulatory Requirements

The purpose of this section is for the staff to determine if the applicant provided sufficient characterization of geology and seismology at the NTEA for staff to be able to assess the applicant's ability to control production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.3.2 Regulatory Acceptance Criteria

The applicant's characterization of geology and seismology at the NTEA was reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.6.3 of NUREG-1569 (NRC, 2003).

2.3.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the geology and seismology of the NTEA. The aspects reviewed in the following sections include: regional geology, site geology, soils, mineralogy, exploration boreholes, and seismology. The information reviewed in this section is from information, data, and maps submitted by Crow Butte Resources, Inc. (CBR) in their application (CBR, 2007) and as updated. NRC staff also visited the site on several occasions during the course of this review.

2.3.3.1 Regional Geology

2.3.3.1.1 Regional Stratigraphy

The applicant presented the regional bedrock geologic map and generalized stratigraphic column, respectively, of northwestern Nebraska in Figure 2.6-1 and Table 2.6-1 of the NTEA application (CBR, 2009). Geological units found in northwestern Nebraska include, from oldest to youngest, the Pierre Shale and the White River Group. The White River Group includes, from oldest to youngest, the Basal Chadron Formation, the Middle and Upper Chadron Formations, and the overlying Brule Formation. The applicant reported that on a regional scale, the Dakota, Morrison, and Sundance Formations underlie the Pierre. NRC staff reviewed the description of the geologic units provided by the applicant (CBR, 2009) and compared this information with independent sources to confirm the applicant's description of the regional geology. NRC staff confirmed that the applicant's description of the regional geology is consistent with the local and regional stratigraphy and geologic descriptions presented by Collings and Knode (1984), Miller and Appel (1997), and Hoganson, et al. (1998).

Staff observes that the region covered by the applicant's characterization of the regional stratigraphy includes both the currently licensed facility and NTEA (CBR, 2009). The staff previously evaluated the regional stratigraphy at the currently licensed facility (NRC, 2012a) and found it acceptable. Therefore, staff has reasonable assurance that the applicant's characterization of the regional stratigraphy is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the applicant's characterization of the regional stratigraphy and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's characterization of the regional

stratigraphy at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's characterization of the regional stratigraphy.

2.3.3.1.2 Regional Structure

The NRC staff reviewed the description of the regional geologic structure provided by the applicant. The applicant described the Black Hill Uplift, Chadron Arc, the White River Fault, Pine Ridge Fault, Bordeaux Fault, Toadstool Park Fault, and Cochran Arch as part of the regional-scale structural features (CBR, 2009). NTEA is located within a structure feature known as the Crawford Basin, which is a triangular shaped basin bounded by the Toadstool Park Fault to the northwest, the Chadron Arch and Bordeau Fault to the east, and the Cochran Arch and Pine Ridge Fault to the south (CBR, 2009). NRC staff confirmed that the applicant's description of regional structural features at and near Dawes County is consistent with the information provided by Collings and Knode (1984).

Staff observes that the region of the applicant's characterization of the regional geologic structure includes both NTEA and the currently licensed facility (NRC, 2009). The staff previously evaluated the regional geologic structure in the prior license renewal review (NRC, 2012a) and found it acceptable. Therefore, staff has reasonable assurance that the applicant's characterization of the regional geologic structure is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the applicant's characterization of the regional geologic structure and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's characterization of the regional geologic structure at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's characterization of the regional geologic structure.

2.3.3.2 Site Geology

2.3.3.2.1 Site Stratigraphy

NRC staff observes recent studies of the regional geology have resulted in the proposal of a new nomenclature for some of the geologic layers within the license area (LaGarry, 1998). In its discussions of site geology, the applicant used the nomenclature found in the prior license applications (CBR, 1995). After reviewing information from the U. S. Geological Survey (USGS), the staff determined that the USGS identifies a basal portion of the Chadron Formation, as well as a Chamberlain Pass Formation of Eocene age (38 to 55 million years ago) (USGS, 2011a). In Nebraska, the USGS does not identify a Chamberlain Pass Formation, but does identify a basal channel deposit at the base of the Chadron Formation (USGS, 2011b). Furthermore, the NDEQ uses the traditional stratigraphic terms, an example of which may be found in the applicant's application for a Class III underground injection control permit for its NTEA (CBR, 2010). Stratigraphic nomenclature aside, nothing in the naming conventions for the geologic units in Nebraska, or at the NTEA changes the interpretation of the physical or hydraulic features of the rock units. Therefore, the staff will continue to use the current naming conventions presented in the application (CBR, 2009).

The applicant provided a detailed description of the stratigraphy at the NTEA. Figures 2.6-2a, 2.6-2b, and 2.6-2c of the application present a stratigraphic column of the geologic units at the NTEA (CBR, 2009). Based on data presented in the application (CBR, 2009), staff observes that following thicknesses of the various geologic units:

Brule	15 to 30 m (50 to 100 ft),	Upper Aquifer
Middle/Upper Chadron	94 to 198 m (310 to 650 ft),	Upper Confining Unit
Basal Chadron Sandstone	6 to 52 m (15 to 170 ft),	Ore Zone Aquifer
Pierre Shale	386 to 477 m (1,265 to 1,565 ft),	Lower Confining Unit

NRC staff observes that these geologic units are consistent with regional units referenced in SER section 2.3.3.1.1. Further detail of staff's evaluation of the applicant's stratigraphic information is provided below for each geologic unit.

Pierre Shale - Lower Confinement

The applicant indicated that the Pierre Shale is a regional marine shale. Staff observes that the depth to the Pierre Shale shown in the applicant's cross sections is approximately 131 to over 213 m (430 to over 700 ft) below the ground surface (bgs). (CBR, 2009)

In section 2.6.2.2 of the application, the applicant reported that the Pierre Shale is the lower confining layer beneath the production zone (the Basal Chadron unit) and is regionally continuous and sufficiently thick throughout the NTEA (CBR, 2009). Staff observes the applicant's borehole geophysical logs as illustrated in the applicant's cross sections and structure contour map show that the Pierre Shale is laterally continuous throughout the NTEA (Figures 2.6-6 to 2.6-14 and 2.6-21 in CBR, 2009). Staff observes that geophysical log of an oil and gas well within the NTEA indicate that the Pierre Shale has a sufficient thickness within the NTEA of around 386 m (1,265 ft) as illustrated in application Figure 2.6-3 (CBR, 2009). Thus, staff finds that the applicant provided information to demonstrate that the Pierre Shale is an underlying confining layer that is sufficiently thick and laterally continuous throughout the NTEA.

The applicant also indicated that its geophysical logs and the oil and gas well geophysical log do not show any significant permeable (water-bearing) zones within the Pierre Shale underlying the NTEA (CBR, 2009). The applicant reported that X-ray diffraction analyses of Pierre Shale samples indicate the unit is comprised of smectite (CBR, 2009). Staff observes that the results of the applicant's particle grain size distribution analyses of a Pierre Shale sample provided in application Table 2.6-4 show a composition consisting of silt- and clay-sized particles. Coupled with the electric log characteristics as shown in the applicant's cross sections (CBR, 2009), staff observes the applicant's sample analysis results demonstrate the impermeable nature of the Pierre Shale. Additionally, the applicant indicated that measured vertical hydraulic conductivity of this regional unit at the nearby CBR operating ISR facility is less than 10^{-10} centimeters per second (cm/sec) (CBR, 2009). Staff finds that the applicant provided sufficient information to demonstrate that the Pierre Shale is a satisfactory underlying confining layer throughout the NTEA. Staff also finds that the applicant's description of the Pierre Shale confining unit to be consistent with the acceptance criteria in Section 2.6.3 of the NUREG-1569 (NRC, 2003) and therefore acceptable.

Basal Chadron Formation - Extraction Unit

The applicant's proposed uranium extraction unit at the NTEA is the Basal Chadron Sandstone. The applicant stated that the Basal Chadron, which lies unconformably over the thick Pierre Shale, is a coarse-grained arkosic sandstone interbedded thin clay beds (CBR, 2009). Staff observes that the applicant's cross sections, isopach contour map, and structure contour map of the Basal Chadron Sandstone (Figures 2.6-6 to 2.6-14, 2.6-21, and 2.6-22 in CBR, 2009) show the Basal Chadron Sandstone is laterally continuous throughout the NTEA and has a thickness that ranges from approximately 6 to 52 m (15 to 170 ft) (CBR, 2009). Staff finds that the applicant has demonstrated the location and lateral continuity of the Basal Chadron Sandstone production interval throughout the NTEA.

The applicant reported detailed geochemical analysis of the Crow Butte uranium ore conducted by Hansley, et al (1989), a USGS publication. The application stated that NTEA ore deposits are roll front deposits with coffinite being the predominant uranium mineral species present (CBR, 2009). The heavy mineral portion of the samples included garnet, magnetite, marcasite, and illmenite. Vanadium was detected in the samples primarily as an amorphous species rather than as discrete mineral phases (Hansley, et al, 1989). The application indicated that Hansley et al (1989) found that uranium has remained in a reduced state, as evidenced by unoxidized minerals (e.g., coffinite and uraninite) comprising the bulk of the ore. The applicant stated that thin section examination of Basal Chadron Sandstone samples collected in the currently licensed Crow Butte facility indicated that the Basal Chadron Sandstone was composed of 50 percent monocrystalline quartz, 30 to 40 percent undifferentiated feldspar, plagioclase feldspar and microcline feldspar (CBR, 2009). The remainder includes polycrystalline quartz, chert, chalcedonic quartz, various heavy minerals and pyrite. X-ray diffraction analyses of samples from the currently licensed facility indicated that the Basal Chadron Sandstone is 75 percent quartz with the remainder K-feldspar and plagioclase (CBR, 2009). The applicant stated that the ore ranges from 0.05 percent to greater than 0.5 U308. Staff finds that the applicant's geochemical description of the Basal Chadron Sandstone production interval to be sufficient for the NTEA. Staff finds that the applicant's characterization of the Basal Chadron Sandstone to be consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

Upper and Middle Chadron Formations – Upper Confinement

The Basal Chadron sandstone is separated from the overlying Brule Formation by the Middle and Upper Chadron confining unit, which is 94 to 198 m (310 to 650 ft) thick. The Middle Chadron is described by the applicant as clay-rich with interbedded bentonitic clay; and the Upper Chadron is described by the applicant to be a bentonitic clay grading downward to green and red clay. Between the Middle and Upper Chadron units, the applicant reported that an intermittent sand layer is present, but is not continuous throughout the NTEA. (CBR, 2009) Staff observes that the intermittent sand layer shown in the applicant's isopach contour map (Figure 2.6-24 in CBR, 2009) is 0 to 26 m (0 to 85 ft) thick within the NTEA.

The applicant reported that X-ray diffraction analyses of Middle Chadron samples indicated that the unit is primarily composed of smectite (CBR, 2009). The applicant also indicated that the results of particle grain size analyses of these samples showed that the Middle Chadron unit is composed of silty claystones or clayey siltstones (CBR, 2009). Staff observes that Middle

Chadron particle grain size sample results provided in application Table 2.6-4 (CBR, 2009) show a composition consisting of silt- and clay-sized particles. Additionally, the applicant reported that X-ray diffraction analyses of red clay samples from the Upper Chadron unit indicated that unit is primarily composed of montmorillonite and calcite (CBR, 2009). Coupled with the electric log characteristics as shown in the applicant's cross sections (CBR, 2009), staff observes applicant's sample analysis results demonstrate the impermeable nature of the Middle and Upper Chadron clay units.

Staff observes that the depth to and thickness of the Middle/Upper Chadron unit in the applicant's cross sections of the NTEA is approximately 15 to 30 m (50 to over 100 ft) bgs and approximately 94 to 198 m (310 to 650 ft), respectively. Staff observes that the thickness of the Middle Chadron unit in the applicant's isopach contour map (Figure 2.6-23 in CBR, 2009) is 30 to 110 m (97 to 360 ft) within the NTEA; and the thickness of the Upper Chadron unit in the applicant's isopach contour map (Figure 2.6-25 in CBR, 2009) is 43 to 84 m (140 to 275 ft) within the NTEA. Based on the applicant's borehole logs as illustrated in the applicant's cross sections and isopach contour maps, staff observes that the Middle and Upper Chadron unit is laterally continuous and sufficiently thick throughout the NTEA (Figures 2.6-6 to 2.6-14, 2.6-23 and 2.6-25 in CBR, 2009). Staff finds the applicant has demonstrated that the Basal Chadron production zone is stratigraphically isolated from the overlying water-bearing Brule Formation by the Middle and Upper Chadron clay units.

Staff finds that the applicant provided information to demonstrate that the Middle and Upper Chadron unit is an overlying confining layer that is sufficiently thick throughout the NTEA. Staff finds that the applicant's description of the Middle and Upper Chadron confining unit to be consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

Brule Formation

The applicant stated that the Brule Formation lies conformably on top of the Chadron Formation (CBR, 2009). Staff observes that the thickness of the Brule Formation in the applicant's cross sections of the NTEA is approximately 15 to 30 m (50 to over 100 ft) bgs (Figures 2.6-6 to 2.6-14 in CBR, 2009). The applicant also stated that Brule Formation in the NTEA primarily consists of the Orella Member. Also present locally is the Whitney Member, which has predominantly been erosionally removed. The Orella Member is composed of volcaniclastic overbank clayey siltstones, silty claystones, overbank sheet sandstones, and volcanic ash. (CBR, 2009).

The application indicates that the Orella Member contains thick channelized sandstones, which the applicant indicated have an apparent limited lateral extent (CBR, 2009). The applicant stated that these sandstones are water-bearing, but do not always produce usable amounts of water. Staff finds that the applicant's characterization of the Basal Chadron Sandstone to be consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

The NRC staff finds the stratigraphy across the NTEA discussed in this SER section is sufficiently described. These descriptions were sufficiently supported by geologic data and data illustrations in the application (e.g., borehole logs, X-ray diffraction, particle grain size analyses, isopach maps, and cross sections) (CBR, 2009). NRC staff's detailed review of the applicant's geologic data and data illustrations (3-D views, isopach maps, cross sections, and logs) found the information to be acceptable. Staff finds the assessment of site stratigraphy to be consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

2.3.3.2.2 NTEA Local Structure

The applicant provided a description of the local structure at the NTEA (CBR, 2009). The applicant also presented cross sections of the top of the Pierre and Basal Chadron (application Figures 2.6-7 through 2.6-15), which illustrate the orientation of formation bedding across the NTEA. Staff observes that the top of the Pierre dips to the south in the NTEA through Sections 22, 27, and 34. (CBR, 2009)

Previous drilling identified a structural feature located between the current permit area and the proposed NTEA permit area (FEN, 1987). The general location of the feature is shown in cross sections, structure contour maps, and three-dimensional geological illustrations (Application Figures 2.6-11 to 2.6-14, 2.6-16 to 2.6-20 and 2.6-22 in CBR, 2009). Staff observes that this feature is oriented NE-SW generally along the drainage of the White River (CBR, 2009). This feature was originally interpreted as the White River Fault (FEN, 1987). In the application (CBR, 2009), the applicant stated that deep geologic data are limited, but suggest that the formation bedding displacement along the feature appears to be approximately 61 m (200 ft), upthrown to the south-southeast (CBR, 2009). The applicant stated that recent close spaced drilling indicates that this feature may be interpreted as a fold or bending of the White River Group above a blind fault structure at stratigraphically lower elevations rather than a fault that cuts through and vertically displaces the White River Formation as initially interpreted by Collings and Knode (1984). The cross sections, structure contour maps, and three-dimensional geological illustrations therefore do not reflect the presence of the White River Fault feature (CBR, 2009).

NRC staff agrees with the applicant that the new interpretation without the fault shown on the cross sections is feasible. However, to further assess whether or not the structural feature is a fault or a monocline fold, NRC staff performed a probabilistic statistics analysis of 2 sets of 5 numerical ground water flow models. This analysis is discussed in SER Section 2.4.3.4.

Based on this evaluation, NRC the staff finds the characterization of the local geologic structure at the NTEA to be consistent with acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and therefore acceptable. The applicant proposed new interpretation of the White River structural feature, by declaring it a monocline fold instead of a fault. The staff concurs with the applicant's new interpretation, as further discussed in SER Section 2.4.3.3.

2.3.3.3 Well / Exploration Boreholes and Economically Significant Deposits

The applicant referred to previous exploratory drill holes that were performed for the NTEA project to explore the uranium deposit and characterize the geology. According to NDEQ (NRC,

2012b), all NTEA exploratory test holes conducted at the NTEA were properly plugged and abandoned in accordance with the requirements of the State of Nebraska. NRC staff observes that evidence of a vertical conduit through the upper confining unit from improper abandoned exploration drill holes was not seen in data collected by the applicant at NTEA (e.g. results of the pumping test conducted at the NTEA (refer to SER Section 2.4 for the analysis of the pumping test)).

Staff also observes that oil and gas activities have not occurred in Dawes County since 1994 (NOGCC, 2011) and coal has not been produced anywhere in Nebraska (U.S. Energy Information Administration, 2011). The applicant stated that the Brule and Chadron at the NTEA have been previously penetrated by an oil and gas test hole, which is located in Section 34, T32N, R52W and referred to as the E.A. Soester No.1. Staff observed that the Nebraska Oil and Gas Conservation Commission (NOGCC) lists the E.A Soester No. 1 test hole (API Well # 26045219730000) as properly plugged and abandoned (NOGCC, 2011). The applicant also stated five other oil and gas test holes were conducted within a two-mile radius of the NTEA and were subsequently abandoned. According to NOGCC regulations, staff observes all oil and gas test holes are properly plugged and abandoned in accordance with the requirements of the State of Nebraska. Staff finds that the oil and gas test holes and the above-referenced exploration test holes are properly plugged are not vertical conduits for fluid migration from the Basal Chadron Sandstone through either the upper or lower confining units.

The applicant stated that sand and gravel are the only non-fuel minerals produced in Dawes County (CBR, 2009). Based on a site visit in 2011, NRC staff did not see any activities for the pursuit of economic deposits. The only significant land disturbance activity seen by the NRC at that time was cultivation for farming. Staff finds the applicant's inventory of economically significant and energy related deposits and well/exploration borehole information to be consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

2.3.3.4 Seismology

Application Figure 2.6-27 adopted from a U.S. Geological Survey illustration shows that NTEA and the surrounding region are in seismic risk Zone 1, which is an area of low Seismic Hazard (CBR, 2009). Staff observes that NTEA and the nearby previously licensed Crow Butte facility are in the same the seismic risk Zone 1 (refer to Section 2.3.3.3 of NRC, 2012a). Staff previously found the applicant's assessment of seismology at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's assessment of seismology is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the assessment of seismology and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's assessment of seismology at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's assessment of seismology.

2.3.3.5 Soils

The applicant described the soils in the NTEA based on a Soil Survey of Dawes County published in 1977 by the Natural Resources Conservation Service (NRCS) (CBR, 2009). Soils in semiarid Dawes County were described as being saprolitic (i.e. formed by weathering of materials of the underlying geologic formations) or formed of materials deposited by wind and

water. Weathered Brule Formation was identified as being exposed on lower slopes producing the Epping, Kadoka, Deota, Schamber and Mitchell soils. Top soil appears to be present over most of the NTEA. Several of the surface soils that are unprotected were described to be a wind or water erosion hazard, or both, at various degrees (CBR, 2009). The staff finds the applicant's assessment of soils to be supported by published studies and maps produced by the NRCS (1977) and consistent with the acceptance criteria in Section 2.6.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

2.3.4 Evaluation Findings

The staff has completed its review of the site characterization information addressing geology and seismology at the NTEA in accordance with Section 2.6.3 of NUREG-1569 (NRC, 2003). The applicant has adequately described the geology and seismology by providing: (1) a description of the local and regional stratigraphy; (2) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy; (3) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone; (4) a description of the local and regional geologic structure; (5) a discussion of the seismicity and seismic history of the region; (6) a generalized stratigraphic column that includes the thickness of rock units, a representation of lithologies, and a definition of mineralized horizon; and (7) a description and map of the soils. Based upon the review conducted by the staff as indicated above, the information provided in the application is consistent with the applicable acceptance criteria of Section 2.6.3 of NUREG-1569 (NRC, 2003) and meets the requirements of 10 CFR 40.41(c).

2.3.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010. Application for a Class III Underground Injection Control Permit, North Trend Expansion Area, January 31, 2010 (ADAMS Accession No. ML100432245).

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession No. ML090750430 (Package)..

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

CBR, 1995. Application for Renewal of USNRC Radioactive Source Material License No. SUA-1534, Crow Butte Resources Inc., December 31, 1995, ADAMS Accession No. ML082060561 (Package).

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Ferret Exploration Company of Nebraska, Inc. (FEN), 1987. Application for Source Material License, Ferret Exploration Company of Nebraska, Inc., October 7, 1987, ADAMS Accession No. ML080940335 (Package).

Hansley, P.L., S.P. Collings, I.K. Brownfield, and G.L. Skipp, 1989. Mineralogy of Uranium Ore from the Crow Butte Uranium Deposit, Oligocene Chadron Formation, Northwestern Nebraska, USGS Open File Report 89-225.

Hoganson, J.W., Murphy, E.C. and Forsman, N.F., "Lithostratigraphy, paleontology, and biochronology of the Chadron, Brule, and Arikaree Formations in North Dakota", in Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., 1998. Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 185-196.

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NOGCC, 2011. Nebraska Oil and Gas Conservation Commission, Nebraska Oil and Gas Well Website, http://www.nogcc.ne.gov/NOGCCOnlineGIS/, accessed on June 8, 2011

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2012b, Conversation Record - Abandonment of Mineral Exploration Drill Holes, Crow Butte North Trend Expansion Area, Docket No. 04008943, September 5, 2012, ADAMS Accession No. ML12290A269

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

US Energy Information Administration, 2011. Nebraska State Profile and Energy Estimates http://www.eia.gov/state/state-energy-profiles.cfm?sid=NE, Accessed June 8, 2011.

USGS, 2011a, Description of the White River Group in South Dakota, http://tin.er.usgs.gov/geology/state/sgmc-unit.php?unit=SDTw%3B0, accessed on December 13, 2011.

USGS, 2011b, Description of the White River Group in Nebraska, http://tin.er.usgs.gov/geology/state/sgmc-unit.php?unit=NETw%3B0, accessed on December 13, 2011.

2.4 HYDROLOGY

2.4.1 Regulatory Requirements

The purpose of this section is to determine if the applicant has demonstrated that the characterization of surface and ground water hydrology at the NTEA ISR Project is sufficient to support an analysis of the applicant's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003).

2.4.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the surface water and ground water hydrology of the NTEA ISR Project. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Crow Butte Resources, Inc. (CBR) in their application (CBR, 2007) and as updated.

2.4.3.1 Surface Water Hydrology

The applicant stated that the NTEA is located within the Upper White River watershed. The Upper White River watershed occupies approximately 9,868 sq km (3,810 sq mi) in Dawes County, Nebraska, and Shannon County, South Dakota (CBR, 2010). Within this watershed, the NTEA is contained within the sub-watersheds of the ephemeral Spring Creek and an unnamed ephemeral stream of White River respectively located in the northern and southern portions of the project (CBR, 2010). Application Figure 2.7-1 provides an illustration of the topography and surface water features at the NTEA. The applicant indicated that natural surface impoundments, ponds, and lakes are absent in the NTEA. Staff corroborated the presence of the two above-referenced sub-watersheds and the absence of surface impoundments, ponds, and lakes within the NTEA using the Nebraska Interactive GIS Map on the Nebraska Department of Natural Resources (NDNR) Web site (NDNR, 2011).

According to the applicant, the White River traverses the southeast corner of both the NTEA and the planned well field NT-9 and flows northeast into the Pine Ridge Sioux Reservation of South Dakota, where it flows into the Missouri River (CBR, 2010). In addition to the perennial White River, ephemeral streams traverse the NTEA. An unnamed ephemeral stream of the White River drains through the southwest corner of both the NTEA and the planned well field NT-9; and the ephemeral Spring Creek runs through planned well fields NT-5 and NT-8 in the northern portion of the NTEA (CBR, 2010). These ephemeral streams drain eastward and eventual empty into White River. Upstream of the NTEA, these ephemeral drainages flow through range and agricultural land (CBR, 2010). Additionally, the abandoned Hall Canal, which was constructed to direct flow from Spring Creek to the White River, crosses the northeast and southeast portions of the NTEA (CBR, 2010). The applicant stated that vestiges of this canal can still be found in some locations. Staff verified that the above-referenced surface water features and topography within NTEA are present in the Crawford Topographic Quadrangle

Map (U.S. Geological Survey, 1980). The staff finds the applicant's description of the surface water drainages to be consistent with acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

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The applicant stated that the NTEA is not recognized by the Federal Emergency Management Agency (FEMA) to be within a 100-year flood plain (CBR, 2010). However, staff observes that FEMA issued a Flood Insurance Rate Map (FIRM) of Dawes County that includes the NTEA on June 16, 2011 (FEMA, 2011). Staff reviewed the FIRM at both the FEMA Web site and the NDNR Web site (FEMA, 2011, NDNR, 2011). Staff has determined that the 100-year flood zones are identified within the NTEA. Staff observes that these flood zones include a topographic low area extending east-west across the northern portion of Sections 27 and 28 of T32N and R52W, as well as the areas along the above-referenced White River, ephemeral Spring Creek, and the unnamed ephemeral stream of White River.

Staff observes that the above-referenced topographic low in Sections 27 and 28 is not identified as a surface water feature within the USGS topographic map of the Crawford quadrangle. Comparing the 100-year flood plain in the FIRM to evaporation ponds depicted in application Figure 2.1-3 (CBR, 2009), staff observes that this flood zone is located immediately adjacent to or partially within the area containing the NTEA evaporation ponds. Staff has determined that the proposed location of the evaporation ponds may be at risk from potential flooding and erosion impacts. Therefore, staff will require a license condition in SER Section 4.2.4 to supplement the applicant's proposed license amendment application of the pond design with an evaluation of potential flood and erosion impacts based on the FIRM that was issued by FEMA for Dawes County, Nebraska in June 2011 (FEMA, 2011).

The applicant stated that the greatest flooding potential at the NTEA exists along the White River at the southeast part of Section 34 of T32N and R52W. Based on surface hydrologic data from the U.S. Geological Survey, the applicant indicated that for the period from 1931 to 2004 the monthly discharge range and the average discharge at the White River Gauging Station at Crawford was 0.37 to 0.76 cubic meters per second (m^3/s) (13 to 27 cubic feet per second (ft^3/s)) to 0.57 m^3/s (20.3 ft^3/s). The average gauge height on the White River at Crawford is less than 1.5 m (5 feet). Staff observes that this range and average discharge is comparable to the recent data provided by the applicant contained in Application Table 2.7-2. This table indicated an average discharge of 0.53 m^3/s (18.8 ft^3/s) and a monthly discharge range of 0.28 to 0.75 m^3/s (10 to 26.4 ft^3/s) and for the period from September 2005 to September 2007 (CBR, 2010). Staff finds the gauging results of the White River to be stable over time and devoid of any significant changes in the recharge from manmade inputs and ground water.

The applicant indicated that the highest gauge height and discharge on record for the period between 1920 and 2004 was 4.97 m (16.32 feet) and in excess of 376.6 cu m/s (13,300 cu ft/s) on May 10, 1991 (CBR, 2009). This event was identified to have a similar gauge height to that of the White River 100-year flood boundary map for the City of Crawford (FEMA, 2011). Thus, peak flow during a 100-year flood along the White River at the NTEA is not anticipated to be in access of approximately 376.6 m^3/s (13,300 cu ft/s) (CBR, 2010). Based on the staff's analysis of the data, staff agrees with this assessment.

The applicant indicated that the portions of well field infrastructure of NT-7 and NT-9 in Section 34 of T32N and R52W nearest the White River may be at risk from a 100-year flood event. The

applicant proposed to address this risk with additional measures in Section 34 to prevent any releases of production fluids at the NTEA. These additional measures include installing dikes or berms in these well field areas to prevent spilled process solutions from entering the White River. In addition, daily inspections for releases in these well field areas would be conducted by facility workers. (CBR, 2010)

Staff observes that if wells are installed within the high water marks of a 100-year flood plain described in the above-referenced FIRM, adequate wellhead protection will be required to protect the wells during flood conditions. Therefore, based on the new information presented in the FIRM, staff will require a license condition in SER Section 2.4.4 to minimize potential damage to infrastructure from peak flows by avoiding well installation in ephemeral drainage flood channels and near the White River channel at the NTEA. This license condition, along with the additional prevention measures described above, provide NRC staff reasonable assurance that the applicant's provisions for well field protection from flooding will be protective of well field infrastructure from potential erosion and flooding risk in peak flow areas and objects (e.g., trees and limbs) carried by flooding currents.

2.4.3.2 Hydrogeology

The applicant conducted a site investigation at the NTEA to develop an understanding of the hydrogeology. The investigation included drilling of exploration borings, installation of monitoring wells, and measurement of hydrogeologic properties within the different aquifers. The results of the site investigation formed the basis of the applicant's understanding of the NTEA Project.

2.4.3.2.1 Regional Hydrogeology

The applicant described the regional hydrostratigraphic units underlying the NTEA and the region (CBR, 2010). These units are horizontal strata that include aquifers and confining units. Aquifers are geological formations with sufficient permeability and porosity to significantly transmit and store ground water and confining units are strata with insufficient permeability (e.g., shale units) that hydraulically separate aquifers. Referring to SER Table 2.4-1, the Brule Formation and the deeper Basal Chadron Formation (ore zone) are identified as regional aquifers relevant to this safety evaluation. Separating these two aquifers are the remaining members of the Brule and Chadron Formations, which collectively are identified as the upper confining unit to the Basal Chadron aquifer. The lower confining unit to the Basal Chadron is the Pierre Shale. Geological descriptions of these units are in SER Section 2.3. NRC staff found that this information is consistent with the general regional-scale hydrogeological descriptions provided by Miller and Appel (1997).

Table 2.4-1: NTEA hydrostratigraphic column
(adopted from Information in Application Section 2.7.2 (CBR, 2010))

Strata	Hydrogeologic Function
Alluvium	Unsaturated
Brule	Uppermost Aquifer
Upper Chadron Formation	Upper Confining Layer
Middle Chadron Formation	Upper Confining Layer
Basal Chadron Formation	Extraction Zone – Confined Aquifer
Pierre Shale	Lower Confining Layer

2.4.3.2.2 Site Hydrogeology

Application Figure 2.7-11 shows the location of monitoring wells installed by the applicant within the NTEA (CBR, 2009). NRC staff observes that well construction information for several of these monitoring wells indicate the depths of the Brule and Basal Chadron ground water-bearing zones beneath the NTEA. According to data in application Table 2.7-8, staff observes the depth to the bottom of the well screen for Brule wells BOW-1 and BOW-2 is respectively 20 and 18 m (65 and 59 ft) below ground surface (bgs), and the screened interval (i.e., the portion of the well receiving ground water) is respectively 1.5 and 3 m (5 and 10 ft). Data in the same table also indicate that the depth to the top of the Basal Chadron in seven monitoring wells ranges from 164 to 199 m (537 to 653 ft) bgs and the screened interval ranges from 3 to 12.4 m (10 to 41 ft).

Brule Aquifer

Regionally, the Brule Aquifer, which is the uppermost aquifer, is part of the High Plains Aquifer (HPA) only where it contains zones of saturation resulting from interconnected porosity (Gutentag and Weeks, 1980). According to Souders (2004), the Brule Aquifer has a minimal hydraulic conductivity of less than 8.8×10^{-3} centimeters per second (cm/sec) (25 feet per day (ft/d)). Independent reviews of various documents (Collings and Knode, 1984, Gutentag and Weeks, 1980, Miller and Appel, 1997, and Weeks and Gutentag, 1981) all indicate that the Brule is not an aerially extensive aquifer near the NTEA or in western Nebraska. All the aforementioned references indicate that the Brule Formation is only an aquifer where it contains sufficient sand beds and the secondary porosity is sufficient to transmit water.

The applicant conducted Brule ground water-level measurements for monitoring events in 1982 to 1993, 2006, and 2008 (refer to application Tables 2.7-3, 2.7-8 and Figures 2.7-2, 2.7-12 in CBR, 2010). Application Figure 2.7-12 shows a ground water surface map for the Brule water-bearing zone based on June 2008 data (CBR, 2010). The applicant estimated the local ground water flow direction in the Brule Formation to be southeast in the northern portion of the NTEA and northeast in the southern portion of the NTEA. The average ground water gradient of the Brule was estimated to be 0.0081. Water level data from the 2006 monitoring event (refer to application Table 2.7-8) indicated that the Brule is unconfined in the NTEA. Ground water recharge to the Brule occurs directly at or immediately north of the NTEA. Staff found the

applicant's hydrogeologic characterization of this unit consistent with acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003) and, therefore, acceptable.

Chadron Confining Layers

The Middle and Upper Chadron Formation were identified by the applicant as the upper confining layer to the Basal Chadron with one exception. A sand layer near the bottom of the Upper Chadron is a saturated zone of limited areal extent (CBR, 2010). The applicant stated that this layer, although monitored during a pumping test, did not produce a sufficient amount of water to develop wells completed to its depth (CBR, 2010). Therefore, representative ground water samples could not be collected (CBR, 2010). Additionally, domestic or livestock wells within the NTEA are not completed in this interval (CBR, 2010). NRC staff concludes that this absence of private wells finished in this interval is likely due to its limitations to produce water. Therefore, Staff did not find this Upper Chadron layer to be a significant aquifer.

NRC staff examined the hydraulic confining properties of the upper confining layer. The applicant identified the above-referenced upper, as well as the lower confining units, as aquicludes (i.e., strata capable of transmitting only minor amounts of fluid either vertically or horizontally). According to Todd (1980), typical vertical and horizontal hydraulic conductivities of aquicludes range from 10^{-7} to 10^{-8} cm/sec ($2.8x10^{-4}$ to $2.8x10^{-5)}$ ft/day). The applicant stated that vertical hydraulic conductivities of the aquicludes in the neighborhood of 10^{-11} cm/sec ($2.8x10^{-8}$ ft/day) were indicated by analysis of pumping tests previously conducted at the previously licensed Crow Butte facility (Ferret Exploration of Nebraska (FEN), 1987). The applicant also stated that vertical hydraulic conductivities on the order of 10^{-10} to 10^{-11} cm/sec ($2.8x10^{-7}$ to $2.8x10^{-8}$ft/day) were indicated from laboratory analyses of cores from wells at the previously licensed Crow Butte facility (FEN, 1987). NRC staff concludes that the minimal hydraulic conductivity of the upper confining layer is sufficient to isolate the production zone from the overlying water-bearing units. The hydraulic confining properties of the upper confining layer were further assessed by pumping test analyses and modeling, as discussed below.

The applicant stated that potentiometric levels measured in the Upper/Middle Chadron sand unit are approximately 27.4 and 24.3 m (90 ft and 80 ft) below the potentiometric levels of the Basal Chadron (CBR, 2010). According to data in application Table 2.7-8 (CBR, 2010), static water levels in three monitoring wells located in close proximity to one another at two different locations show similar potentiometric differences, roughly 26 to 30.5 m (85 to 100 ft), between the Basal Chadron and the overlying units. These monitoring wells are: (1) BOW-1, MCOW-1, CPW-2, and (2) BOW-2, MCOW-3, COW-5 (CBR, 2010). NRC staff concludes that these potentiometric differences further demonstrate the hydraulic isolation of the Basal Chadron aquifer from the upper Brule Aquifer.

The applicant stated that the geochemical characteristics of the Brule and Basal Chadron sandstones presented in the application further suggest a significant hydraulic separation of these aquifers (CBR, 2010). NRC staff observes that ground water concentrations of sulfate, sodium, chloride, and specific conductance presented in the application are significantly different in the Brule and Basal Chadron Aquifers. Staff finds these differences in ground water chemistry to further support the conclusion that the Brule and Basal Chadron water-bearing zones are hydraulically separated.

Basal Chadron Aquifer

The Basal Chadron is confined in the NTEA by the overlying Chadron confining layers and the underlying Pierre Shale (CBR, 2010). Ground water recharge to the Basal Chadron Sandstone occurs where the Basal Chadron outcrops approximately 16 km (10 mi) north of the NTEA (CBR, 2010). The applicant conducted Basal Chadron ground water-level measurements for monitoring events in 1982 to 1993, 2006, and 2007 (Application Tables 2.7-3, 2.7-8 and Figures 2.7-3, 2.7-14 in CBR, 2010). Based on the February 2007 data, the applicant provided a depiction of the ground water potentiometric surface of the Basal Chadron water-bearing zone (application Figure 2.7-14). Based on ground water-level measurements at seven NTEA wells conducted in February 2007, the ground water flow direction in the Basal Chadron Sandstone was estimated by the applicant to be east-southeast (CBR, 2010). The ground water gradient of the Basal Chadron was estimated to be 0.0016 (CBR, 2010), which was verified by NRC staff using the scaled application Figure 2.7-14 (CBR, 2010). Staff found the applicant's hydrogeologic characterization of this unit to be consistent with acceptance criteria 2.7.3 presented in the NUREG-1569 (NRC, 2003) and, therefore, acceptable.

Pierre Shale Confining Layer

The Pierre Shale acts as a lower confining unit to the Basal Chadron. This shale unit is a thick confining layer (Pierre Shale) below the ore-bearing aquifer and the water-bearing layers below the confining layer have naturally elevated levels of total dissolved solids (TDS) (CBR, 2010). Staff concluded that the Pierre shale was a satisfactory underlying confining layer in SER Section 2.3.3.2.1.

The applicant identified the principal water bearing aquifers below the Pierre Shale in the area on NTEA and the current Crow Butte licensed facility to be the G Sand, J Sand, and the Dakota, Morrison and Sundance Formations (CBR, 2010). These regional aquifers were encountered during deep oil and gas exploration logs and testing of the deep disposal well at the current Crow Butte licensed facility (CBR, 2010). NRC observes that these regional hydrostratigraphic units below the Pierre Shale are consistent with the regional stratigraphic column presented by Driscoll, et al. (2002).

2.4.3.3 Aquifer Test

Application Appendix C provided details of the pumping test performed at the NTEA to confirm the hydraulic properties and degree of isolation of the Basal Chadron Formation (CBR, 2007). A total of six production zone (Basal Chadron) monitor wells (identified as COW wells) were installed and monitored; overlying wells included four Upper/Middle Chadron wells (MCOW wells) and two Brule Formation wells (BOW wells). A summary of well completion data is included in Application Table 2.7-8 and in Application Appendix A. The monitor wells were drilled and completed consistent with CBR's NDEQ permit for the current mining area. (CBR, 2007)

This test also provided information on the nature of the White River Fault that traverses the southern portion of the site (CBR, 2007). As part of this pumping test, the applicant installed a pumping well CPW-2 and monitoring wells (CPW-1, COW-1, COW-2, COW-3, and COW-4) in the Basal Chadron Sandstone (refer to Application Figure 2.7-11 in CBR, 2010). CPW-1 was

installed specifically for use as a pumping well and the remainder of the wells were installed as observation wells. One pre-existing Basal Chadron well (RC-2) also was used as a monitoring location. In addition, new wells were installed in the monitoring zone within the Brule Formation (BOW 2004, later referred to as BOW-1) and the Upper/Middle Chadron Formation (MCOW 2004, later referred to as MCOW-1). (CBR, 2007)

The original pumping well,CPW-1, was plugged and abandoned due to casing problems. The applicant replaced CPW-1 with CPW-2 prior to the initial test in 2004 (CBR, 2007). Two additional wells, MCOW-2 and COW-5, were subsequently installed in the Upper/Middle Chadron and Basal Chadron, respectively. The applicant also installed the following additional wells prior to the 2006 testing operations: (1) two wells in the Upper/Middle Chadron sand, MCOW-3 and MCOW-4, and (2) one well in the Brule Formation, BOW-2. This was done to specifically address a request from NDEQ for additional monitoring locations. (CBR, 2007)

The applicant conducted the 2006 NTEA pumping test in the Basal Chadron with the following objectives:

- demonstrate hydraulic communication between the Production Zone (Basal Chadron) pumping well and the surrounding monitor wells (COW wells)
- assess the hydrologic characteristics of the Production Zone aquifer within the test area
- evaluate the presence or absence of hydrologic boundaries in the Production Zone within the NTEA test area
- demonstrate sufficient hydrologic isolation exists between the Production Zone and the Overlying (Upper/Middle Chadron) sand for the purposes of ISL mining

Staff observes that application Figure 2.7-11 presented the proposed permit area outline and the locations of the pumping and observation (monitor) wells used during the NTEA hydrologic testing operations (CBR, 2007). The pumping well (COW-5) was screened across the entire thickness of the Basal Chadron Production Zone (refer to application Table 2.7-8) (CBR, 2007). A step-rate test was performed on COW-5 on June 8, 2006 (CBR, 2007). Based on evaluation of the data, it was anticipated that a pumping rate on the order of 109 cubic meters per day (m^3/day) (20 gallons per minute (gpm)) would be needed to: (1) operate the well with approximately 42.7 m (140 ft) of drawdown, and (2) achieve 0.3 to 0.6 m (1 to 2 ft) of drawdown in the most distant COW wells within a reasonable time (e.g., less than 15 days) (CBR, 2007). Based on these assumptions, the radius of influence for the test was estimated to be approximately 2286 m (7,500 ft) (CBR, 2007).

The general testing procedures were as follows: (1) install automated monitoring equipment in the wells to be used in the test; (2) verify setting depths and head readings with manual water level measurements; (3) measure and record background water levels at least every 12 hours for a minimum of 96 hours prior to the test; (4) run the pumping well at a constant rate (or as close as practical); and (5) record water levels and barometric pressure throughout the background, pumping, and recovery periods. (CBR, 2007)

A summary of the wells used for observation points during the NTEA testing follows (well designation number):

- overlying Brule Formation (BOW wells) 2
- overlying Mid/Upper Chadron Sand (MCOW wells) 4
- production Zone Basal Chadron Sand (COW, CPW, RC-2 wells) 6
- Basal Chadron Sand pumping well (COW-5) 1
- total 13

Staff observes the distances of the respective monitor wells from the pumping well range from 698.3 to 2022.3 m (2,291 to 6,635 ft) (Basal Chadron Sandstone COW wells), 13.1 to 708 m (43 to 2,323 ft) (overlying Upper/Middle MCOW completions), and 9.8 to 701.6 m (32 to 2,302 ft) (overlying BOW completions)

Staff observes the pumping test was performed by pumping COW-5 at an average rate of 89.4 cu m/day (16.4 gpm) from 1030 hours on June 28, 2006 until 0700 hours on July 13, 2006. The total pumping duration was 356.5 hours (14.9 days). The drawdown achieved in the pumping well was 34 m (111 ft); drawdown in the Basal Chadron monitor wells ranged from 0.4 to 3 m (1.4 to 10.0 feet) (Table 4-2 of Application Appendix C in CBR, 2007)). Water levels were automatically measured and recorded every 15 minutes during the pumping and recovery periods (CBR, 2007). Pumping rate data for the pumping test are shown in Table 4-3 of Application Appendix C (CBR, 2007). Water-level recovery was monitored for 14 days (CBR, 2007). The applicant used the Theis equation to analyze the pumping test data to determine the transmissivity, storativity, and hydraulic conductivity by calculation (CBR, 2007). According to the applicant, the transmissivity, hydraulic conductivity, and storativity are 6.45 cubic meters (cu m/s) (60 cubic feet per day (cu ft/d)), 8.1×10^{-4} cm/sec (2.3 ft/d) and 5.3×10^{-5} (dimensionless), respectively (CBR, 2007).

NRC staff reviewed the applicant's pumping test procedures and results. Based upon the staff's evaluation, the 2006 pumping test where the pumping well COW-5 was screened in the Basal Chadron Sandstone, the uranium production zone, appears to have been adequately performed and evaluated. The staff finds the applicant's pumping test results are consistent with acceptance criteria 2.7.3(3) of NUREG-1569 (NRC, 2003) and therefore acceptable.

2.4.3.4 Evaluation of White River Structural Feature by Ground water Modeling

As discussed in SER Section 2.3.3.2.2, the applicant identified a structural feature in the southern portion of the proposed NTEA that is known as the White River Fault. The applicant expressed uncertainty as to whether this feature is expressed as a fault through the formations of interest, or as a fold (CBR, 2009). The applicant proposed that recent close-spaced drilling data indicate that the feature could be interpreted as a fold in the Basal Chadron and Brule Formations (CBR, 2010). The applicant provided cross sections, structure contour maps, and three-dimensional geological illustrations and a discussion that supported this interpretation in the application. NRC staff observes the definition of this feature is important to determine the ground water flow in and around the NTEA. The staff observes that if the fault is not present in the Basal Chadron and Brule Formations, then the probability that a pathway exists through which water would be transmitted between the Basal Chadron and Brule aquifers would be very low.

To examine this issue, NRC staff performed an independent modeling exercise to assess conclusions drawn by the applicant that the White River Fault may not be expressed as a fault within the Basal Chadron and Brule formations. Specifically, as part of its review of the NTEA application, NRC staff performed a modeling and uncertainty analysis to investigate the probability that the White River structural feature conducts water between the Basal Chadron and Brule aquifers. The staff used the maximum likelihood (ML) portion of the Maximum Likelihood Bayesian Model Averaging (MLBMA) model uncertainty procedure to assess this probability. This procedure is described in NUREG/CR-6940 (Meyer et al., 2007). The purpose of the ML procedure is to eliminate unreasonable ground water flow scenarios and, correspondingly, to identify those that are the reasonable or likely. The ML method involved creating multiple ground water models, calibrating the models, and using Bayesian statistics to estimate the relative probability of each scenario.

2.4.3.4.1 Ground water Model Development

To undertake the ML analysis, NRC staff first developed two different base ground water models (simulations) for the NTEA using MODFLOW 2000, as incorporated into a commercially front-end user interface known as the Ground water Modeling System (GMS) developed by the U.S. Army Corps of Engineers. MODFLOW is a finite difference, ground water flow modeling program developed by the U.S. Geological Survey and is widely used. The two base models differed by the manner in which the White River structural feature was simulated. Differences between these two models are as follows:

Simulation 1

- 6-layer model- geologic layers interpolated based on boring date
- model boundaries at basic site boundaries or physical feature boundaries
- discrete zone of different hydraulic conductivity to address pumping well efficiency
- fault simulated by converting one boundary in the ore zone layer to a drain to model a conductive fault and a barrier to model a no-flow fault
- all other hydraulic, geologic, and model parameters held constant
- none of the input data were weighted

Simulation 2

- 6-layer model, geologic layers linear, thickness based on borehole data
- artificial model boundaries beyond site boundaries
- fault simulated by a thin zone of differing hydraulic conductivity, high hydraulic conductivities to model a conductive fault and low hydraulic conductivities to model a no-flow fault
- all other hydraulic, geologic, and model parameters held constant
- none of the input data were weighted

Data input included well boring log data, hydraulic properties of the geologic units down to the Pierre Shale, well water level data, and boundary conditions. Field data used for model development were obtained from the application (CBR, 2009). After model development, the

staff calibrated each model using PEST, a parameter estimation and automated calibration software package which is included in the GMS software. Each model was calibrated to a pumping test previously performed by the applicant.

NRC staff subsequently developed eight ground water flow model scenarios (four based on each simulation) with variations to the base model to study the effect of a potential fault on the Basal Chadron aquifer flow system. Two models for each simulation assumed the fault acted as a transmissive flow boundary and two models for each simulation assumed it was a no flow or restricted flow boundary. These scenarios were developed by altering the conditions of the southern boundary of the proposed NTEA for Simulation 1 and altering the hydraulic conductivity of the linear zone for Simulation 2. After development, each scenario was calibrated. The weighted sum of the squared residuals (WSSRs) are presented in Table 2.4-2.

Table 2.4-2: Model Scenario WSSRs

Model	Drain/Barrier	Conductance or Conductivity	WSSR
Simulation 1			
Baseline	NA	0.56 m^2/d/m (6 ft^2/d/ft)	27.47
2	Barrier – Low Cond.	1E-5**	27.04
3	Barrier – very low cond.	1E-9	27.13
4	Drain- medium conductance	0.01 m^2/d/m (0.12 ft^2/d/ft)	2.15E+5
5	Drain -high conductance	9.3 m^2/d/m (100 ft^2/d/ft)	8.84E+5
Simulation 2			
Baseline	NA	1.5 m/d (5 ft/d)	620.2
2	Barrier – Low Cond.	3E-4 m/d (1.0E-3 ft/d)	783.1
3	Barrier – very low cond.	3E-6 m/d (1.0E-5 ft/d)	666.3
4	Conductive – medium k	3 m/d (10 ft/d)	916.2
5	Conductive – high k	305 m/d (1000 ft/d)	8.0e+4

*MODFLOW uses the term “hydraulic characteristic” for barriers which is units of 1/time.

2.4.3.4.2 Maximum Likelihood Analysis

Once the calibrations were completed, the NRC staff performed an ML analysis using all the aforementioned models, the two base models plus the eight scenario models. Procedures for this analysis are documented in NUREG/CR-6940 (Meyer et al., 2007). The objective of this analysis is to calculate the probability of each scenario relative to the other scenarios where posterior probability is computed using Bayes’ Theorem. Bayes’ Theorem is used to calculate conditional probabilities. One form of the formula is, as follows:

$$p(M_k \mid D) = \frac{p(D \mid M_k)p(M_k)}{\sum_{l=1}^{K} p(D \mid M_l)p(M_l)}$$

where:

$p(D|M_k)$ = likelihood of Model M_k
$p(M_k)$ = prior probability of Model M_k
$p(M_k|D)$ = posterior probability of all models

Prior probability is a value assigned by the modeler or other technical staff that reflects the opinions regarding the probability of certain scenarios being the most likely or reasonable. In this case NRC staff assigned the same prior probability to all the scenarios as to not interject any bias into this exercise. The likelihood term, in this case, is actually the Kashyap Information Criterion (KIC), as calculated by the following formula:

$$\mathrm{KIC} = \mathrm{N}\ln\hat{\sigma}^2_{\mathrm{ML}} - \mathrm{N_k}\ln 2\Pi + \ln|\mathrm{I}|$$

where:

$\ln|I|$ = natural log of the determinant of the Fisher Information Matrix

$$\ln|I| = -N_k \ln\left(\frac{N - N_k}{N_k}\right) - \sum_{i=1}^{N_k} \ln \lambda_i$$

$$\hat{\sigma}^2_{\mathrm{ML}} = \frac{\mathrm{WSSR}}{\mathrm{N} - \mathrm{N_k}}$$

WSSR = weighted sum of the square residuals
N = number of calibration data
N_k = number of calibration parameters
λ_t = eigenvalues calculated during calibration using PEST

Results of the ML analyses are presented in Tables 2.4-3 and 2.4-4

Table 2.4-3: Maximum Likelihood Analysis Results – Simulation 1

Data	BASELINE	BARRIER-LOWK	BARRIER-VLOWK	DRAIN-MEDK	DRAIN-HIGHK
N	35	34	34	32	32
Nk	3	3	3	3	3
WSSR	27.47	27.04	27.13	215000	8840000
Sigma Square	0.78	0.8	0.8	6718.75	276250
ln|I|	-87.27	-6.89	-1.4	-53.95	-41.4
KIC	-101.48	-19.99	-14.5	222.54	354.02
p(Mk) (Prior Probability)	0.2	0.2	0.2	0.2	0.2
p(Mk|D) (Posterior Probability)	1.0	0	0	0	0

Table 2.4-4: Maximum Likelihood Analysis Results – Simulation 2

Data	BASELINE	WALL-LOWK	WALL-VLOWK	FAULT-MEDK	FAULT HIGHK
N	37	37	37	37	37
Nk	3	3	3	3	3
WSSR	620.2	783.1	666.30	916.20	80000.00
Sigma Square	16.76	21.17	18.01	24.76	2162.16
ln|I|	-163.83	-163.9	-168.5	-96.97	-48.55
KIC	-65.04	-56.47	-67.05	16.26	230.05
p(Mk) (Prior Probability)	0.2	0.2	0.2	0.2	0.2
p(Mk|D) (Posterior Probability)	0.267	0.004	0.729	0	0

A review of Tables 2.4-3 and 2.4-4 indicates that, for both modeling simulations, a structural feature with higher conductivities is the least likely scenario based on the negligible posterior probabilities. For both simulations, the results indicate that a structural feature with a low hydraulic conductivity is more probable and thus consistent with the observed data. Such a feature will serve as a barrier to flow, rather than a feature that is capable of conveying flow from the Chadron Aquifer upward to the Brule Aquifer.

Based on this analysis, the NRC staff concludes that the presence of a fault capable of conveying ground water from the Pierre Shale through the Chadron and Brule Formations does not appear probable. Staff's finding is consistent with the applicant's interpretation that the White River structural feature may be expressed as a fold rather than a fault because the features shown to have the highest probabilities of occurring have conductivities similar to, or less than those estimated for the formations of interest. As such, NRC staff has reasonable assurance that a hydraulic connection to transfer process water between the Basal Chadron ore zone and Brule Aquifers is highly unlikely.

2.4.3.5 Water Use

The applicant described water usage in the region of the NTEA (CBR, 2009). Plausible municipal or domestic surface water resources in the form of ponds and lakes, and surface water impoundments are not present within the NTEA (CBR, 2009). In the vicinity of the NTEA, the White River and its tributaries support agricultural production and indirectly supply some of the drinking water to the 1,115 citizens of Crawford (CBR, 2009). NRC staff observes that the intake for some of the City's water supply is from infiltration galleries, located southwest of the City and next to the White River (upstream from the NTEA) within Section 8 of Township 31N and Range 52W. The infiltration galleries are 8.2 m (27 ft) deep and receive water from the White River infiltration through surficial sediments (CBR, 2009).

In the vicinity of the NTEA, the applicant stated that domestic ground water use is limited to two wells completed in the Brule Formation (CBR, 2009). Further south of the NTEA, there are two Crawford City public water wells that are completed to a depth of 30.5 m (100 ft) (CBR, 2009). These wells are located south of the NTEA and the city within Section 15 of Township 31N and

Range 52W and are believed to produce ground water under the influence of surface water (CBR, 2009). According to data in the application, the capacity of these two wells is 204 Lpm (54 gpm) and 394 Lpm (104 gpm), and the capacity of the above-referenced infiltration galleries is 1,590 Lpm (420 gpm) (CBR, 2009). Noting the City's average daily use in 2006 was 1,586,7223 L (419,181 gal), the staff observes that the wells appear to supplement the City's main water supply from infiltration galleries.

The applicant indicated that with the exception of one private well, the Basal Chadron within the NTEA and its vicinity is not tapped by domestic wells due its greater depth and inferior water quality (CBR, 2009). However, it is used by a small number of private land owners as an alternate supply for stock water in the region of the NTEA, but not within the NTEA (CBR, 2009). The exception noted above is private well 98. According to application Table 2.2-12, this well is used for domestic and agricultural purposes. Application Figure 2.2-4 shows that this well is located at a remote distance of approximately 2.8 km (1.75 mi) from the NTEA (CBR, 2009).

The applicant stated that based on population projections, future water use within the NTEA and its vicinity are anticipated to be a continuation of present use (CBR, 2009). The limited water supplies, topography, and semi-arid climate are likely to restrain any irrigation development (CBR, 2009). The applicant stated that it anticipates that the City of Crawford municipal water supply will continue to get it water supply from ground water and infiltration galleries related to the White River (CBR, 2009). The staff finds the applicant's description of the water use at NTEA and the surrounding area is consistent with acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

2.4.4 Evaluation Findings

The staff has completed its review of the hydrologic site characterization information for the proposed NTEA. Staff concludes that the applicant has acceptably described the surface water hydrology by providing the location, data, and description of the drainages in and around the license area, and a flood potential analysis for the facility; protection against the effects of flooding from the White River. To minimize potential flood impact to the proposed evaporation ponds, staff the staff is imposing a license condition in SER Section 4.2.4.

Based on the new information presented in the FIRM referenced in SER Section 2.4, the applicant is required to demonstrate that its provisions for wellfield protection from flooding will be protective of wellfield infrastructure from potential erosion and flooding risk in peak flow areas and objects (e.g., trees and limbs) carried by flooding currents. Therefore, the staff is imposing the following license condition:

> The licensee shall minimize potential damage to infrastructure from peak flows by avoiding well installation within ephemeral drainage flood channel areas and within or near the White River flood channel areas at the NTEA. For wells installed within the high water marks of a 100-year flood plain in the Flood Insurance Rate Map issued by the Federal Emergency Management Agency, wellhead protection measures that are protective of the wells during flood conditions shall be provided to the NRC for review and written verification.

The applicant has acceptably described the ground water hydrology by characterizing the regional hydrogeology, the overlying aquifer, the extraction zone aquifer, and underlying aquifer hydrogeology using potentiometric surfaces maps with acceptable contour intervals based on an appropriate number of monitoring wells, hydraulic parameters and the integrity confining layers data collected at the site.

The applicant provided new information regarding the composition of the White River structural feature, which the staff incorporated into a modeling investigation. Based on the modeling effort and hydrogeologic characterization data presented above, the staff determined that the White River structural feature is most likely not a fault but rather a fold, and as such, does not hydraulically connect the Basal Chadron with the Brule aquifer. This combined with pumping test data provided by the applicant (CBR, 2009) reinforces previous conclusions that the Basal Chadron aquifer is hydraulically isolated from the Brule formation, above.

Based upon the staff's review of NTEA hydrology presented in the application and staff's independent analysis, the information provided by the applicant, as supplemented by information to be collected in accordance with the previously discussed license conditions, the staff concludes that the information is consistent with the applicable acceptance criteria of Section 2.7.3 of NUREG-1569 (NRC, 2003) and meets the requirements of 10 CFR 40.41(c).

2.4.5 References

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2.5 BACKGROUND SURFACE WATER AND GROUND WATER QUALITY

2.5.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the characterization of surface and ground water quality at the NTEA has been performed to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.2 REGULATORY ACCEPTANCE CRITERIA

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003).

2.5.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the surface water and ground water quality of the NTEA. Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Crow Butte Resources in their application (CBR, 2007) and as updated. NRC staff inspected records for the proposed NTEA at the current Crow Butte licensed facility during the course of this review to confirm information presented in the application.

2.5.3.1 Surface Water

Regulatory Guide 4.14 (NRC 1980) recommends surface water sampling for several types of areas. The locations can include large permanent onsite water impoundments, such as a pond or lake, offsite impoundments that may be subject to direct surface drainage from potentially contaminated areas, surface waters or drainage systems crossing the site boundary and surface waters that may be subject to drainage from potentially contaminated areas.

The applicant stated (CBR, 2010) that the following ephemeral stream drainage channels and river are present in and around the site:

Spring Creek
Un-named Creek
Hall Canal
White River

The applicant indicated (CBR, 2010) that surface water samples will be collected from the ephemeral stream drainage channels (Spring Creek, Un-named Creek, and Hall Canal) subject to the seasonal nature of flow. NRC staff has determined from the applicant's statement that there are four surface water sampling locations. The applicant identified the location of the surface water samples in Figure 2.9-5 of the TR and indicated that the surface water sampling frequency will be monthly (CBR, 2010). NRC staff observes that the number of surface water sampling stations for the White River in Figure 2.9-5 (i.e., two surface water sampling stations) is different from what the applicant identified in the application text (i.e., four surface water sampling stations). In addition, NRC staff determined from Figure 2.9-5 of the TR (CBR, 2010)

that surface water sampling location W-2 is not at or near the site boundary as recommended by Regulatory Guide 4.14 for surface water sampling locations. The applicant did not adequately explain the difference in the number of sample locations (i.e., two versus four). Therefore, NRC staff is imposing a license condition to require the applicant to provide justification for surface water sampling location W-2. This license condition is presented in SER section 2.5.4.

The applicant stated (CBR, 2010) that grab samples will be collected monthly from the White River, with the exception of the ephemeral streams, where grab samples will be collected monthly or when flow is available in the ephemeral stream. The applicant stated that surface water samples will be analyzed for suspended and dissolved natural uranium, Ra-226 and Th-230. NRC staff has determined that the applicant's proposed sampling and analysis for surface water samples is consistent with Regulatory Guide 4.14 and is, therefore, acceptable.

The applicant stated (CBR, 2010) that there are no private surface water impoundments at or within the NTEA license boundary, nor are there any offsite (outside of license boundary) surface impoundments subject to direct drainage from potentially contaminated areas associated with the site operation. Therefore, the applicant stated that no surface water impoundment samples are required. As discussed in SER Section 2.6.3.6, NRC staff reviewed USGS topographical maps and determined that there are no natural impoundments on the proposed site (USGS, 1984). Based on the NRC staff review of the USGS topographical maps and the applicant's statements and commitments, NRC staff has determined that the applicant does not have to collect surface water samples because the applicant will not have private surface water impoundments at or within the license boundary nor are there any offsite surface impoundments subject to direct drainage from potentially contaminated areas consistent with Regulatory Guide 4.14 (NRC, 1980).

Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has proposed a surface water sampling program consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003), except for the issues noted above. However, staff cannot make a final determination until the applicant has submitted the surface water sampling results to staff for review and written verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit surface water sampling results. This license condition is presented in SER section 2.6.4.

The applicant provided water quality data for the White River assembled by the U.S. Environmental Protection Agency (USEPA, 2010). The data consists of results of 11 sample events for period from 1969 to 1994 (CBR, 2010). The water was tested for the following qualities:

- temperature
- flow,
- turbidity,
- specific conductance
- dissolved oxygen
- pH
- alkalinity

- nitrite
- phosphate
- hardness
- calcium,
- sodium,
- potassium,
- chloride.

Staff observes that the applicant did not collect quarterly water samples from the White River for a period of one year. Therefore, staff has determined that the applicant did not collect background water samples from the White River consistent with acceptance criteria 2.7.3(4) of NUREG-1569 (NRC, 2003) or an alternate list of constituents tailored to the site with appropriate justification. Therefore, staff is imposing a license condition in Section 2.6.4 to obtain satisfactory background surface water quality data for the White River.

According to the EPA, the White River has been listed as an impaired stream from a water quality perspective (U.S. EPA, 2010). The causes of the impairment are e. coli, fecal coliform, nutrients, and total suspended solids. These impairments are only attributed to the White River in Nebraska and South Dakota. Staff observes EPA's water quality data pertaining to the White River, provided by the applicant, indicated that water quality of the White River had been reasonably consistent from 1968 to 1994.

2.5.3.2 Ground water

In application Section 2.7, the applicant provided quarterly ground water sample results for a period of one year starting in the third quarter of 1996 for Basal Chadron well 81 and Brule well 78 (CBR, 2010). These wells are located within the NTEA and down gradient of the aerial extent of the ore zone (refer to application Tables 2.7-12, 2.7-13 (CBR, 2010), and application Figure 2.2-4 (CBR, 2009)). The applicant also provided background ground water quality data for the Basal Chadron wells within mine units 1 to 3 of the current Crow Butte license area (refer to application Tables 2.7-14a to 2.7-14c in CBR, 2010). The applicant indicated that this data is presumed to be representative of ground water constituent concentrations within the roll front uranium deposit at the NTEA (CBR, 2010). The applicant's basis for this presumption included: the close proximity of the NTEA to the current license area, the similarity of the NTEA ore body geology to that of the current license Crow Butte area, and the same source of mineralization (CBR, 2010). Based on staff's review of records for the proposed NTEA (CBR, 2013), staff observes that the analytical results of baseline ground water samples from Basal Chadron wells CPW-2 and COW 1 to 6 and indicated background radionuclide and non-radionuclide concentrations within the NTEA ore zone were similar to the background ground water concentrations of the ore zone of the previously licensed Crow Butte facility (NRC, 2012). Staff finds the background ground water quality data for the NTEA meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7 and, therefore, acceptable.

The applicant also provided results of radionuclide analysis of ground water samples obtained from Brule and Basal Chadron wells W-77, W-78, W-81, W-83, and W-107 (CBR, 2010). These wells are located both within and immediately outside of the NTEA license boundary as shown on application Figure 2.2-4 (CBR, 2009). Staff observes these sample results consist of quarterly concentrations for U-Nat, Th-230, Ra-226, Pb-210, Po-210, obtained for a period of

one year starting in with third quarter of 1996. Also included are quarterly concentrations for U-Nat and Ra-226 for a period of three quarters starting with the first quarter of 2005. The radionuclide results are provided in application Table 2.9-6 (CBR, 2010).

According to application Tables 2.7-12 and 2.7-13 (CBR, 2010), the analytical results for the Basal Chadron and Brule samples indicated levels of total dissolved solids (TDS) ranging from 1790 to 1820 mg/L and 423 to 479 mg/l, respectively. NRC staff observes the TDS results for the Basal Chadron samples were significantly above EPA Secondary Drinking Water Maximum Contaminant Level (SMCL) of 500 mg/L, whereas those for the Brule were under the EPA SMCL. NRC staff agrees with the applicant that higher major ion content in ground water of the Basal Chadron versus the Brule would be expected due to differences in TDS levels between these two ground water zones. In addition, relatively high levels of alkalinity and conductivity were seen in the results for both formations, but neither formation showed concentrations of most trace metals above detection levels.

An analysis of radionuclides in samples from Chadron Well W-81 indicated that Radium-226 concentrations ranged from 10.3 to 14.7 pCi/l and uranium concentrations ranged from <0.0003 to 0.006 mg/l (CBR, 2010). NRC staff observes that the radium-226 levels are above the USEPA Drinking Water MCL of five pCi/l (Table 2.7-12 in CBR, 2010). Radium-226 and uranium levels in samples from Brule well 78 range from below detection to 0.5 pCi/l and 0.0003 to 0.016 mg/l, respectively (Table 2.7-12 in CBR, 2010). Other background samples from Brule wells W-77, W-83 and W-107 (Table 2.9-5 in CBR, 2010) indicated similar Radium-226 and uranium concentration levels. Staff observes that the concentrations of uranium and radium-226 in the Brule Wells 77, 78, 83 and 107 at the NTEA appear to comparable with historical concentration levels at the current Crow Butte license area provided in application Table 2.7-11b (CBR, 2010).

Staff observes that ground water flow rate variations or recharge rates were not found in the available ground water data for both the Brule and Chadron. Staff observes that the Brule is not an extensive producer of water (refer to SER section 2.3) and seasonal effects are not clearly seen across the NTEA within water quality data for this zone or within the Basal Chadron (refer to application Tables 2.7-12 and 2.7-13 in CBR, 2010). NRC staff finds the applicant's analysis of the variability in the ground-water flow rates and recharge to be acceptable.

Application Table 2.7-15 (CBR, 2010) provides projections of the anticipated change in water quality during IRS production. The applicant stated that the chemicals used in the mining and recovery process will include sodium bicarbonate, an oxidizer such as oxygen, carbon dioxide, and chloride for elution (CBR, 2010). The use of these constituents is expected to result in significant changes in alkalinity, bicarbonate, chloride, sodium, conductivity, and TDS. The addition of the oxidant constituent(s) injected into the production zone will generally result in significant increases in dissolved-phase uranium, vanadium, and radium and minor increases in trace metals such as copper, arsenic, molybdenum and selenium (CBR, 2010). Also, ion exchange with clays is likely to result in significant increases in calcium concentrations (CBR, 2010). NTEA's change in water quality is anticipated to be similar to that seen at the current Crow Butte license area, where the applicant has demonstrated the ability to successfully restore ground water to established restoration standards. NRC staff found the data presented by the applicant for water quality to be consistent with acceptance criteria presented in Section 2.7.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

2.5.4 Evaluation Findings

The staff reviewed the preoperational ground water and surface water quality of the proposed NTEA facility in accordance with Section 2.7.3 of NUREG-1569. The applicant described the preoperational ground water quality by providing appropriate chemical and radiochemical analyses of water samples from the production aquifer and overlying aquifer. As discussed in SER Section 5.7.8, sampling the underlying aquifer was not found to be necessary at the NTEA. However, staff has determined that the applicant has not collected background quarterly surface water samples from the White River consistent with acceptance criteria 2.7.3(4) of NUREG-1569 (NRC, 2003). Therefore, staff is imposing the following license condition (presented in SER Section 2.6.4 and repeated here):

> Prior to major site construction, the licensee shall submit a preoperational radiological environmental monitoring program report for NRC review and written verification that will include air particulate, air radon, vegetation, food/crop, direct radiation, surface and subsurface soils, sediments, and surface water as described in Regulatory Guide 4.14 to comply with 10 CFR Part 40, Appendix A, Criterion 7.
>
> Surface soil samples shall include samples at 15 cm depth as described in NUREG-1569, Acceptance Criteria 2.9.3(2) for decommissioning purposes.
>
> Surface water samples shall also be analytically analyzed quarterly for the list of constituents in Table 2.7.3-1 of NUREG-1569. Sample analytical results shall be submitted to the NRC for written verification. If an alternate list of constituents tailored to the site, appropriate justification shall submitted to the NRC for review and approval before the sampling is implemented.

Based on the review conducted by the staff as indicated above, the information provided in the application, as supplemented by the information to be collected in accordance with the license condition, meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, “Domestic Licensing of Source Material”.

CBR, 2013. Crow Butte North Trend Expansion Area Background Ground water Quality Data for the Basal Chadron Sandstone, January 16, 2013, ADAMS Accession No. ML13037A169.

CBR, 2010, Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession Nos. ML103010522 and ML103010525.

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

NRC, 2012. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

NRC 1980, Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills", April 1980.

U.S. Environmental Protection Agency, (USEPA), 2010. Storage and Retrieval/Water Quality Exchange, http://www.epa.gov/stroret/, accessed on October 26, 2011.

USGS, 1984. http://msrmaps.com/image.aspx?T=2&S=14&Z=13&X=196&Y=1478&W=3&qs=%7cCrawford%7cNE%7c, Accessed on 10/4/2012, U. S. Geological Survey Crawford, NE, Topographic Quadrangle Map, July, 1, 1984

2.6 BACKGROUND RADIOLOGICAL CHARACTERISTICS

This section discusses the background radiological characteristics of the surrounding environment. The background radiological characteristics are used to evaluate the potential radiological impact of operations on the environment. This includes spills, routine discharges from operations, and other potential releases to the environment. In addition, the data collected is used to identify a radiological baseline for decommissioning, restoration, and reclamation.

2.6.1 Regulatory Requirements

The staff will determine if the applicant has demonstrated that the background radiological characteristics or the preoperational environmental monitoring program is in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

A preoperational monitoring program must be conducted at least one-full year prior to any major site construction, and establishing background concentrations in environmental media is needed to determine operational compliance.

2.6.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria presented in Section 2.9.3 of the standard review plan. Also, as discussed in Regulatory Guide 4.14 (NRC, 1980), the preoperational monitoring program should include at least 12 consecutive months of data, in accordance with 10 CFR Part 40, Appendix A, Criterion 7, including the submittal of complete soil sampling, direct radiation, and radon flux data prior to any major site construction.

The staff discusses ground water and surface water background radiological characteristics in SER Section 2.5 and is therefore not discussed here.

2.6.3 Staff Review and Analysis

2.6.3.1 Air (Particulate and Radon) Sampling

Regulatory Guide 4.14 (NRC 1980) recommends preoperational air particulate and radon sampling at three locations at or near the site boundaries, one location at or close to the nearest residence, and one control location remote from the site. Factors to consider in determining sampling locations include: (1) average meteorological conditions (wind speed, wind direction, atmospheric stability); (2) prevailing wind direction; (3) site boundaries nearest to mill; (4) direction of nearest occupiable structure; and (5) location of estimated maximum concentrations of radioactive materials.

In Section 2.9.2.1.2 of the TR (CBR, 2010), the applicant described the five air particulate monitoring stations for pre-operational monitoring. These air particulate and radon monitoring stations are AM-22, AM-23, AM-24, AM-25, and AM-26. The air particulate and radon monitoring stations are shown in Figure 2.9-3 of the TR (CBR, 2010). The applicant indicated that air particulate and radon monitoring stations AM-22, AM-23, and AM-24 are located downwind of the three wind rose sectors shown to have the predominant wind direction (S, SSW, and SW) for data collected at the Crow Butte Meteorological Station. The air

particulate and radon monitoring stations are depicted in Figure 2.9-3 of the TR (CBR, 2010). The applicant established air particulate and radon monitoring at station AM-25 as the location for the nearest residence located near the license boundary approximately 0.5 miles east of the proposed satellite facility (CBR, 2010).

NRC staff reviewed the applicant's proposed environmental air monitoring stations using the guidance in Regulatory Guide 4.14 (NRC, 1980). NRC staff determined that AM-24 is not within the three downwind sectors. NRC staff reviewed the locations as identified in Figure 2.9-3, and observes that AM-22, AM-23 and AM-24 are not at or near the site boundaries. With respect to the nearest resident, the applicant needs to provide justification for how it determined the locations of the environmental air sampling stations and explain the basis for each of these locations. The applicant should reference meteorological data and other applicable factors (e.g., locations of estimated maximum concentrations of radioactive materials) for each location and provide maps with sectors and distance from the proposed site boundary as well as an explanation for locations that are not consistent with Regulatory Guide 4.14 (NRC, 1980) (e.g., lack of access roads, etc.).

In Section 7.3.3 of the TR, the applicant indicated that Receptor #31 (NT-1) is the closest resident in the downwind direction (CBR, 2010). Receptor #31 is shown in Figure 7.3-2 of the TR (CBR, 2010). NRC staff observes that Receptor #31 and station AM-25 are at two different locations and it is not clear how AM-25 is consistent with respect to the nearest resident with the highest projected radiation dose as described in Regulatory Guide 4.14 (NRC 1980). In addition to these two locations, the applicant identified a resident location within the site boundary. This location is on the south side of the site boundary. Based on the information provided by the applicant, there is insufficient clarity for NRC staff to verify the nearest resident as described in Regulatory Guide 4.14 (NRC 1980).

The applicant indicated that the air particulate and radon monitoring station at AM-26 will be located west of the license boundary in the direction of the least predominant wind direction and will serve as the background air particulate and radon monitoring station (CBR, 2010). Based on a review of Figure 205-6 of the TR (CBR, 2010), NRC staff finds this location acceptable.

NRC staff is imposing a license condition to obtain sufficient justification and clarity for the placement of air monitoring stations AM-22, AM-23, AM-24, and AM-25 to ensure that environmental air sampling stations are located consistent with Acceptance Criteria 2.9.3(1) of NUREG-1569 (NRC, 2003) as discussed above. This license condition is presented in SER Section 2.6.4.

Regulatory Guide 4.14 (NRC 1980) recommends continuous air sampling with weekly filter changes, or more frequently due to dust loading. The applicant stated (CBR, 2010) that air particulate samples will be collected on Type A/E 47 mm glass fiber filter paper using a low volume air sampling system. The system will include a vacuum pump, an airflow regulator, a rotameter-type airflow indicator, and filter paper holder. Air particulate samples will be continuous using a continuous sampler operation with the filter changed weekly or more frequent due to dust loading. The applicant also indicated (CBR, 2010) that the composite samples will be analyzed for the concentrations of natural uranium, Ra-226, Th-230, and Pb-210. The actual volume of air filtered at each station for the quarter is also forwarded to the contract laboratory with the filters. NRC staff has determined that the applicant's proposed

collection of air particulate samples is consistent with Regulatory Guide 4.14 (NRC 1980) and is therefore acceptable.

For radon air sampling, Regulatory Guide 4.14 (NRC 1980) recommends continuous sampling, or at least one week per month representing about the same period each month. The applicant stated (CBR, 2010) that monitoring will be performed continuously using Landauer Radtrak Type DRNF dosimeters. The Radtrak dosimeters will be maintained at the air monitor station and placed at a height from 0.9 m to 1.8 m (3 ft to 6 ft) from the ground. The applicant indicated (CBR, 2010) that radon air sampling will be performed at semiannual intervals to ensure that it meets the lower limit of detection. NRC staff has determined that the applicant's proposed collection of radon samples is consistent with Regulatory Guide 4.14 (NRC 1980) and is therefore acceptable.

Based on the applicant's statements and commitments, NRC has reasonable assurance that the applicant has identified a preoperational particulate and radon air sampling program consistent with Acceptance Criteria 2.9.3(1) of NUREG-1569 (NRC, 2003). However, staff can't make a final determination until the applicant has submitted the air particulate and radon sampling results to staff for review and verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit air particulate and radon air sampling results. This license condition is presented in SER section 2.6.4.

2.6.3.2 Radon Flux

Regulatory Guide 4.14 (NRC, 1980) states that radon-222 flux measurements should be made in three separate months during normal weather conditions in the spring through the fall when the ground is thawed. The measurements should be made at the center of the milling area and at locations 750 and 1500 meters from the center in each of the four compass directions. Measurements should not be taken when the ground is frozen or covered with ice or snow or following periods of rain.

Although it did not address radon flux monitoring in Section 2.9 of the TR (CBR, 2010), the applicant indicated in Section 3.11.2 of the Environmental Report that it will have no tailings impoundment on site (CBR, 2007b). This issue was discussed and resolved in a teleconference between NRC staff and the applicant (NRC, 2009). In addition, the applicant stated that wastes associated with its evaporation ponds (pond water, sludge, liners, etc.) will be properly disposed of (refer to Section 6.2.3 of CBR, 2009). Lastly, the applicant stated that upon site decommissioning, soils near the former storage pond locations will be remediated, if necessary, as part of site closure plans. These soils will subsequently be surveyed according to applicable regulatory guidance to demonstrate compliance with all applicable soil cleanup standards (CBR, 2009).

Based on the applicant's proposed operations and cleanup activities, NRC staff has determined that radon flux monitoring is not necessary for preoperational monitoring because radon flux measurements are only needed if the applicant is required to demonstrate compliance with 40 CFR 192.02. Radon flux measurements measure radon emitted per unit area per time, such as radon emitted from a tailings impoundment. Therefore, the staff concludes the applicant is not required to collect radon flux measurements to comply with Criterion 7 of Appendix A to 10 CFR Part 40.

2.6.3.3 Vegetation, Food, and Fish Sampling

Regulatory Guide 4.14 (NRC 1980) recommends sampling vegetation (three times during growing season) from three locations near the site in three different sectors having the highest predicted airborne radionuclide concentration due to milling operations. It also recommends collecting three food samples [crops (including vegetable gardens), livestock etc., within 3 km (1.9 mi) of the site] once at time of harvest or slaughter, and fish in each body of water twice, semiannually.

The applicant stated in Section 2.9.5.2 of the TR (CBR, 2010) that they selected three vegetation sampling locations on the northern site boundary. The locations are depicted in Figure 2.9-6 and Figure 2.9-7 of the TR (CBR, 2010) and they are identified as Veg-1, Veg-2, and Veg-3. The applicant stated that these sampling sites were selected due to being located around the centerpoint of the satellite facility downwind of the three predominant wind direction sectors. The predominant wind sectors are S, SSW, and SW as identified in Figure 2.5-6 of the TR (CBR, 2010). Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has identified three vegetation sampling locations near the site in different sectors that will have the highest predicted air particulate concentration during milling operations consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003). However, staff can't make a final determination until the applicant has submitted the vegetation sampling results to staff for review and verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit vegetation sampling results. This license condition is presented in SER section 2.6.4.

The applicant indicated (CBR, 2010) that when obtaining vegetation grab samples at a selected location, the samples will be mainly grasses or leafy plant as used as forage by domestic and wild animals. A minimum of 8 kg -10 kg (wet weight) (18 lb - 22 lb) of vegetation will be collected to meet minimum detection limits. The applicant indicated (CBR, 2010) that the samples will be collected three times during the grazing season and will be analyzed for natural uranium, Ra-226, Th-230, Pb-210, and Po-210 after each collection.

The applicant indicated (CBR, 2010) that the preoperational baseline plan will provide for a survey of a three km (1.9 mi) area around the centerpoint of the satellite facility as to the availability of crops, livestock, fowl, and other applicable food sources for sampling. The applicant indicated (CBR, 2010) that initial efforts will be made to collect crop and livestock samples from the quadrants located downwind of the three predominant wind direction quadrants. The applicant identified these sectors in Figure 2.9-7 of the TR (CBR, 2010). The applicant stated (CBR, 2010) that if efforts to locate crops or livestock are unsuccessful, this area will be expanded to include the other quadrants. Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has identified food and crop sampling locations consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003). However, NRC staff cannot make a final determination until the applicant has submitted the food/crop sampling results to staff for review and verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit food and crop sampling results. This license condition is presented in SER section 2.6.4.

The applicant stated (CBR, 2010) that samples for crop and livestock will be obtained one time at the time of harvest or slaughter and analyzed for natural uranium, Ra-226, Th-230, Pb-210, and Po-210. NRC staff has determined that the applicant's proposed process for the collection and analysis of food samples is consistent with Regulatory Guide 4.14 (NRC 1980) and is therefore acceptable

The applicant indicated (CBR, 2010) that they will carry out a fish sampling program as part of the preoperational baseline monitoring program. The applicant stated that fish will be collected from the White River at or near a designated water sampling points W-1 and W-2 as denoted in Figure 2.9-5 of the TR (CBR, 2010). The applicant also indicated (CBR, 2010) that Spring Creek and Un-named Creek only have flow during the spring runoff and the majority of the time these streams are dry. Therefore, the applicant does not consider the collection of fish in these streams/creeks a valid or meaningful option. Based on the applicant's statements, NRC staff agrees that the applicant's fish sampling program does not need to include Spring Creek or Un-named Creek.

The applicant indicated (CBR,2010) that fish sampling will be conducted semiannually two times prior to construction activities, in early spring and late summer, and that fish samples will be analyzed for natural uranium, Ra-226, Th-230, Pb-210, and Po-210. NRC staff has determined that the proposed frequency of the fish sampling collection and the type of analysis is consistent Regulatory Guide 4.14 (NRC, 1980) and is therefore acceptable.

Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has proposed a preoperational fish sampling program consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003). However, the applicant did not provide 12 months of consecutive fish data collection from the location(s) provided in Figure 2.9-5 of the TR (CBR, 2010). Therefore, staff cannot make a final determination on the fish sampling program until the applicant has submitted the fish sampling results to staff for review and verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit fish sampling results. This license condition is presented in SER section 2.6.4.

2.6.3.4 Direct Radiation

Regulatory Guide 4.14 (NRC 1980) recommends a total of 80 direct radiation measurements at 150 meter (492 ft) intervals up to a distance of 1500 meters (4921 ft) in eight directions from the center of the milling area. In addition, direct radiation measurements should also be made at the same locations used for the collection of particulate air samples once prior to site construction. Direct radiation analysis includes gamma exposure rate, using passive integrating devices, or properly calibrated portable survey instruments.

The applicant stated that direct gamma measurements will be made along transects radiating in eight compass directions from the center of the satellite production facility at 300 m (984.25 ft) intervals out to a maximum distance of 1500 m (4921 ft) (CBR, 2012a). The direct radiation measurement sampling points are shown in Figure 2.9-6 of the TR (CBR, 2010). NRC staff reviewed the number of gamma survey locations in Figure 2.9-6 of the TR and determined that there are 74 gamma survey locations. NRC staff determined that the applicant identified all the gamma survey locations at 150 meter (492 feet) intervals within the site boundary. NRC staff

has determined that the difference between the recommended 80 direct radiation measurements in Regulatory Guide 4.14 and the applicant's number of measurements (i.e., 74) reflect the short radial distance in the west and east. NRC staff has determined that the applicant's proposed direct radiation measurement program depicted in Figure 2.9-6 of the TR (CBR, 2010) is consistent with the guidance in Regulatory Guide 4.14 (NRC 1980) and is therefore acceptable.

The applicant stated (CBR, 2010) that direct gamma radiation measurements will be conducted utilizing a Ludlum Model 2221 ratemeter/scaler and Trimble ProVRG GPS survey meter. The detector will be carried approximately 0.8 m (18 in) above the ground surface. Survey personnel will walk the designated transects and any other designated areas to be monitored at a rate of approximately 0.8 m/s (2.5 ft/s) with a transect spacing of approximately 3 m (10 ft). A Ludlum Model 19 micro-R meter will be used for exposure rate measurements at soil sample locations. The applicant stated (CBR, 2010) that correlations between soil samples, sodium iodide readings, and energy independent exposure rate measurements will be performed during soil sampling and gamma surveys if areas of the site exhibit significantly different gamma count rates.

NRC staff observes that for gamma exposure measurements, Regulatory Guide 4.14 recommends using passive integrating devices (e.g., Thermoluminescent Dosimeters (TLDs)), pressurized ionization chamber, or properly calibrated survey instruments. Without additional information from the applicant, NRC staff cannot evaluate the applicant's method of calibrating the sodium iodide readings. More specifically, NRC staff cannot determine how the applicant will correlate the count rate to exposure rate after calibration. Based on the applicant's statements and commitments, NRC has reasonable assurance that the applicant has identified the type of analysis for direct radiation consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003). However, staff cannot make a final determination until the applicant adequately describes the calibration methodology for its portable radiation instrument. Therefore, staff is imposing a license condition to require the applicant to submit information on how its calibration methodology for portable radiation survey technique is consistent with Regulatory Guide 4.14 for NRC review and written verification. This license condition is presented in SER Section 2.6.4.

The applicant also plans to take direct radiation measurements at each of the air particulate sampling stations shown in Figure 2.9-3 of the TR (CBR, 2010). NRC staff has determined that the applicant's proposed direct radiation measurements at the air particulate sampling stations are consistent with Regulatory Guide 4.14 and therefore acceptable. However, as noted above, NRC staff is imposing a license condition to ensure correct placement of the air particulate sampling stations. Therefore, staff can't make a final decision until that issue is resolved.

The applicant indicated (CBR, 2010) that the measurements will be taken over a 12 month period with Landauer InLight EX9 dosimeters deployed at the beginning of each quarter. These dosimeters will have a minimum detection limit of 0.1 mrem. NRC staff reviewed the last four quarters of environmental TLD reports for the currently operating facility (CBR, 2012b, 2012c) to determine if this was a reasonable minimum detection limit. The quarterly TLD measurements ranged from 3.5 mrem to 15.2 mrem. NRC staff has determined that the minimum detection limit of 0.1 mrem is consistent with Regulatory Guide 4.14 (NRC, 1980) in that the proposed

minimum detection limit is less than 10 percent of the lowest measured value and is therefore acceptable.

Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has proposed a preoperational direct radiation measurement program consistent with Acceptance Criteria 2.9.3(1) of NUREG-1569 (NRC, 2003). However, staff can't make a final determination until the applicant has submitted the direct radiation measurement results to staff for review and written verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit direct radiation measurement results. This license condition is presented in SER Section 2.6.4.

2.6.3.5 Soil Sampling

Regulatory Guide 4.14 (NRC 1980) recommends that up to 40 surface soil samples be collected at 300 meter (984.25 ft) intervals to a distance of 1500 meters (4921.26 ft) in eight meteorological sectors, as well as 5 or more surface soil samples collected at air particulate stations. The applicant stated (CBR, 2012a) that soil samples will be collected along transect lines radiating in eight compass directions from the center of the satellite facility at 300 meter (984.25 ft) intervals. The soil sampling locations are depicted in Figure 2.9-6 of the TR (CBR, 2010).

In addition to the soil samples collected at a depth of 5 cm (2 inches) as recommended in Regulatory Guide 4.14, soil sampling is recommended in NUREG-1569, Acceptance Criteria 2.9.3(2) at depths of 15 cm (6 inches) for background decommissioning.

NRC staff reviewed the soil sampling locations as identified in Figure 2.9-6 of the TR (CBR, 2010) and determined that there are 37 soil sampling locations. NRC staff has determined that the difference between the number of soil samples identified in Regulatory Guide 4.14 and the number of soil sampling locations identified in Figure 2.9-6 of the TR (CBR, 2010) is due to the short radial distance in the west and east sectors. NRC staff has determined that the number of soil sampling locations is consistent with Regulatory Guide 4.14 and therefore, the soil sampling program proposed by the applicant is acceptable.

In accordance with Regulatory Guide 4.14 (NRC, 1980) surface soil samples should be collected to a depth of 5 cm (2 in). Acceptance Criteria 2.9.3(2) of NUREG-1569 (NRC, 2003) also recommends soil sampling at 15 cm (6 in) depth for background decommissioning data. 10 CFR 40 Appendix A, Criterion 6(6) is written in terms of soils analyzed for Ra-226 at a depth averaged over the first 15 cm below the surface and subsequent 15 cm layers below the first 15 cm thereafter for subsurface soils. In addition, at least five subsurface soil samples in each of the four compass directions should be collected.

The applicant proposed an alternate soil sampling strategy by not taking soil samples at both 5 cm (2 in) and 15 cm (6 in.) depth as recommended by NUREG-1569, Acceptance Criteria 2.9.3(2). As its basis, the applicant cited a previous NRC staff conclusion (NRC, 2012) that relied on an EPA finding that there was no difference in health protection between averaging contamination throughout the top 5 cm (2 in) of soil versus the top 15 cm (6 in) of soil. The applicant proposed not sampling at a depth of 15 cm (6 in) (CBR, 2012a). This approach is not consistent with the approach leading to NRC staff's previous conclusion (NRC, 2012). More

specifically, 10 CFR 40 Appendix A, Criterion 6(6) contemplates, so as to determine its applicability, soil sampling at 15 cm (6 in) intervals during decommissioning. As a result, NRC staff does not find the applicant's proposed soil sampling strategy acceptable. Therefore, NRC staff is imposing a license condition to obtain pre-operational soil sampling results for soils at a depth of 15 cm (6 in) so that a comparison can be made during decommissioning activities. This license condition is presented in SER Section 2.6.4.

The applicant proposed collecting surface and subsurface soil samples as indicated in Table 2.6-1 (CBR, 2010). The applicant indicated that soil samples will be conducted once prior to construction, and repeated for locations disturbed by excavation, leveling, or contouring (CBR, 2010).

Table 2.6-1: Soil Samples

Type of Soil Sample	Location	Sample Depth	Total # of Samples	Analyses Performed
Surface	300 meter intervals to a distance of 1500 meters in each of 8 directions from center of milling area.	5 cm	31	Ra-226 and ten percent of the samples analyzed for natural uranium, Th-230, and Pb-210
Surface	air particulate sampling stations as shown in Figure 2.9-3 of the TR	5 cm	5	natural uranium, Ra-226, Th-230, and Pb-210
Subsurface	Center point of satellite facilities and at distances of 750 m in each of 4 directions	15 cm increments to a depth of 105 cm	5	Ra-226 and one set of samples analyzed for natural uranium, Th-230, and Pb-210

Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has proposed a preoperational soil sampling program consistent with Acceptance Criteria 2.9.3(1) of NUREG-1569 (NRC, 2003). However, NRC staff cannot make a final determination until the applicant has provided the soil sampling results to staff for review and written verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit soil sampling results. This license condition is presented in SER section 2.6.4.

2.6.3.6 Sediment Sampling

Regulatory Guide 4.14 (NRC 1980) recommends sediment sampling at two locations for each surface water feature (e.g., streams, rivers, drainages) passing through the site and one in each water impoundment. These include onsite locations as well as offsite locations that may be

subject to drainage from potentially contaminated areas. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence (NRC, 1980). In addition, Regulatory Guide 4.14 (NRC 1980) recommends grab sediment samples for upstream and downstream locations once following spring runoff and late summer following periods of extended low flow. Sediment samples should be analyzed for natural uranium, Ra-226, Th-230, and Pb-210 for each sampling period (NRC, 1980).

The applicant stated in Section 2.9.9.2 of the TR (CBR, 2010) that sediment samples will be collected from eight ephemeral stream drainage channels Spring Creek, Un-named Creek, and Hall Canal. These sediment sampling locations are identified in Figure 2.9-5 of the TR (CBR, 2010).

The applicant also identified four sediment sampling locations for the White River in Section 2.9.9.2 of the TR (CBR, 2010). However, the applicant only identified two sediment sampling locations for the White River (W-1 and W-2) in Figure 2.9-5 of the TR (CBR, 2010). NRC staff determined from Figure 2.9-5 of the TR (CBR, 2010) that sediment sampling location W-2 is not near the site boundary as recommended by Regulatory Guide 4.14 (NRC 1980). Therefore, staff is imposing a preoperational license condition to require the applicant to submit additional information and justification for the sediment sampling stations for its review and written verification. This license condition is presented in SER section 2.6.4.

Regulatory Guide 4.14 (NRC, 1980) recommends that sediment samples will be grab samples and analyzed for natural uranium, Ra-226, Th-230, and Pb-210. The applicant stated (CBR, 2010) that at each of the sampling locations as shown in Figure 2.9-5 of the TR four sediment sub-samples will be collected with a hand trowel, core sampler or other applicable sampling device. The applicant stated (CBR, 2010) that four sub-samples at each sampling location will be composited (thoroughly mixed) in order to collect a representative sample so that the average radionuclide concentration across the stream/river beds are obtained. The applicant indicated (CBR, 2010) that the samples will be analyzed for natural uranium, Ra-226, Th-230, and Pb-210. NRC staff has determined that the applicant's proposed sampling and analysis of sediment samples is consistent with Regulatory Guide 4.14 (NRC, 1980) and is therefore acceptable.

The applicant stated that there are no surface impoundments subject to drainages from the satellite operations and therefore sediment samples will not be collected from surface impoundments (CBR, 2010). NRC staff reviewed USGS topographical maps and determined that there are no natural impoundments on the proposed site (USGS, 1984). Based on the NRC staff review of the USGS topographical maps and the applicant's statements and commitments, NRC staff has determined that the applicant will not have surface impoundments onsite and therefore no sediment sampling associated with impoundments.

Based on the applicant's statements and commitments, NRC staff has reasonable assurance that the applicant has identified a preoperational sediment sampling program consistent with Acceptance Criterion 2.9.3(1) of NUREG-1569 (NRC, 2003), except for the issues noted above. However, NRC staff can't make a final determination until the applicant has provided the sediment sampling results to staff for review and written verification. Therefore, staff is imposing a preoperational license condition to require the applicant to submit sediment sampling results. This license condition is presented in SER section 2.6.4.

2.6.3.7 Ground water Sampling

For ground water analyses, see Section 2.5 on water quality.

2.6.3.8 Surface Water Sampling

For surface water analyses, see Section 2.5 on water quality.

2.6.4 Evaluation Findings

The staff reviewed the background radiological characteristics of the NTEA in accordance with Section 2.9.3 of the Standard Review Plan. The applicant has proposed a background radiological characteristics program that includes sampling frequency and methods, sampling locations, and types of analyses. The applicant described the environmental sampling locations and the methods and analysis for the environmental media air particulate, air radon, food crop/vegetation and fish, direct radiation, soil, and sediment. The applicant has provided adequate justification for not conducting radon flux monitoring during preoperational monitoring.

The applicant has not provided 12 consecutive months for air particulate, air radon, vegetation, food/crop, direction radiation, surface and subsurface soil, and sediment results from sample collection. The applicant shall collect, analyze, and provide results for the previously mentioned sampled medias representing 12 consecutive months required by 10 CFR 40 Appendix A, Criterion 7.

The applicant stated that it was not necessary to sample soil at a depth of 15 cm (6 in.) because EPA found no difference in health protection between averaging contamination throughout the top 5 cm (2 in.) of soil and the top 15 cm (6 in.) of soil, and therefore, it was not necessary to sample to 15 cm (6 in.). This is not consistent with the Acceptance Criteria 2.9.3(2) of NUREG-1569 (NRC, 2003). NRC staff observes that while both 5 cm and 15 cm soil samples at the same location may not be necessary, 10 CFR 40, Appendix A, Criterion 6(6) contemplates soil sampling to a depth of 15 cm (6 in.) during decommissioning activities. Therefore, NRC staff is imposing the following license condition so that results from pre-operational soil samples can be meaningfully compared to soil sample results during decommissioning to determine the impact of operations consistent with Criterion 6(6).

Because the applicant has not provided the required information, the staff is adding the following license condition to ensure that representative data are collected prior to the beginning of operations. This condition also addresses the results of NRC's analysis of surface water quality discussed in SER Section 2.5.

> Prior to major site construction, the licensee shall submit a preoperational radiological environmental monitoring program report for NRC review and written verification that will include air particulate, air radon, vegetation, food/crop, direct radiation, surface and subsurface soils, sediments, and surface water as described in Regulatory Guide 4.14 to comply with 10 CFR Part 40, Appendix A, Criterion 7.
>
> Surface soil samples shall include samples at 15 cm depth as described in NUREG-1569, Acceptance Criteria 2.9.3(2) for decommissioning purposes.

> Surface water samples shall also be analytically analyzed for the list of constituents in Table 2.7.3-1 of NUREG-1569. Sample analytical results shall be submitted to the NRC for written verification. If an alternate list of constituents tailored to the site, appropriate justification shall submitted to the NRC for review and approval before the sampling is implemented.

NRC staff does not agree with the applicant's proposed locations for environmental air sampling locations AM-22, AM-23, AM-24, and AM-25. The applicant did not provide sufficient technical basis or justifications for these locations. NRC staff determined that AM-22, AM-23, and AM-24 are not at or near the site boundaries. In addition, NRC staff could not determine if AM-24 is located within the three downwind sectors with the highest potential airborne concentration. The applicant identified several air sampling locations in the application that is the air sampling station at the nearest resident. NRC staff could not verify which location represents the air sampling location that is at the nearest resident (designated as AM-25 by the applicant). Because the applicant has not provided the required information, the staff is adding the following license condition to ensure that adequate justification and technical bases for AM-22, AM-23, and AM-24 are provided prior to operations:

> At least 60 days prior to the preoperational inspection, the licensee shall provide additional information to NRC for review and written verification for the justification and technical basis of the selection of the environmental air particulate sampling locations for AM-22, AM-23, AM-24 and AM-25 and how these sampling locations comport with Regulatory Guide 4.14.

The applicant identified 4 sediment sampling locations for the White River in the application but only identified 2 sampling locations in Figure 2.9-5 of the TR (CBR, 2010). In addition, the applicant identified sediment and surface water sampling location W-2 that is not in a location consistent with Regulatory Guide 4.14 (NRC, 1980). The applicant needs to provide further justification for sediment and surface water sampling location W-2 or relocate sediment and surface water sampling location W-2 to a location consistent with Regulatory Guide 4.14 (NRC, 1980), and identify the location in Figure 2.9-5 for the other two sediment samples. Therefore, NRC staff is imposing the following license condition:

> At least 60 days prior to the preoperational inspection, the licensee shall provide justification that the location of sediment and surface water sampling location W-2 is consistent with Regulatory Guide 4.14 and identify the location of the other two sediment and surface water sampling locations (other than W-1 and W-2) for NRC review and written verification.

The applicant stated that correlations between soil samples, sodium iodide readings, and energy dependent exposure rate measurements will be performed during soil sampling and gamma surveys if areas of the site exhibit significantly different gamma count rates. The applicant has not provided sufficient information for staff to determine how the applicant will correlate the count rate to exposure rate after calibration. Therefore, NRC staff is imposing the following license condition:

At least 60 days prior to the preoperational inspection, the licensee shall submit information on how its portable radiation survey technique (i.e., the sodium iodide readings) is consistent with the recommendations in Regulatory Guide 4.14 regarding gamma exposure rate measurements for NRC review and written verification.

Based upon the review conducted by the staff as indicated above, the information provided in the application, as supplemented by information to be collected in accordance with the noted license conditions, meets the applicable acceptance criteria of this section and the requirements of 10 CFR 40, Appendix A, Criterion 7.

2.6.5 References

10 CFR 40, Part 40, "Domestic Licensing of Source Material," Appendix A, Criterion 7

CBR, 2012a. Email from J. Schmuck to R. Burrows, North Trend Replacement Pages, dated October 18, 2012, ADAMS Accession No. ML 12299A212
CBR, 2012b. Semiannual Radiological Effluent and Environmental Monitoring Report, Cameco Resources, Crow Butte Operation, August 30, 2012, ADAMS Accession No. ML12257A470

CBR, 2012c. Semiannual Radiological Effluent and Environmental Monitoring Report, Cameco Resources, Crow Butte Operation, February 22, 2012, ADAMS Accession No. ML12110A247

CBR, 2010. Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Radioactive Source Material License no. SUA-1534, Crow Butte Resources Inc., October 22, 2010, ADAMS Accession No. ML103010525

CBR, 2009. Response to Letter Received November 20, 2008-Request for Additional Information, License Amendment for the North Trend Expansion Area, Crow Butte Resources, Inc., Crawford, Nebraska ML090750430

CBR, 2007a, Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report-Volume II, Appendices A through E ADAMS Accession No. ML071760350.

CBR, 2007b Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Environmental Report, Volume 1, ADAMS Accession No. ML071730274

NRC, 2012. Public meeting summary from August 30, 2012 Teleconference regarding Powertech's proposed environmental monitoring program related to the proposed Dewey-Burdock Project ADAMS Accession No. ML12255A258.

NRC, 2009. Minutes from October 5, 2009 Teleconference Regarding Open Issues, Crow Butte, Inc., North Trend Expansion Area License Amendment ADAMS Accession No.ML093060326

NRC, 2003. NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications-Final Report." June 2003.

NRC 1980, Regulatory Guide 4.14, Revision 1, “Radiological Effluent and Environmental Monitoring at Uranium Mills”, April 1980.

USGS, 1984. http://msrmaps.com/image.aspx?T=2&S=14&Z=13&X=196&Y=1478&W=3&qs=%7cCrawford%7cNE%7c, Accessed on 10/4/2012, U. S. Geological Survey Crawford, NE, Topographic Quadrangle Map, July, 1, 1984

3.0 DESCRIPTION OF THE PROPOSED FACILITY

3.1 IN SITU RECOVERY PROCESS AND EQUIPMENT

3.1.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has demonstrated that the equipment and processes used in the wellfields during operation at the NTEA (NTEA) will meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the licensing basis were reviewed for compliance with the applicable requirements of 10 CFR 40 using the acceptance criteria outlined in Section 3.1.3 of NUREG-1569 (NRC, 2003a).

3.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by the applicant in the NTEA application (CBR, 2007a) and as updated. As part of its review of the information supplied by the applicant, the NRC staff also examined past inspection reports of the Crow Butte facility for similar processes and equipment proposed for NTEA. (NRC, 2008, 2009, 2010a, and 2011).

The following subsections present the staff's review and analysis of various aspects of the ISR processes and equipment proposed for the NTEA facility. Review areas addressed in this section include: the uranium extraction and restoration operations, wellfield infrastructure, and the proposed schedule for operations.

3.1.3.1 Mine Unit and Mineralized Zone Description

The applicant described the ISR process and equipment to be used at NTEA (CBR, 2009). The NTEA includes 530 hectares (1,310 ac) of wellfields and construction disturbed areas. Within the NTEA, a satellite plant will be located within a fenced area, which is 12.1 hectares (30 ac) in size. (CBR, 2009)

For wellfield infrastructure, the applicant stated that the ore zones at the NTEA will be divided into separate production areas (wellfields) where the injection and extraction wells will be installed. Consistent with the currently licensed Crow Butte facility, wells will be arranged in 7-spot patterns with injection wells spaced between 19.8 meters (m)-45.7 m (65 feet (ft)-150 ft) apart (CBR, 2009). Staff previously found the applicant's injection and production well arrangement at its main facility to be acceptable (NRC, 2012). Staff finds nothing to invalidate these previous findings on NTEA facility injection and production well arrangement and spacing that are used at the currently licensed facility and thus, previous staff conclusions remain valid. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of facility injection and production well arrangement and spacing used at both the NTEA and the currently licensed facility.

Staff observes that Application Section 3.1.3 states, “Other wellfield designs include alternating single line drives.” As presented in the application, staff does not approve of the use of line drives for the NTEA because the applicant did not sufficiently demonstrate the containment of injected fluids and a monitoring program for a line drive at the NTEA. Therefore, NRC staff will impose a license condition requiring CBR to amend its license if wellfield designs are to include line drives. This license condition is presented in SER Section 3.1.4.

The applicant stated that uranium at NTEA will be extracted from an ore body in the Basal Chadron Sandstone at depths of 122 m to 244 m (400 ft to 800 ft) below ground surface. In plan view, the ore zone is a 31 m to 305 m (100 ft to 1,000 ft) wide strip trending generally North to South (CBR, 2009). The average thickness of ore-bearing Basal Chadron Sandstone is 6.1 m - 18.3 m (20 ft -60 ft), and the average uranium grade is above 0.20% U_3O_8. (CBR, 2007a). Staff finds this description of the NTEA mineralized zone to be consistent with acceptance criteria presented in Section 3.1.3 of NUREG 1569 (NRC, 2003a).

3.1.3.2 Well Design, Construction and Integrity Testing

The applicant described in detail the well installation and cementing procedures to protect overlying and underling aquifers and prevent cross contamination. A description of three well construction methods was provided (CBR, 2009). Typical well completion schematics for each of these methods are provided in Application Figures 3.1-3, 3.1-2 and 3.1-3. The applicant stated the well casing would be 11.4 cm (4.5 inches) in diameter. Connections between factory-constructed well casing sections will be joined using an O-ring and spline locking system. The screen interval is determined by the applicant’s geologic staff review of geophysical logs. The screened interval of an injection and production well is selected by identifying ore-bearing sand zones to be mined, which is hydraulically connected to surrounding wells. As discussed in SER Section 3.1.3.3, the screen interval of monitoring wells will include sand horizons that are impacted by nearby mining wells. The applicant committed to maintaining well completion reports associated data (geophysical logs) on-site for review (CBR, 2009). The staff found the applicant’s description of the proposed well construction to be consistent with acceptance criteria presented in Section 3.1.3 of NUREG 1569 (NRC, 2003a).

After the completion of well installation, the applicant stated that the wells will be developed by airlifting and tested for mechanical integrity. Airlift well development entails the injection of air to breakdown the mud-cake left on the borehole wall and to remove fine grained sediments. Mechanical integrity tests (MITs) will be performed when wells are brought into service initially and every five years after. They will also be tested after any repair or work is done on the well and whenever there is any question of casing integrity. MITs will be performed at a pressure which is 125 percent of the maximum operating wellhead casing pressure. A well passes the MIT if a pressure drop of less than 10 percent occurs over a minimum 20-minute period. All MITs will be documented and the records will be maintained on site for NRC review (CBR, 2010).

Based on the staff’s review of information provided in the application, the applicant’s past experience with the above-referenced mechanical integrity testing procedures, and the requirements of the current license, the staff finds that the applicant’s mechanical integrity testing procedures for the NTEA (CBR, 2009) are consistent with those used at its main facility. Staff previously found the applicant’s mechanical integrity testing procedures at its main facility

to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's mechanical integrity testing procedures are relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the mechanical integrity testing procedures and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the mechanical integrity testing procedures at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of the mechanical integrity testing procedures.

3.1.3.3 Excursion Monitoring Wells

Staff observes that the applicant's proposed configuration and density for NTEA ground water monitoring wells in the overlying Brule aquifer and wellfield perimeter monitoring wells in Basal Chadron aquifer (production aquifer) are similar to that of the currently licensed Crow Butte facility (CBR, 2007b, 2009). Based on annual inspection of facility records by the NRC (NRC, 2008, 2009, 2010a, and 2011), staff observes that the monitoring well pattern at the currently licensed Crow Butte facility has been demonstrated to be effective in detecting excursions. Based on the staff's review of information provided in the application and the applicant's past experience with the above-referenced monitoring well pattern, the staff finds that the applicant's NTEA monitoring well pattern is consistent with that used at its main facility. Staff previously found the applicant's monitoring well pattern at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's monitoring well pattern is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the monitoring well pattern, and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the monitoring well pattern at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the monitoring well pattern.

Screened intervals of the NTEA wellfield perimeter monitor wells will be half the thickness of the mining zone. The screened interval will be determine by Crow Butte geology staff using borehole geophysical logs and formation samples. The screened interval will include sand horizons that are impacted by nearby mining wells (CBR, 2009). Staff finds the proposed excursion monitor well network for the NTEA Project are sufficient and consistent with acceptance criteria presented in Section 3.1.3 of NUREG-1569 (NRC, 2003a) and therefore acceptable. The applicant's monitoring program and procedures for control excursions at the NTEA are further discussed in SER section 5.7.8 and a discussion of the flare factor that may result in excursions is further discussed in SER section 6.1.

3.1.3.4 Spills and Leaks

Staff observes that the applicant proposes to implement for the NTEA the same operational controls to maintain a balance in production and extraction rates and to control and capture excursions as those employed at the currently licensed Crow Butte facility (CBR, 2007b, 2009).

The applicant stated that wellfield piping will be constructed of polyvinyl chloride (PVC) or high density polyethylene (HDPE). In application Section 7.5.4, the applicant stated that individual well lines and trunk lines will be buried to prevent freezing. Individual well lines and trunk lines are pressure tested at operating pressures prior to their final burial below the frost line prior to operations and following maintenance activities that may affect the integrity of the system (CBR, 2009). As the applicant is committed to piping installation procedures that will prevent piping

failures, the staff finds the procedures are sufficient and consistent with acceptance criteria presented in Section 3.1.3 of NUREG-1569 (NRC, 2003a) and therefore acceptable.

The applicant provided a description of the header houses that will be used to distribute injection fluid to injection wells and collect production solution. In application Sections 3.3 and 7.5.4, the applicant stated that pressure and flow of injection and production wells will be continuously monitored for pressure and flow at each header house using an electronic monitoring system. This system will allow these monitoring parameters to be observed at the control room of the NTEA Plant. The control system will contain high and low alarms for pressure and flow, which will alert control room personnel to certain ranges of pressure and flow that signal a potential pipe leak and trigger automatic shutoffs and shutdowns. Additionally, the header houses will be equipped with an alarm for the presence of liquids in the header house sump (CBR, 2009).

Based on the staff's review of information provided in the application, the staff finds that the proposed instrumentation and operation of wellfield piping, header houses, and associated control systems are consistent with that used at the main CBR facility. Staff previously found the applicant's instrumentation and operation of wellfield piping, header houses, and associated control systems at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's instrumentation and operation of wellfield piping, header houses, and associated control systems are relevant and effective for the NTEA. The staff is not aware of any safety-related reason why instrumentation and operation of wellfield piping, header houses, and associated control systems implemented and used at the currently licensed facility would not be appropriate for the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of the instrumentation and operation of wellfield piping, header houses, and associated control systems.

The applicant stated that a program of continuous wellfield inspections will be implemented by wellfield operators. Various process components within process, storage, and wellfield areas will be inspected to ensure proper operation and to detect leaks (CBR, 2009). Staff observes the inspection program is consistent with those at the currently licensed Crow Butte facility, which have been previously found to be acceptable by NRC staff (NRC, 2008, 2009, 2010a, and 2011). Staff finds nothing to invalidate these previous findings on NTEA facility wellfield inspection program that are used at the currently licensed facility and thus, previous staff conclusions remain valid.

An evaluation of the provisions for well head protection from flooding is provided in SER Section 2.4. Staff's proposed license condition associated with the evaluation is presented in SER section 2.4.4.

3.1.3.5 In Situ Process

3.1.3.5.1 Injection Pressures

Based on regional information, previous CBR permit submittals, and historical operational practices, the applicant estimated that the formation fracture gradient (i.e., pressure required to induce fractures in rock at a given depth) for the license area is 14.25 kPa/m (0.63 psi/ft) (CBR,

2009). Staff observes that the applicant's proposed formation fracture gradient (production aquifer) is consistent with that previous used for the currently licensed Crow Butte facility (NRC, 1998). Staff previously found the applicant's formation fracture gradient at its main facility to be acceptable (NRC, 1998). Therefore, staff has reasonable assurance that the applicant's formation fracture gradient is relevant and acceptable for the NTEA. Staff finds nothing to invalidate the previous findings on the formation fracture gradient, and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the formation fracture gradient at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's formation fracture gradient.

Using the formation fracture gradient, the staff estimated the maximum bottom-hole injection pressure that could be maintained without fracturing at the NTEA. The staff estimated the pressure to be 3.48 MPa (504 psi) for the maximum well depth of 244 m (800 ft). Using a hydrostatic pressure gradient of 9.79 kPa/m (0.433 psi /ft), NRC staff estimated the wellhead pressure for these bottom hole pressure constraints would be 2.39 MPa (346 psi). As required by standard license condition, the injection pressures during wellfield operations shall not exceed 0.69 MPa (100 psi) at the injection well heads (refer to SER Section of 3.3.3). As the design operating wellhead pressure (i.e., 0.69 MPa (100 psi)) is less than the wellhead pressure constraints (i.e., 2.39 MPa (346 psi)), the staff finds the operating pressures are acceptable and will not cause the well to exceed the estimated bottom-hole formation fracture pressures at the NTEA.

3.1.3.5.2 Bleed

The applicant stated that the NTEA will be operated at a maximum rate of 17,034 liters per minute (Lpm) (4,500 gallons per minute (gpm)), and that more fluid will be recovered than injected to maintain an overall inward hydraulic gradient in each wellfield in the ISR operation (CBR, 2012). This difference, known as a bleed, is adjusted as necessary to maintain an inward hydraulic gradient at each wellfield to prevent excursions. As required by standard license condition (refer to Section 3.1 of NRC, 2012), the applicant will maintain an overall inward hydraulic gradient during operations and restoration at the perimeter ore zone monitoring wells for each wellfield. NRC staff evaluated the ability of the applicant to maintain an overall inward hydraulic gradient at the NTEA project during production to prevent excursions at perimeter ore zone monitoring wells. Due to similarities between the proposed NTEA project and the currently licensed Crow Butte project, this evaluation centered on a review of records for the current Crow Butte license area. The similarities considered in staff's evaluation include:

- NTEA's production wellfield bleed is approximately 83 Lpm to 256 Lpm (22 gpm to 67.5 gpm) or 0.5 to 1.5 percent of the production flow (CBR, 2009). Staff observes that this production bleed and NTEA proposed wellfield operations (CBR, 2009) are currently being implemented at the currently licensed Crow Butte facility (CBR, 2007b);
- Referenced published information referenced in SER Section 2.3 indicate that the ISR related regional stratigraphic units in this portion of the State of Nebraska are present beneath both of the above-referenced projects (CBR, 2007b, 2009);

- Hydrogeological characterization of the NTEA project (refer to SER Section 2.4) indicate the ISR hydrogeology and Basal Chadron aquifer properties are similar to that of the currently licensed Crow Butte facility (CBR, 2007b, 2009).

Staff's review of the currently licensed Crow Butte facility's records included inspection reports (NRC 1999 - 2002, 2003b, 2004-2006, 2007a, 2008, 2009, 2010a) and numerous excursion monitoring reports. From 2000 to 2011, NRC records indicate 11 perimeter monitoring wells were placed on excursion status (See section 5.7.9 of NRC, 2012). Of these, further sampling of nine of these wells indicated that nine of the well samples that indicated an excursion were in error and thus, were taken off excursion status. Staff observes that the three confirmed excursions were effectively corrected with special adjustments of the wellfield bleed (See section 5.7.9 of NRC, 2012). Staff finds the record of historical excursions demonstrates the applicant's ability to maintain the containment of ISR fluids within the wellfield. Based on the above-referenced similarities between the NTEA and the currently licensed Crow Butte Facility and the applicant's demonstrated ability to maintain an overall inward gradient at their currently licensed facility, staff has reasonable assurance that the applicant will be able to maintain an overall inward gradient at the proposed NTEA project.

The applicant stated that the eluant bleed stream at the central processing plant (CPP) at the currently licensed Crow Butte facility is anticipated to increase by a maximum of 10 percent due to processing of loaded ion exchange resin from the NTEA Satellite Plant. The applicant committed to managing the eluant bleed waste stream by its reuse in the CPP, or by disposal at existing ponds or by deep disposal well injection, at the currently licensed Crow Butte facility (CBR, 2007a). Staff observes after the applicant upgraded the facility's processing equipment in 2008, the average net consumption at the current license area is 473 Lpm (125 gpm) (CBR, 2007b). Staff finds this net consumption to be sufficiently below the above-referenced estimated injection rate capacity of the existing deep disposal well of 1,136 Lpm to 1,514 Lpm (300 gpm to 400 gpm). Therefore, staff has determined that adequate disposal capacity is available at the currently licensed Crow Butte facility for the additional eluant liquid waste generated from the CPP processing of NTEA loaded ion exchange resin.

3.1.3.5.3 Plant Material Balance and Flow Rates

The applicant provided a water balance schematic for the proposed NTEA production in Application Figure 3.1-8 and a restoration process flow schematic in Application Figure 6.1-1 (CBR, 2009). The application indicated that the byproduct material liquid waste generated from NTEA Operation will be composed primarily of the combination of operational bleed and restoration liquid waste flow. The bleed is estimated to be 83 Lpm to 256 Lpm (22 gpm to 67.5 gpm), which is the reported 0.5 to 1.5 percent of the NTEA plant production capacity of 17,034 Lpm (4,500 gpm). Coupled with other liquid waste contributions such as restoration liquid waste, the applicant stated that the expected net consumption for the entire operation will be on the order of 189 Lpm to 379 Lpm (50 gpm to 100 gpm). (CBR, 2009)

The applicant reported that byproduct material liquid wastes that will be generated by the NTEA will include well development water, process bleed solutions, and restoration water. The applicant described the plan to handle and dispose of these liquid wastes at the NTEA through deep disposal well injection and solar evaporation ponds. The ponds will also provide surge capacity (CBR, 2009). The surge capacity will allow the applicant to direct additional liquid

waste to a pond(s) when needed (e.g., to clean or conduct maintenance on a particular pond and maintain consistent flow from wellfields). The Crow Butte license stipulates that all liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall either be returned to the process circuit; discharged to the solar evaporation ponds, disposed by land irrigation, or deep well injected (NRC, 2010b). The applicant stated that the use of the land application disposal method is not planned at the NTEA at this time (CBR, 2007a). Staff observes that if land application is proposed for the NTEA in the future, land application must be approved by staff to be protective of health and safety. Therefore, NRC staff is imposing a license condition that requires the applicant to amend its license if land application would be utilized. This license condition is presented in SER Section 3.1.4. Land application is further discussed in SER Section 4.2.

The staff observes that the existing deep disposal well at the currently licensed Crow Butte facility is completed into the same regional aquifer formation as the deep disposal well proposed for the NTEA project (CBR, 2000, 2012). According to a document submitted by the licensee to the NRC in 2000 (CBR, 2000), the potential injection rate capacity of the existing deep disposal well is estimated to be between 1,136 Lpm to 1,514 Lpm (300 gpm to 400 gpm). Staff observes that the liquid disposal injection rate capacity of the North Trend deep disposal well will likely be sufficient, but also observes that the deep well capacity will not be definitively known until after its installation. Staff also observes that adequate disposal capacity is critical for ISR operations. To ensure adequate capacity for deep disposal of byproduct material, the staff is imposing a license condition to require the applicant to demonstrate that the installed disposal well provides adequate deep well capacity to dispose of the projected liquid volume under normal operating conditions during production and restoration phases. This license condition is presented in SER Section 3.1.4 and has been combined with the above-referenced license condition for land application. . Disposal of liquid byproduct material in the deep disposal well is further discussed in SER Section 4.2.

The applicant is currently in the NDEQ application process to secure a permit to install a Class I Underground Injection Control (UIC) deep disposal well at the NTEA. Application Figure 3.2-2 provides a schematic of the proposed location of the deep disposal well. The applicant plans to install the proposed deep well prior to the commencement of operations at the NTEA ISR Project (CBR, 2009). NRC staff observes that the applicant will have to amend its license to propose another disposal option if they do not receive the UIC permit.

3.1.3.5.4 Lixiviant Makeup

By license condition, the lixiviant injected into the production aquifer consists of native ground water, with added sodium carbonate/bicarbonate, carbon dioxide, oxygen and/or hydrogen peroxide (Section 3.1 of NRC, 2012). Staff has previously concluded that the lixiviant composition was acceptable during the prior license renewal reviews for the current licensed facility (NRC, 1998, 2012). Staff has found nothing to invalidate previous findings as applied to the use of the same lixiviant composition at the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the mechanical integrity testing procedures at the NTEA. Therefore, the original findings stand and previous staff conclusions remain valid. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not reexamining this issue.

3.1.3.5.5 Drawdown

In application Section 2.2.3, the applicant stated that water supply well use in the vicinity of the NTEA use is limited to small volumes and is expected to have a minimal effect on the capture of production fluids. Application Figure 2.2-4 shows the location of the private wells that are within 3.6 km (2.25 mi) radius of the NTEA Project. The applicant stated that active wells in this figure are used for livestock or domestic purposes (CBR, 2009). Considering the relative quantity of water drawn for these types of consumptive uses, staff evaluated active water wells that are finished in the Chadron Formation and hydraulically downgradient of the NTEA for potential affects to the containment of production fluids. Staff observes that the applicant does not indicate the presence of active Chadron private wells within the NTEA License Boundary, but does illustrate the location of active Chadron private wells that are hydraulically down-gradient of the NTEA production areas. Of these Chadron wells, those that are operated by private entities other than Crow Butte Resources include wells 97, 98, 114, 123, 437, 440, and 441.

Staff found that four of the above-referenced active Chadron wells do not draw ground water from the production water-bearing zone (Basal Chadron). In Application Table 2.2-12, the applicant indicated that the above-referenced Chadron wells 98, 437, 440, and 441 (shown in Application Figure 2.2-4) are finished in overlying confining zone at a depth below ground surface of 30.5 m, 61 m, 73 m, and 73 m (100 ft, 200 ft., 240 ft., and 240 ft.), respectively, and are hydraulic connected to the Brule water-bearing zone. Staff also observes that the Nebraska Department of the Natural Resources Database of Register Ground water Wells (NDNR, 2011) indicates that the above-referenced Chadron well 114 was decommissioned and replaced by a Brule well on October 18, 2008.

The remaining active Chadron wells listed above are private wells 97 and 123. In Application Table 2.2-12, the applicant indicated that these well are finished to depths of 116 m and 85 m (380 ft and 280 ft), respectively. These depths also appear to be within the overlying confining zone. The applicant indicated that these wells are located approximately 0.8 km (0.5 mi) from the nearest NTEA production area, NT-7 (CBR, 2009). Staff observes that the Dawes County (Nebraska) Assessor Property Search and Mapping Database (Dawes County Assessor, 2011) indicates that these two wells are located on a property whose land use is grassland. This is considered by staff to imply that the property and the wells are likely used for livestock. Staff observes that the likely use of these wells is consistent with the applicant's statement that the Chadron is tapped by private land owners as alternate supply for stock water in the region of the NTEA, but not within the NTEA. To evaluate the amount water that may be drawn from the two subject livestock wells, staff found that livestock may require approximately an average of 37 Lpm (10 gpm) per head per day (Lardy and Stoltenow, 1999) and that several Brule private wells used for livestock in the vicinity of the NTEA Project have a limited capacity of 15 Lpm (4 gpm) or less to water livestock. Thus, based on staff's review of industry knowledge (Dawson and Istok, 1991, Driscoll, 1986) and staff's site visits to the NTEA during 2010 and 2011 inspections of the current license area, staff agrees with the applicant that the current use of livestock wells 97 and 123 will not draw enough ground water to hydraulically influence the movement of production fluids from the NTEA to the surrounding environments (CBR, 2007a).

In application Section 2.2.3 (CBR, 2009), the applicant indicated that future increased pumping rates at nearby private wells screened in the Basal Chadron Sandstone are unlikely to allow production fluids to escape the NTEA. However, as a precaution, the applicant plans to develop procedures so that adjustments in their balance of production and injection rates can be made to compensate for such affects (CBR, 2009). Staff observes that new ground water wells, or new use of an existing well, may potentially impact or be impacted by NTEA operations. Therefore, staff is imposing a license condition to require the applicant to: (1) identify the location, screen depth, and estimated pumping rate of any new ground water wells, or new use of an existing well within the licensed area, (2) evaluate the impact of ISR operations to potential ground water users, and (3) recommend any additional monitoring or other measures to protect ground water users. This license condition is presented in SER Section 3.1.4.

Based on NTEA pump test results, drawdown over the life over the life of the NTEA project is estimated by the applicant to be 10 percent or less of the available head in the Basal Chadron Sandstone (CBR 2007a). Staff observes this estimated drawdown is same as the estimated drawdown of the current license facility, which has a similar geology and hydrogeology to the NTEA (NRC, 2012). Considering that potentiometric head of the Basal Chadron is 3m to 15m (10 ft to 50ft) above the ground surface (CBR, 2009), staff expects a drawdown in the Chadron aquifer to be minimal at the NTEA. Staff has previously concluded that the drawdown prediction was acceptable during the prior license renewal review (NRC, 1998). Since the prediction is the same as that for the original facility, staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not reexamining this issue.

3.1.3.6 Schedule

The applicant committed to further evaluate the following issues at each of the nine wellfields by performing a pumping test at each wellfield before commencement of operations (CBR, 2009):

- demonstrating hydraulic isolation of the production zone relative to the overlying aquifer,
- demonstrating communication between the production zone and the exterior monitor wells, and
- evaluating the hydrologic properties of and the presence/absence of boundaries with the Basal Chadron Sandstone over the test area (CBR, 2009).

As shown in the wellfield schedule provided in application Figure 3.1-5, the applicant plans to initiate wellfield production in succession, and restore wellfield ground water sequentially. The NTEA will be divided into nine adjacent wellfield areas as shown in the well field map provided in application Figure 3.1-4 (CBR, 2010). Operations will start at wellfield NT-1, followed by startup of NT-2 in approximately six months. The initiation of production in wellfield NT-3 will occur approximately one and one half years from the startup of NT-2, and the remaining wellfields will begin operation one year apart in succession. As the uranium yield for a wellfield drops below the economic benefit of the production operations, wellfield restoration will begin with the cessation of lixiviant injection and will occur for a period of two years (CBR, 2010). The applicant stated that as the NTEA is developed, the mine schedule will be updated as necessary (CBR, 2010). Staff observes that the maximum period of restoration specified in 10 CFR 40.42(h) is 2 years. If restoration exceeds two years, 10 CFR 40.42(i) allows NRC to approve a request for an alternate decommissioning (ground water restoration) schedule if the

Commission determines it is warranted by considering certain specific factors. In application Figure 3.1-5, the applicant also indicated that wellfield reclamation will commence in wellfields at the end of NTEA restoration (CBR, 2010). Staff found the description of the schedule for the NTEA operation to be consistent with acceptance criteria presented in Section 3.1.3 of NUREG-1569 (NRC, 2003a) and 10 CFR 40.42, and therefore acceptable.

3.1.4 Evaluation Findings

The staff reviewed the ISR process and equipment proposed for use at the NTEA ISR Project in accordance with Section 3.1.3 and Appendix A of NUREG-1569 (NRC, 2003a). The applicant described the wellfield infrastructure, equipment, and ISR operations and used the results from field testing to support the safe application of ISR. The applicant addressed the mineralized zone and demonstrated protection against the vertical and horizontal migration of water, proposed acceptable well designs and tests for well integrity, and demonstrated that the ISR process will meet the following criteria:

- Down-hole injection pressures are less than formation fracture pressures,
- Overall production rates are higher than injection rates to create and maintain a cone of depression,
- Plant material balances and flow rates are appropriate,
- Reasonable estimates of gaseous, liquid, and byproduct material and effluents are provided (used in evaluation of effluent monitoring and control measures in Section 4.0 of NUREG-1569 (NRC, 2003a),
- Disposal operations and capacity are sufficient (see SER Section 4.2.4 for the staff's findings on disposal operations).

Staff observes that Application Section 3.1.3 states, "Other wellfield designs include alternating single line drives." As presented in the application, staff does not approve of the use of line drives for the NTEA because the applicant did not sufficiently demonstrate the containment of injected fluids and a monitoring program for a line drive at the NTEA. Therefore, the staff is imposing the following license condition:

> If well field designs include a line drive(s), a demonstration of the containment of fluids injected at the line drive and a description of the associated monitoring program shall be provided to NRC for review and written verification.

As discussed in SER Section 4.2 as well as this SER section, the applicant described the solid and liquid effluents that would be generated at the facility. An acceptable disposal method (i.e., deep disposal well and evaporation ponds) is identified for liquid byproduct material, pending approval through a NDEQ permit for the deep disposal well, and the disposal method will be of sufficient capacity to handle liquids from production and restoration efforts. As the safe disposal of liquid byproduct material is an important component of operations at the facility, the staff will include the following condition in the license issued to the applicant:

> The licensee will obtain the necessary underground injection control (UIC) permit to construct a minimum of one deep disposal well prior to the commencement of operations of the NTEA (NTEA). The licensee shall ensure the deep disposal well shall have enough capacity to handle the disposal of the total liquid effluent generation. The

> licensee shall ensure adequate deep well disposal capacity exists to dispose of liquids under normal operating conditions during production and restoration phases. If land application disposal is necessary in the future at the NTEA, a facility specific land application plan under a license amendment application shall be submitted to the NRC for review and approval six months prior to its construction.

Staff observes that new ground water wells or new use of an existing well may be impacted by NTEA operations. Therefore, the staff will impose the following license condition:

> The licensee shall identify the location, screen depth, and estimated pumping rate of any new permitted ground water wells, or permitted change to the use of an existing well, within the licensed area and within two kilometers of any production area. The licensee shall evaluate the impact of ISR operations to potential ground water users and recommend any additional monitoring or other measures to protect ground water users. The evaluation shall be submitted as part of the semiannual reporting to the NRC specified under license condition 11.1 (D).

Staff has determined that the confined and saturated aquifer conditions and properties at the NTEA are similar to those observed at the currently licensed Crow Butte facility, that staff has determined to be operated safely and has been protective of human health and the environment (NRC, 2008, 2009, 2010a, and 2011). Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented by information to be collected in accordance with the license conditions during operations, the staff finds that the information is consistent with the applicable acceptance criteria of Section 3.1.3 and Appendix A of NUREG-1569 (NRC, 2003a), where noted, and the requirements of 10 CFR 40.32(c), and 10 CFR 40.41(c).

3.1.5 References

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3.2 FACILITY EQUIPMENT USED AND MATERIALS PROCESSED

3.2.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has sufficiently demonstrated that the equipment and processes to be used during operations in the facility at the NTEA will meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 3.2.3 of NUREG-1569 (NRC, 2003).

3.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and drawings submitted by Crow Butte Resources, Inc. (CBR) in their NTEA application (CBR, 2007) and as updated.

The NTEA will consist of wellfields in the ore zone, a plant to extract uranium from the lixiviant by ion exchange (IX), evaporation ponds, deep disposal well, and chemical storage areas (CBR, 2009). Major equipment inside the 39.6 m by 30.5 m (130 ft long by 100 ft) wide NTEA plant will be the IX circuit and the lixiviant make-up circuit. Loaded IX resin generated at the NTEA plant will be transported to the central processing plant (CPP) at the currently licensed Crow Butte facility for elution, precipitation, drying, and packaging using equipment and processes covered under the existing Crow Butte license. The eluted resin will be transported back to the NTEA Satellite Plant and reused in ion exchange columns. (CBR, 2009)

The applicant committed to satisfactorily increasing the capacity of the central processing unit at the current license area for resin handling and cleaning, elution, precipitation, dewatering and washing, and drying to handle the processing of uranium material produced from both the NTEA and the currently licensed area (CBR, 2009). The applicant also committed to increasing the belt filter and dryer capacity if uranium recovery schedules for the existing wellfields at the currently licensed area and those at the NTEA require it (CBR, 2009). Staff observed an example of this commitment during the NRC facility inspection in 2011 (NRC, 2011). At that time, the licensee was in the process of installing a second yellowcake dryer that was to be completed in August 2011.

The plant at the NTEA will consist of an extraction circuit. The extraction circuit includes the flow of lixiviant from the wellfield to the eight fixed-bed ion exchange columns and back to the wellfield. Bleed, as discussed previously, will constitute 0.5 to 1.5 percent of the barren lixiviant stream. Bleed waste fluids would be handled and disposed of in evaporation ponds and deep disposal well (CBR, 2009). Staff has determined that the applicant's description of facilities and equipment are consistent with acceptance criteria presented in Section 3.2.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

The applicant stated that "…the principal radioactive airborne gaseous radiological effluent at the North Trend Satellite Facility will be Radon-222 gas. The effluents of concern at ISL operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake" (CBR, 2009). To prevent any potential accumulation, building ventilation systems and tank vents will be used. In application Section 4.1, the applicant committed to maintain general ventilation of work areas with a forced air system circulating through the process area. Local ventilation piping will also be provided for process vessels where significant concentrations of radon may be released. In application Section 4.1.2.2, the applicant stated that other emissions to the air are limited to exhaust and dust from limited vehicular traffic (CBR, 2009). Staff finds that the applicant's identification of potential effluents and sources of radiological emissions, as well as proposed ventilation is sufficient and consistent with acceptance criteria presented in Section 3.1.3 of NUREG-1569 (NRC, 2003a) and therefore acceptable.

The applicant stated that the NTEA will be equipped with ion exchange and reverse osmosis equipment capable of processing up to 17,034 Lpm (4,500 gpm) of production flow and 1,893 Lpm (500 gpm) of restoration flow (CBR, 2009). The applicant plans to handle and dispose of liquid wastes generated by well development, production, and aquifer restoration through the combination of evaporation ponds and a deep disposal well injection at the NTEA. To accomplish this, the applicant plans to design the ponds with a satisfactory capacity to handle surges from operations and, in addition, to secure a permit from the NDEQ for installing a deep disposal well with sufficient injection capacity to accommodate projected operations and restoration at NTEA. (CBR, 2009)

The applicant included a list of chemicals that may be used in the uranium recovery process. These include sodium carbonate, sodium bicarbonate, carbon dioxide, oxygen, hydrogen peroxide, and sodium sulfide (CBR, 2009). The applicant stated that hazardous chemicals, and reactive substances listed in Appendix A to 29 CFR §1910.119 and hazardous chemicals covered under EPA's Risk Management Program regulations will not be used at the NTEA Satellite Plant (CBR, 2009). The chemicals proposed for use are similar to those discussed in Chapter 4 of NUREG/CR-6733 (NRC, 2001). Table 4-1 of this NUREG presents a list of chemicals used at ISR facilities and pertinent regulations for those chemicals. Consistent with NUREG/CR-6733 the applicant has listed the specific regulations that apply to the chemicals that will be used (CBR, 2009). The applicant's identification of applicable industry standards to ensure proper handling of hazardous chemicals is consistent with acceptance criteria presented in Section 3.2.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

Since oxygen readily supports combustion, fire and explosion, oxygen is a primary ignition source for the NTEA (CBR, 2010). If the oxygen storage tank explodes, damage to the plant and subsequent radiological releases could occur. However, the applicant stated that the oxygen storage facility would be located a safe distance from the plant to minimize potential damage (refer to Section 3.2.2 in CBR, 2009). In Section 3.2.2 in the application, the applicant stated that it will use sodium sulfide as a reductant during the restoration process (CBR, 2010). To prevent accidents, the applicant stated that it will store sodium sulfide bags or sacks in a cool, dry, and clean area to prevent contact with acids, oxidizers, or other potentially reactive materials. The applicant also stated that it may use hydrogen sulfide as a reductant, if necessary, and that proper safety precautions will be taken to minimize impacts of hydrogen sulfide on radiological safety (CBR, 2010).

Based on representations made by the applicant (CBR, 2009), the staff considers sodium sulfide to be the primary reductant for the NTEA. Inversely, the staff does not approve of the use of hydrogen sulfide at the NTEA or any facilities under the applicant's license SUA-1534 because the applicant did not sufficiently discuss, relevant to the use of this chemical, storage and handling procedures in the application. Based on a standard license condition imposed under CBR's license renewal (Refer to Section 3.2.4 and LC 10.10 in Appendix A of NRC, 2012), CBR is required to amend their license if hydrogen sulfide will be used at the NTEA or any other facilities under the applicant's license.

Gasoline, diesel and propane will also be used, but not in the uranium process. Since these materials are flammable, bulk quantities will be stored outside process areas at the satellite plant. The storage tanks will be located above ground and within secondary containment basins in compliance with EPA requirements (CBR, 2009). Based on a risk assessment for chemical storage, the applicant identified hydrochloric acid as the most significant hazard with respect to chemical and radiological safety. Hydrochloric acid will neither be used nor stored at the NTEA (CBR, 2009).

Based on the staff's review of information provided in the application and the applicant's past experience with the above-referenced flammable materials storage and hazardous chemical controls, equipment, and procedures, the staff finds that the applicant's NTEA flammable materials storage and hazardous chemical controls, equipment, and procedures are consistent with that used at its main facility. Staff previously found the applicant's flammable materials storage and hazardous chemical controls, equipment, and procedures at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's flammable materials storage and hazardous chemical controls, equipment, and procedures are relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the flammable materials storage and hazardous chemical controls, equipment, and procedures, and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the flammable materials storage and hazardous chemical controls, equipment, and procedures at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the flammable materials storage and hazardous chemical controls, equipment, and procedures.

3.2.4 Evaluation Findings

The staff reviewed the proposed equipment to be used and materials to be processed in the recovery plant and chemical storage facilities at the NTEA ISR Project in accordance with Section 3.2.3 and Appendix A of NUREG-1569 (NRC, 2003). The applicant described the equipment, facilities, and procedures that will be used to protect health and minimize danger to life or property.

Based upon the review conducted by the staff as indicated above, the staff finds that the information provided in the application is consistent with the applicable acceptance criteria of Section 3.2.3 and Appendix A in NUREG-1569 (NRC, 2003) and meets the requirements of 10 CFR 40.32(c) and 10 CFR 40.41(c). The staff concludes that the applicant adequately described the equipment, facilities, and procedures that will be used during operations to protect health and minimize danger to life or property.

3.2.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, “Domestic Licensing of Source Material”.

CBR, 2010, Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession Nos. ML103010522 and ML103010525.

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML71760343 (Package).

NRC, 2012, Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012 (ADAMS Accession No. ML103470470).

NRC, 2011. NRC Inspection Report 040-08943/11-001, Arlington, TX, August 4, 2011, ADAMS Accession No. ML11216A179.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 2001, NUREG/R-6733, “A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees,” June.

3.3 INSTRUMENTATION AND CONTROL

3.3.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has adequately demonstrated that the instrumentation and control proposed for the NTEA facility meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.3.2 Regulatory Acceptance Criteria

If not specifically stated otherwise, changes to the licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 3.3.3 of the standard review plan (NRC, 2003).

3.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and drawings submitted in the application (CBR, 2007a) and as updated.

The applicant indicated that instrumentation would be provided for the NTEA to monitor and control the ISR process (CBR, 2009). Staff observes that this instrumentation is similar to that used at the currently licensed Crow Butte facility (CBR, 2007b). The description of the ISR systems and variables that will be monitored and controlled include the liquid levels of chemical storage and process tanks, flow and pressure within production and injection well pipelines, trunk lines, and pipelines at the plant including all waste flow leaving the NTEA plant. The control system will contain continuous monitoring and alarms that are activated when operating parameters are outside of the specified operating ranges. (CBR, 2009)

Pipeline flow instrumentation will be provided to monitor and control flow and will include a variety of flow meters (CBR, 2009). These include turbine meters, ultrasonic meters, variable area meters, electromagnetic flow meters, differential pressure meters, positive displacement meters, piezoelectric and vortex flow meters. These flow meters will allow for the monitoring and controlling of pipeline flow to and from each of the proposed production and injection wells, total production and injection flow at trunk lines, and total flow to and from the proposed satellite plant including total waste flow leaving the plant. (CBR, 2009)

At the currently licensed Crow Butte facility, staff observes that the operating pressures at the injection well heads are required to be maintained at or below 0.69 MPa (100 psi) (refer to Section 3.1 of NRC, 2012) by means of a facility-specific license condition. Since the proposed NTEA ISR infrastructure and operations associated with this requirement are similar to that of the currently licensed Crow Butte facility, staff is imposing the same requirement for the NTEA by revising this facility-specific license condition to a standard license condition.

Instrumentation provided to monitor and control the trunk line pressures will include pressure gauges, pressure shutdown switches, and pressure transducers (CBR, 2009). The injection system will be equipped with instrumentation to record an alarm and operators are notified in the event of any pressure loss, which might indicate a leak or rupture. Wet alarms will be installed in header houses to monitor the presence of liquids within the header house sumps

(CBR, 2009). Staff has determined that the applicant's description of processing facility components and instrumentation for the monitoring and control by the plant operator is consistent with acceptance criteria presented in Section 3.3.3 of NUREG-1569 (NRC, 2003) and therefore acceptable.

The applicant described the automated control system for NTEA as a Sequential Control and Data Acquisition (SCDA) network with programmable logic controllers. In addition, a processor will be installed in each wellfield house that is separate from the main control system. A local area network (LAN) will be used to interconnect the control system throughout the facility to many computer screens. This system will allow for continuous monitoring and control of critical processes, pressures, all waste flows, wellfield flows, and recovery plant operations. The system will have alarm set points that will alert operators when any parameters are outside of satisfactory levels. An uninterruptible power supply system will be equipped to all critical systems in the event of a power failure (CBR, 2009). Staff observes that a similar system is being used at the current licensed facility (CBR, 2007b).

Based on the staff's review of information provided in the application and the applicant's past experience with the above-referenced automated control system, the staff finds that the applicant's NTEA automated control system is consistent with that used at its main facility. Staff previously found the applicant's automated control system at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's automated control system is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the automated control system and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the automated control system at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the automated control system.

3.3.4 Evaluation Findings

The staff reviewed the proposed instrumentation and control for the NTEA facility in accordance with Section 3.3.3 and Appendix A of NUREG-1569 (NRC, 2003). The applicant adequately described the instrumentation and controls that will be used at the NTEA facility. Based on the staff's review of information presented in this section, the information provided in the application is consistent with the applicable acceptance criteria of Section 3.3.3 and Appendix A of NUREG-1569 (NRC, 2003) and meets the requirements of 10 CFR 40.32(c) and 40.41(c)

3.3.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007a, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML71760343 (Package).

CBR, 2007b, Application for Renewal of Source Material License No. SUA-1534, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML073480264 (Package).

NRC, 2012, Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

4.0 EFFLUENT CONTROL SYSTEMS

4.1 GASEOUS AND AIRBORNE PARTICULATES

This section discusses the basic design of the gaseous and airborne particulates effluent control systems for the NTEA as proposed by the applicant in the application (CBR, 2007a), as updated. The purpose of the effluent control systems is to prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere by the use of emission controls and to ensure compliance for radiation dose limits to the public.

4.1.1 Regulatory Requirements

For gaseous and airborne particulates generated at the North Trend facility, the staff determines if the applicant has demonstrated that operations at the North Trend facility will comply with Criterion 8 of Appendix to 10 CRF Part 40 which requires milling operations to be conducted so that all airborne effluent releases are reduced to levels as low as reasonably achievable (ALARA). The licensee must also demonstrate that releases of gaseous and airborne particulate are in compliance with other relevant sections of 10 CFR Parts 20 and 40.

4.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 4.1.3 of NUREG-1569 (NRC, 2003).

4.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007a) and as updated. The following sections present the staff's review and analysis of various aspects of the gaseous and airborne particulates that will be generated at the North Trend facility as well as the applicant's proposed control measures for those particulates.

4.1.3.1 General

As discussed in Section 3.2 of the application (CBR, 2009), the applicant will only be processing uranium onto ion exchange resin at the NTEA. The remainder of the processes, including elution, precipitation, drying, and packaging of the yellowcake product will be performed using equipment and processes at the currently licensed Crow Butte facility (CBR, 2009) .

The applicant will provide both general work area ventilation and point source (e.g., IX columns and process tanks) ventilation at the NTEA as discussed below (CBR, 2009, Cameco, 2013). Monitoring for the effectiveness of the ventilation systems is further discussed in SER Sections 5.7.4 (in-plant monitoring) and 5.7.8 (airborne effluent and environmental monitoring).

4.1.3.2 Work Area Ventilation

The applicant stated in Section 4.1.2.2 of the TR that the ventilation system at the proposed North Trend Facilities would be similar to the ventilation system used at the currently licensed Crow Butte facility (CBR, 2010). In Section 4.1.2.1 of the TR, the applicant described the operation of the ventilation system at that facility. The current work area ventilation system consists of three wall fans that exhaust air out of the building while drawing across the plant floor. Each fan has a capacity of 11, 000 cubic feet per minute (cfm). The total plant air volume is approximately 988,949 cubic feet. Based on the fan capacities and the total volume of the facilities, the turnover of the complete plant air volume is approximately 29.97 minutes. The applicant also stated that separate and independent local ventilation systems may be used temporarily as needed for non-routine activities such as maintenance. (CBR, 2010)

As previously noted, the ventilation system proposed for the NTEA is similar to that in place at the currently licensed facility. Staff previously found the work area ventilation at the currently licensed Crow Butte facility acceptable (refer to Sections 4.1 and 5.7.4 of NRC, 2012). Based on the information provided by the applicant and staff's review of the applicant's historical results of its in-plant airborne radiation monitoring program for radon and uranium (refer to Section 5.7.4 of CBR, 2012), NRC staff has reasonable assurance that the applicant's proposed work area ventilation is relevant and effective for the NTEA. Staff has not identified any unreviewed safety-related concerns pertinent to the work area ventilation at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its work area ventilation.

4.1.3.3 Airborne Uranium

As discussed in SER Section 4.1.3.1, the applicant will not be performing any drying or packaging operations at the NTEA. Because of this, the applicant indicated in Section 4.1.2.1 of the TR that the in-plant air particulate concentrations at the North Trend would be expected to be lower than at the currently licensed Crow Butte facility (CBR, 2009). Staff agrees with the applicant's assessment as it is consistent with radioactive particulate source terms analyzed in NUREG/CR-6733 (NRC, 2001).

Because there are no drying or packaging operations at the NTEA, staff observes that there are no ventilation or effluent controls specifically associated with potential uranium particulate releases from these operations. However, the applicant addressed the potential for uranium exposure from spills from resin transfer and maintenance operations (CBR, 2009). The applicant stated that spills will be cleaned up as soon as possible to avoid the wet material from drying and creating the potential for airborne particulates (CBR, 2009). In addition, all non-routine operations or maintenance activities where the potential exists for significant exposure to radioactive materials, and for which no standard operating procedure exists, require a radiation work permit (CBR, 2009). Lastly, the applicant committed to establishing one stationary sample point near the resin transfer station that will be sampled monthly for potential airborne uranium particulates (refer to Sections 4.1 of CBR, 2009 and 5.7.3.1 of CBR, 2010).

As discussed in SER Section 4.1.3.2, and in light of the lower expected airborne uranium concentrations at the NTEA compared to the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's proposed work area ventilation is relevant and effective for the NTEA, including for airborne uranium particulates. In accordance with

Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its work area ventilation for airborne uranium particulates.

4.1.3.4 Radon

Staff observes that prior to November 30, 2007, the applicant was only licensed to use unpressurized upflow type ion exchangers at its currently licensed Crow Butte facility (NRC, 2007). The applicant estimated that these upflow ion exchangers release 100 percent of the contained radon found in the water processed by these ion exchange columns (18,930 Lpm (5000 gpm)) will be released to the environment (refer to Section 7.12.3 of CBR, 2007b).

The applicant indicated in Section 3.2.1 (CBR, 2009) that the ion exchange system at the NTEA consists of eight fixed-bed ion exchange columns. The applicant described the NTEA ion exchange columns as the pressurized downflow type where there is no overflow of water, oxygen stays in solution, and radon emissions are contained (CBR, 2009, 2010). Radon releases only occur when the columns are disconnected from the circuit and opened to remove the resin for elution (CBR, 2009). The applicant estimated that 10 percent of the contained radon found in the water processed by the NTEA ion exchange columns (17,030 Lpm (4500 gpm)) will be released to the environment (refer to Section 7.3.1 of CBR, 2010). Therefore, staff concludes that the amount of radon released from ion exchange operations at the NTEA in the satellite plant and to the environment should be less than at the currently licensed Crow Butte facility compared to flow conditions prior to November 30, 2007, when there was comparable flow through the ion exchangers.

In Section 4.1.2.2 of the TR, the applicant stated that the ventilation system at the NTEA would be similar to the ventilation system used at the currently licensed Crow Butte facility (CBR, 2010). The currently licensed Crow Butte facility utilizes vent fans that discharge radon emissions from the ion exchange columns to the outside of the building utilizing a common vent system (refer to Section 4.1.2.1 of Cameco, 2013). This configuration is shown for the NTEA in Figure 3.2.1 (CBR, 2009) and further discussed in Section 7.3.1 of the TR (CBR, 2010).

The applicant stated in Section 4.1.1 of the TR that separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected during resin transfer (Cameco, 2013). The system will consist of an air duct or piping system connected to the top of each of the process tanks with redundant exhaust fans directing collected gases to discharge piping that will exhaust fumes to the outside atmosphere by forced ventilation). The applicant indicated that the design of the fans will be such that the system will be capable of limiting employee exposure with the failure of any single fan. In addition, the applicant stated that discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Regulatory Guide 8.31 (NRC, 2002). Cameco, 2013

As discussed in SER Section 4.1.3.2, and in light of the lower expected radon concentrations at the NTEA compared to the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's proposed point source and work area ventilation is relevant and effective for the NTEA, including for radon. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its point source and work area ventilation for radon.

4.1.4 Evaluation Findings

The staff reviewed the proposed effluent control systems for gaseous and airborne particulates for NTEA in accordance with Appendix A of NUREG-1569 (NRC, 2003).

The applicant acceptably described the release points and sources of both uranium and radon at NTEA. The proposed facility will not include a yellowcake drying system. The applicant has discussed monitoring activities for routine operations, maintenance activities, and spill cleanups. The applicant has committed to meeting 10 CFR Part 20 occupational dose limits and public dose limits and to maintaining these doses ALARA.

Based upon the review conducted by the staff as indicated above, the information provided in the application meets the requirements of 10 CFR 20 Parts 20 and 40.

4.1.5 References

10 CFR Part 20.Code of Federal Regulations, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, “Domestic Licensing of Source Material”.

Cameco, 2013. E-mail from Cameco Resources to NRC staff transmitting revision to Section 4.1.1 of North Trend Technical Report, e-mail dated January 16, 2013, ADAMS Accession No. ML13023A148.

CBR, 2010. Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No. ML103010525

CBR, 2009. Crow Butte Resources, Inc., Response to NRC Staff’s Request for Additional Information of November 17, 2008, February 27, 2009, ADAMS Accession No. ML090750430.

CBR, 2007a. Crow Butte Resources, Inc., Application for an Amendment to UNSRC Source Materials License SUA-1534 – North Trend Expansion Area, May 30, 2007, ADAMS Accession No. ML072540671 (Package)

CBR, 2007b. Application for Renewal of Source Material License No. SUA-1534, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML073480264.
.
NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2007. License Amendment No. 22, Central Processing Plant Upgrade, Crow Butte Resources, Inc. Crawford Nebraska, SUA-1534, November 30, 2007, ADAMS Accession No. ML072700204

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June 2003.

NRC, 2002. “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Regulatory Guide 8.31, Revision 1. Washington, DC: May.

NRC, 2001. “A Baseline Risk-Informed Performance-Based Approach for In-Situ Leach Uranium Extraction Licensees,” NUREG/CR–6733, September 2001.

4.2 LIQUID AND SOLID EFFLUENTS

4.2.1 Regulatory Requirements

For liquid effluents generated at the NTEA facility, the staff determines if the applicant has demonstrated compliance with 10 CFR 20.1301, 20.2002, and 20.2007. For solid effluents generated at the NTEA facility, the staff determines if the applicant demonstrated compliance with 10 CFR Part 40, Appendix A, Criterion 2.

4.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 4.2.3 of NUREG 1569 (NRC, 2003).

4.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by Crow Butte Resources in their application (CBR, 2007) and as updated. The following sections present the staff's review and analysis of various aspects of the liquid and solid waste that will be generated at the NTEA facility, including the control and disposal of such wastes.

4.2.3.1 Liquid Wastes

In Section 4.2.1 of the application (CBR, 2009), the applicant discussed the different liquid waste streams that will be generated at the NTEA facility which are categorized as 11e.(2) byproduct or non-byproduct. The applicant further categorized liquid waste based on the type of waste, its source, and chemical constituents. Liquid wastes generated from the uranium recovery process are considered liquid byproduct material. Development water and domestic sewage are considered liquid non-byproduct material (CBR, 2009).

4.2.3.1.1 Disposal Options

For liquid byproduct material, the disposal methods proposed by the applicant include direct injection of the material into an on-site deep disposal well and solar evaporation into the atmosphere from the on-site evaporation ponds. The applicant has committed to using one deep disposal well at the NTEA and to submitting a license amendment application with pond design and specifications will be submitted to the NRC prior to their construction (CBR, 2009). The applicant stated that it does not intend to apply for a permit to enable it to allow land application disposal at the NTEA (CBR, 2009). The disposal options are evaluated below.

4.2.3.1.2 Liquid Byproduct Material Waste

The applicant identified the following sources of liquid byproduct waste: ISR process eluant and production/restoration bleed, and laboratory wastes (CBR, 2009). ISR process waste water is fluid generated from the eluant or production/restoration bleed. It is characterized as byproduct material. The bleed fluids are routed to either the deep disposal well or the solar evaporation pond at the discretion of the applicant. The final source of byproduct material is laboratory

waste. The applicant indicated that the laboratory waste is disposed of on-site in the solar evaporation ponds or deep disposal well. (CBR, 2009)

Based on the staff's review of the application (CBR, 2009), the applicant's past experience with the control of liquid wastes using surface impoundments and deep well injection, and the requirements of the current license, the staff concludes that the applicant's proposed control of liquid wastes at the NTEA is consistent with that used at its main facility (refer to Section 4.2.3.1 of NRC, 2012a). Staff previously found the applicant's control of liquid wastes at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's control of liquid wastes is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the control of liquid wastes and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the control of liquid wastes at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the control of liquid wastes using surface impoundments and deep well injection.

The applicant indicated that even though the applicant does have a National Pollutant Discharge Elimination System (NPDES) permit from the NDEQ for land application of treated wastewater at the currently licensed Crow Butte facility, the applicant has not used land application there and does not intend to apply for an NPDES permit to allow land application at the NTEA at this time (CBR, 2009). Staff observes that if land application is later proposed for the NTEA in the future, land application must be approved by staff to be protective of health and safety in accordance with regulatory requirements and guidance. Therefore, NRC is imposing a license condition that states if land application is proposed at the NTEA, the applicant must submit a license amendment application to propose land application for review and approval six months prior to its construction. This license condition is presented in SER Section 3.1.4.

NRC staff observes that the application does not address the solar evaporation pond design or the associated site evaluation for the pond. However, the applicant committed to submitting a license amendment application to the NRC with the design and specifications of the evaporation ponds at the NTEA prior to pond construction (CBR, 2009). NRC staff also observes that since the applicant plans to discharge, in part, well development water and production liquid waste to the evaporation ponds at the NTEA, the ponds will have to be operational prior to the commencement of production. The applicant plans to develop the license amendment application using the requirements of their most current solar evaporation pond design and construction regulatory guides and a site geotechnical assessment of the pond site (CBR, 2009). The exact number and capacity of the ponds at the NTEA will depend upon on the performance of the proposed deep disposal well in terms of the waste disposal injection rate. The license amendment application will also include plans for pond monitor wells used to demonstrate compliance with 10 CFR 40, Appendix A, Criterion 7a (CBR, 2009).

The applicant currently operates a Class I underground injection control (UIC) permitted deep disposal well in the currently licensed CBR facility for disposal of wastewater and is committed to securing a Class I UIC permit for the proposed deep disposal well at the NTEA (CBR, 2009). Staff observes that the State of Nebraska is an EPA-authorized state for primary enforcement responsibility (primacy) of the UIC Program (EPA, 2012). As such, staff observes that CBR is required to satisfy regulatory provisions in 40 CFR Part 146 for obtaining a UIC Class I disposal well permit for the proposed NTEA deep disposal well from the NDEQ. Consistent with

acceptance criteria 13 in Section 6.1.3 of NUREG-1569 (NRC, 2003), the proposed NTEA deep disposal well must satisfy both EPA regulations under the UIC Program and applicable provisions of 10 CFR Part 20.

The staff finds that approval of the deep disposal well(s) by NDEQ in the form of a UIC permit comports with 10 CFR 20.2007. This regulation states that compliance with the NRC's regulations regarding disposal by injection in deep wells does not relieve a licensee from complying with any and all other applicable Federal, State, and local regulations. As a license condition, the applicant will be required to submit a copy of the NDEQ approved permit to the NRC before injection of lixiviant can commence. This license condition is presented in SER Section 3.1.4.

SER Section 3.1 provides staff's evaluation of the applicant's plans, mine unit timetables, and water balance for the operation. In these plans, the applicant committed to an operational throughput for NTEA of 17,034 Lpm (4,500 gpm) (CBR, 2009). Staff observes that the operation flow rate (throughput) is a critical component of maintaining adequate liquid byproduct disposal capacity for the operation at the NTEA. Therefore, staff will include a condition in the license to ensure adequate liquid byproduct disposal capacity for the NTEA. This license condition is presented in SER Section 4.2.4.

Class I UIC wells are used to inject wastes into deep, isolated aquifers. Typically, deep disposal wells are constructed with several layers of materials that provide redundant layers of protection to minimize the possibility of liquids contaminating underground sources of drinking water. In addition, operators are required by the NDEQ to demonstrate that no significant leaks exist by performing a mechanical integrity test (MIT) of the deep disposal well prior to operation and every five years after for the life of the well. Operators are required to monitor several parameters, such as injection pressure, that would indicate potential failure of a deep injection well. This operational data will be available in reports that are available for NRC review during inspections of the NTEA facility.

Staff previously evaluated the operation of the deep disposal well at the currently operating main facility (refer to Section 4.2.3.1.2 of NRC, 2012a) and found it acceptable. Staff has also determined that the operation of the proposed deep disposal well at the NTEA is bounded by these previous findings for the following reasons:

- the deep disposal well proposed for the NTEA and the two deep disposal wells in operation at the currently licensed CBR facility will use the same aquifer unit to inject process wastes (refer to section 4.2.1.1 of CBR, 2012, and NRC, 2012a, b)
- since the deep disposal wells at the NTEA and the current licensed facility will inject into the same aquifer, the NTEA deep disposal well will inject process wastes at a similar depth as the deep disposal wells at the currently licensed facility (approximately 1042 m to 1139 m (3420 ft to 3738 ft) bgs for deep disposal well #2 at CBR's main facility). (refer to section 4.2.1.1 of CBR, 2012, NRC, 2012b).
- the density of sediment and rock layers are similar for the NTEA and the currently licensed facility (CBR, 2009, NRC, 2012a)
- the applicant described the expected liquid byproduct material composition to be discharged to the NTEA deep disposal well to be chemically and radiologically similar to

the waste disposed of in the currently operating ISR deep disposal well (refer to Section 4.2.1.1.1 of CBR, 2009, NRC, 2012a)

As noted, staff previously found the applicant's operation of the deep disposal wells at its main facility to be acceptable (NRC, 2012a). Therefore, considering an unlimited flow rate (CBR, 2000) and the total expected curie content (NRC, 2012a) of all of the effluent to be injected into the proposed NTEA deep disposal well, staff has reasonable assurance that the disposal of licensed material in the deep well at the NTEA will meet the requirements of 10 CFR 20.2001(a)(3). This regulation requires disposal of licensed material by release in effluents to be within the dose limits specified for individual members of the public in 10 CFR 20.1301. Based on the expected flow, staff finds nothing to invalidate the previous findings on the operation of deep disposal wells and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the operation of a deep disposal well at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of waste disposal using a deep disposal well.

Liquid wastes also may occur due to accidental releases. The applicant stated that if a spill occurs in the plant (e.g., via a piping failure or a process storage tank failure), the spill or leak would be contained within the plant structure and limited by the immediate shut down of the pump system in the event of a piping failure (CBR, 2009). Liquid waste released inside the plant from a spill or the associated wash down water will be drained through a sump and sent to the NTEA liquid waste disposal system discussed in SER Section 4.2.3.1.1. The plant will have a building pad and concrete curb built around the entire plant building, which will be designed to contain the contents of the largest tank within the building in the event of a rupture. The applicant also stated that well field buildings will have wet alarms for early detection of leaks and the deep disposal well pump house and wellhead will be designed to contain any release of liquids within the building or surrounding bermed containment area. (CBR, 2009)

4.2.3.1.3 Other Liquid Wastes

The NRC staff observes that the sources of liquid waste that are not byproduct material will consist of water generated during well completion and development, storm water runoff, and domestic liquid waste (CBR, 2009). Well development water is ground water recovered from a well generally after its initial installation, but before the aquifer had been exposed to the ISR process. For some wells, particularly those screened in the mineralized zone, the development water may contain naturally occurring radionuclides. The applicant stated that well development water will be collected and discharged to the solar evaporation ponds.

The storm water runoff will be managed and controlled under permits issued by the NDEQ. Storm water is not specifically collected nor diverted for disposal. Domestic liquid waste water is sanitary waste generated from restrooms and the lunchroom (CBR, 2009). These systems must meet the requirements of the State of Nebraska and the discharge is limited to nonhazardous materials.

Staff observes that the design and operation of the proposed nonbyproduct waste disposal system at the NTEA is consistent with that of the system in place at the currently licensed facility (refer to Section 4.2.3.1.3 of NRC, 2012a). Staff previously found the applicant's nonbyproduct waste disposal system at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's nonbyproduct waste disposal system is relevant and

effective for the NTEA. Staff finds nothing to invalidate the previous findings on the nonbyproduct waste disposal system and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns particularly pertinent to the nonbyproduct waste disposal system at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's nonbyproduct waste disposal system.

4.2.3.1.4 Monitoring of the Disposal Options

Deep Disposal Well

NRC staff observes that monitoring of the deep disposal well will be required by the Nebraska UIC permit program to ensure the health and safety of worker and the public. The monitoring will consist of daily measurements of flow rates and pressures, and performing mechanical integrity testing (MIT) every five years for the life of the well.

Staff observes that the proposed operation and monitoring of deep well disposal at the NTEA is consistent with that in place at the currently licensed facility (refer to Section 4.2.3.1 of NRC, 2012a). Staff previously found the applicant's operation and monitoring of deep well disposal at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's operation and monitoring of deep well disposal is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the operation and monitoring of deep well disposal and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns particularly pertinent to the operation and monitoring of deep well disposal at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's operation and monitoring of deep well disposal.

On-site Ponds

The applicant stated that it will submit plans for monitor wells used to demonstrate compliance with 10 CFR 40, Appendix A, Criterion 7a, as part of the license amendment application to be submitted for the evaporation pond design (refer to SER Section 4.2.1.1.2) (CBR, 2009). The applicant indicated that the solar evaporation pond monitoring and inspection program, as well as the pond leak corrective action program, used in the past at the currently licensed Crow Butte facility will be implemented at the NTEA (refer to Section 4.2.1.1.2 of CBR, 2009). As discussed in Section 4.2.3.1.4 of the CBR License Renewal SER, staff revised an existing license condition for the applicant's Evaporation Pond Onsite Inspection Program to require more frequent inspections of the pond leak detection system and to strengthen the applicant's corrective action program in regards to leaks discovered in the ponds (refer to Section 4.2.4 of NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Staff continues to evaluate the applicant's pond inspection and corrective action program through onsite inspections. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's pond inspection and corrective action program is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's pond inspection and corrective action program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its pond inspection and corrective action program.

4.2.3.2 Solids

Solid waste can be generated from maintenance or non-routine activities, routine operations, and general housekeeping. The types of waste can include, but not be limited to, spent resin, resin fines, empty reagent containers, miscellaneous piping and fittings, and domestic trash. The applicant classified the solid waste into four types: (1) non-contaminated solid waste, (2) byproduct material, (3) septic system solid waste, and (4) hazardous waste (CBR, 2009).

1) Non-contaminated waste is waste which is not contaminated with byproduct material or is waste that can be decontaminated to remove any radioactivity to levels that are protective of human health and the environment. This type of waste may include, but not be limited to, piping, valves, instrumentation, equipment and any other item which is not contaminated or may be successfully decontaminated. The applicant estimated approximately 535 cubic meters (700 cubic yards) will be generated each year and this waste is disposed of at the nearest permitted sanitary landfill.

2) Byproduct material is tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Byproduct material can include, but not be limited to, filters, personal protective clothing, spent resin, piping, etc. The applicant estimated approximately 45.9 cubic meters (60 cubic yards) of 11(e).2 byproduct material waste will be generated each year.

3) Domestic solid waste is that generated during normal operations of the restrooms and/or lunchrooms. The domestic solid waste is collected in the septic tanks of the septic system approved by the State of Nebraska. The domestic solid waste is extracted from the tank and hauled off-site for further processing by licensed haulers.

4) Hazardous Waste is solid waste that meets the definition of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). The applicant stated that the site only generates universal hazardous wastes, such as used waste oil and batteries. The facility is classified as a Conditionally Exempt Small Quantity Generator under the RCRA hazardous waste program. To maintain this classification, the amount of hazardous waste generated or handled at this facility must be less than 100 kg (220 pounds) for any one month.

NRC staff observes that the classification of solid waste sources for the NTEA is the same as what is being used at the currently licensed facility (refer to Section 4.2.3.2 of NRC, 2012a). Staff previously found the applicant's classification of solid waste sources at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the classification of solid waste sources by the applicant is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the classification of solid waste sources by the applicant and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the classification of solid waste sources by the applicant at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the classification of solid waste sources by the applicant.

4.2.3.2.1 Solid Waste Disposal Options

NRC staff observes that for noncontaminated solid waste and domestic solid waste, the material must be disposed of off-site at a facility permitted by the State to accept those materials (e.g., solid waste landfill). For hazardous waste, the material must be disposed of offsite at a facility permitted to accept hazardous waste (e.g., a treatment, storage and disposal facility permitted by the approved RCRA program). For the byproduct material, the material must be disposed of at a NRC-licensed facility.

4.2.3.2.2 Monitoring of any Onsite Storage of Solid Wastes

The staff believes it important to note at the outset of this section that solid waste other than byproduct material is not regulated by the NRC. Solid byproduct material will be stored in appropriate containers within a restricted access area before being shipped to a licensed disposal facility. Staff observes that the applicant is required by an existing license condition to maintain an agreement for disposal of byproduct material with a licensed byproduct disposal facility or cease operations (refer to license condition 9.7 of NRC, 2010b). To ensure that the byproduct material disposal agreement is applicable to both the currently licensed Crow Butte facility and the NTEA, staff is modifying the existing license condition. The modified license condition is presented in SER Section 4.2.4.

The current byproduct material disposal agreement is with the operator of the White Mesa Mill, near Blanding, Utah. NRC staff previously reviewed the applicant's byproduct disposal agreement and found it acceptable (NRC, 2010a, 2012b). For this agreement, the maximum annual volume for disposal is 3823 cubic meters (5,000 cubic yards) of byproduct material; this maximum volume is common to many agreements. This volume will cover the projected amount of solid byproduct material from both the currently licensed CBR facility and NTEA.

4.2.3.3 Spill Contingency Plans

The applicant indicated that the spill contingency plan for unplanned spills or releases to the environment at the currently licensed facility will be adapted for use at the NTEA (refer to Section 4.2.1.2.6 of CBR, 2009). Staff previously found the applicant's spill contingency plan at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's spill contingency plan is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the applicant's spill contingency plan and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's spill contingency plan at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's spill contingency plan.

4.2.4 Evaluation Findings

The staff reviewed the type, disposal, and monitoring of liquid and solid effluents at the NTEA in accordance with Section 4.2.3 of NUREG-1569 (NRC, 2003). The applicant described the solid and liquid effluents that are generated at the facility. An acceptable disposal method was identified for liquid byproduct material including a deep disposal well to be approved through a Nebraska UIC permit as well as disposal through evaporation ponds. The disposal systems

have adequate capacity to handle the anticipated byproduct fluids volumes. Acceptable methods of disposal were also provided for byproduct solid wastes. The monitoring of disposal of liquid and solid waste was also found to be acceptable.

The staff reviewed the aspects of solid and liquid effluents of the proposed NTEA in accordance with Section 4.2.3 of NUREG-1569 (NRC, 2003). Staff observes that the applicant has committed to an operational throughput for NTEA of 17,034 Lpm (4,500 gpm) (CBR, 2009). To ensure adequate liquid byproduct disposal capacity for the operation at the NTEA, staff will include the following condition in the license:

> The satellite plant throughput shall not exceed a maximum flow rate of 4,500 gallons per minute, excluding restoration flow.

Staff observes that the applicant has committed to providing the design and specifications for the solar evaporation ponds in a license amendment request to the NRC (CBR, 2009). Since the flood delineation information recently released by the Federal Emergency Management Agency (refer to SER section 2.4) is likely to affect the design and specifications of the solar evaporation ponds proposed for the NTEA, staff will include the following condition in the license issued to the applicant:

> The licensee shall submit a license amendment application for the solar evaporation pond design and specifications to the NRC for review and approval at least six months before the applicant's planned commencement of NTEA operations. As part of this amendment application, the licensee shall use the Dawes County, Nebraska Flood Insurance Rate Map issued by the Federal Emergency Management Agency in June 2011 (as revised), to demonstrate whether the proposed location of the evaporation ponds in the NTEA will subject the ponds to potential flooding and erosion impacts. If a potential flood and erosion impact is identified or if the evaporation ponds are within a 100 year flood plain, the amendment application shall either include a flood and erosion protection design that will be maintained until the ponds are decommissioned, or propose a new location for the evaporation ponds within the NTEA that will not pose flood and erosion impacts.

Staff observes that the applicant is required by an existing license condition to maintain an agreement for disposal of byproduct material with a licensed byproduct disposal facility or cease operations (refer to license condition 9.9 in Appendix A of NRC, 2012a). To ensure that the byproduct material disposal agreement is applicable to both the currently licensed Crow Butte facility and the NTEA, staff will include the following modification to the license condition in the license.

> The licensee shall dispose of solid byproduct material from the Crow Butte facility and the NTEA at a site that is authorized by NRC or an NRC Agreement State to receive byproduct material. The licensee's approved solid byproduct material disposal agreement must be maintained on site. In the event that the agreement expires or is terminated, the licensee shall notify the NRC within seven working days after the date of expiration or termination. A new agreement shall be submitted for NRC review within 90 days after expiration or termination, or the licensee will be prohibited from further lixiviant injection.

The applicant has shown that effluent control systems, procedures, and required training will limit radiation exposures under both normal and accident conditions by providing information on the health and safety impacts of system failures and identifying preventive measures and mitigation for such occurrences.

Based upon the review conducted by the staff as indicated above, the information provided in the application, as supplemented by information submitted in accordance with the noted license conditions, is consistent with the applicable acceptance criteria of Section 4.2.3 of NUREG-1569 (NRC, 2003) and meets the requirements of 10 CFR Parts 20 and 40.

4.2.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

40 CFR Part 146. Code of Federal Regulations, Title 40, Protection of Environment, Part 146, Underground Injection Control Program.

CBR, 2012, , North Trend Expansion Area License Amendment Application Page Changes, Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., June 10, 2012, ADAMS Accession No. ML12165A343

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession No. ML090750430 (Package).

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML71760343 (Package).

CBR, 2000. Request to Amend License Condition 10.7, September 12, 2000, ADAMS Accession No. ML003753427

EPA, 2012, State UIC Program Primacy, http://water.epa.gov/type/groundwater/uic/Primacy.cfm#who, accessed on May 28, 2011.

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2010a. NRC letter to Crow Butte Resources, Inc., License Condition 9.7 to Source Material License SUA-1534 -11e.(2) Byproduct Material Disposal Agreement, September 13, 2010, ADAMS Accession No. ML102510131.

NRC, 2010b. License Amendment No. 25, Crow Butte Resources In Situ leach Facility, License No. SUA-1534, April 20, 2010, ADAMS Accession No. ML100830012.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 1998, Environmental Assessment for Renewal of Source Material License No. SUA-1534, Crow Butte Resources, Inc., Crow Butte Uranium Project, Dawes County, Nebraska. February 1998. ADAMS Accession No. ML071520242.

5.0 OPERATIONS

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

5.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed corporate organization relevant to the operations at the NTEA are consistent with the requirements of 10 CFR 40.32(b) which requires that the applicant is qualified through training and experience to use source materials.

5.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 5.1.3 of NUREG-1569 (NRC, 2003).

5.1.3 Staff Review and Analysis

5.1.3.1 Corporate Organization

Figure 5.1-1 of the license renewal application presents the corporate organization for CBR (CBR, 2012). Application Section 5 describes the responsibilities for each position in the management chain. The Board of Directors is ultimately responsible for setting health and safety policy which gets directed and implemented down the chain of command through the President of Cameco Resources, Inc., General Manager, Director of Safety, Health, Environment, and Quality (SHEQ), SHEQ Manager, and the RSO. Both the General Manager and the Director of SHEQ report directly to the President. (CBR, 2012)

The Director of SHEQ reports directly to the Ppresident and is responsible for ensuring that personnel comply with radiation safety and quality programs as required by NRC regulations and established in the Cameco program (CBR, 2012). The Director of SHEQ has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health (CBR, 2012).

The SHEQ Manager is responsible for radiation protection, health and safety, and environmental programs as stated in the SHEQ Management System (SHEQ MS) and for ensuring that the applicant complies with applicable regulatory requirements (CBR, 2012). The SHEQ Manager drafts, approves and updates SHEQ MS procedures annually. This manager reports directly to the General Manager and assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The SHEQ manager may also suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations. As such, the SHEQ Manager has a secondary reporting requirement to the Director of SHEQ. (CBR, 2012)

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs at the NTEA and the currently licensed Crow Butte facility (CBR, 2012). This person reports directly to the General Manager, and is provided sufficient authority to maintain

facility safety. For example, the RSO is authorized to review and approve plant changes, and suspend, modify, or postpone planned work activities based on radiological health and safety concerns. The RSO also reports indirectly to the Director of SHEQ as a secondary requirement. As discussed in the previously issued SER for the renewal of the operating Crow Butte ISL facility (refer to Section 5.1 of NRC, 2012), RSO qualifications are specified in Regulatory Guide 8.31 (NRC, 2002b). License Condition 9.12 (NRC, 2010) requires the applicant to follow this guidance. This condition will be retained with this amendment. NRC staff observes that any deviation from these RSO qualifications would require a license amendment.

The applicant will be using the same management organizational structure as that used at its main facility (see Section 5.1 of NRC, 2012a). Staff previously found the applicant's management organizational structure at its main facility acceptable (NRC, 2012a, 2012b). Therefore, staff has reasonable assurance that the applicant's management organizational structure is relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings regarding the management organizational structure and, as such, previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the proposed management organizational structure at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its management organizational structure.

The applicant's Safety and Environmental Review Panel (SERP) composition for the currently licensed Crow Butte facility is described by license condition 9.4 (D) (NRC, 2010). This license condition will not change with this license amendment. NRC staff previously evaluated this information and found it acceptable (NRC, 2012a, 2012b). Therefore, based on that prior review, staff has reasonable assurance that the applicant's SERP composition is relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on the applicant's SERP composition and, as such, previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's SERP composition at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its SERP composition.

5.1.3.2 Administrative Procedures and ALARA

The applicant compiles its safety and environmental programs into a series of procedures entitled, "The Safety, Health, Environment, and Quality Management System" (SHEQ MS) (CBR, 2010). The SHEQ MS centralizes the operating, safety, and monitoring procedures for the current Central Processing Facility and will be used for NTEA, as well (CBR, 2010). NRC staff periodically reviews these procedures, as they relate to environmental protection, radiation protection, and public and employee safety, during inspections to determine their adequacy.

The applicant presented its basic program to maintain exposures ALARA (CBR, 2010). The applicant stated that it attempts to keep exposures to all radioactive materials and other hazardous material as low as possible and to as few personnel as possible, taking into account certain conditions, such current technology and cost/safety benefit of improvements. This discussion also provides the responsibilities of all pertinent personnel in complying with the ALARA policy. Personnel involved in the ALARA program include senior managers, the RSO, facility supervisors, and facility employees. The applicant listed the responsibilities of these employees in its application (CBR, 2010).

In particular, ALARA responsibilities of the RSO are as follows:

1. The responsibility for the development and administration of the ALARA program;
2. Enforcement of regulations and administrative policies that affect any radiological aspect of the SHEQ MS;
3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the radiological aspects of the SHEQ MS;
4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA program;
5. Assist with conducting an Annual ALARA audit to determine the effectiveness of the program and make any appropriate recommendations or changes as may be dictated by the ALARA philosophy;
6. Review annually all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure the procedures are ALARA and do not violate any newly established or instituted radiation protection practices; and
7. Conduct (or designate a qualified individual to conduct) daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle. (CBR, 2010)

The staff reviewed the applicant's ALARA commitments and administrative procedures and determined that they are consistent with the acceptance criteria in Section 5.1.3 of NUREG-1569 (NRC, 2003). This determination is based on the applicant's delineation of ALARA responsibilities, as presented in the application, which are consistent with Regulatory Guide 8.31 (NRC, 2002b). Furthermore, the current license requires (refer to LC 9.12 of NRC 2010) that the applicant maintain an ALARA program consistent with Regulatory Guide 8.31 (NRC, 2002b), and the staff has determined that the applicant meets that requirement. This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

5.1.4 Evaluation Findings

The staff has completed its review of the corporate organization and administrative procedures proposed for use at the NTEA. This review was performed using the acceptance criteria in Section 5.1.3 and Appendix A of NUREG-1569 (NRC, 2003). The staff determined that the applicant's corporate organization is acceptable for managing the health and safety aspects of the proposed ISR facility. The staff also determined that the applicant has established an acceptable Safety and Environmental Review Panel. The applicant demonstrated that it will maintain system of procedures to ensure radiological health and safety and environmental protection (*i.e.*, the SHEQ MS). The staff has reviewed pertinent procedures contained in the SHEQ MS and finds that the applicant's procedures address the necessary health and safety and environmental protection aspects of the proposed operation. The applicant's description of its ALARA program is acceptable because it contains the necessary management and worker responsibilities for maintaining radiological exposures ALARA. The staff also observes that the applicant is committed to the standards set forth in Regulatory Guides 8.22 (NRC, 1988), 8.30

(NRC, 2002c), and 8.31 (NRC, 2002b) in accordance with the current license (refer to license condition 9.12 of NRC, 2010). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

5.1.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2012. Cameco response to NRC revisions to the Draft License Crow Butte License Renewal, February 8, 2012, ADAMS accession No. ML120450518 (Package).

CBR, 2010. Replacement pages and response to NRC letters dated November 12, 2009 and March 24, 2010, Open Issues, North Trend Expansion Area License Amendment, Crow Butte Resources, Inc., Crawford Nebraska, October 22, 2010, ADAMS Accession No. ML103010530 (Package).

NRC, 2012a. Safety Evaluation Report License Renewal of the Crow Butte Resources ISR Facility, Dawes County, Nebraska, Materials License No. SUA-1596, Docket No. 40-8943, December 28, 2012**,** ADAMS Accession No. ML103470470.

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2011. NRC Inspection Report 040-08943/11-001, Arlington, TX, August 4, 2011, ADAMS Accession No. ML11216A179.

NRC, 2010. License Amendment No. 25, Crow Butte Resources In Situ leach Facility, License No. SUA-1534, April 20, 2010, ADAMS Accession No. ML100830012.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June, ADAMS Accession No. ML032250177.

NRC, 2002a. License Amendment 12, Crow Butte Resources In Situ leach Facility, License No. SUA-1534, July 24, 2002, ADAMS Accession No. ML022060156.

NRC, 2002b. Regulatory Guide 8.31, Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable, May 2002.

NRC, 2002c. Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, May 2002.

NRC, 1988. Regulatory Guide 8.22, Bioassays at Uranium Mills, August 1988.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed management control program for the NTEA is consistent with the requirements of 10 CFR Part 20, Subpart L, Subpart M and with 10 CFR 40.61. The staff also determines whether or not the applicant has demonstrated compliance with the health and safety requirement of 10 CFR 40.32(c).

5.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria presented in Section 5.2.3 of NUREG-1569 (NRC, 2003).

5.2.3 Staff Review and Analysis

5.2.3.1 Written Procedures

In its application, the applicant presented a discussion of its written procedures process. This process centers on the following aspects: SHEQ MS, Performance-Based License Condition, and the SERP (CBR, 2010). Regarding the SHEQ MS, this document contains eight volumes of standards and procedures including the following:

Volume 1 - Standards
Volume 2 - Management Procedures
Volume 3 - Operating Manual (SOPs)
Volume 4 - Health Physics Manual
Volume 5 - Industrial Safety Manual
Volume 6 - Environmental Manual
Volume 7 - Training Manual
Volume 8 - Emergency Manual

The applicant developed written operating procedures for all process activities including those activities involving radioactive materials for the currently licensed Crow Butte facility. Where radioactive material handling is involved, pertinent radiation safety practices are incorporated into the operating procedure. Additionally, written operating procedures have been developed for non-process activities including: environmental monitoring, health physics procedures, emergency procedures, and general safety. The applicant maintains these procedures at the currently licensed Crow Butte facility. The SHEQ Manager with assistance from the RSO, is responsible for drafting, approving, and updating the SHEQ MS manuals. The applicant stated that the SHEQ MS manual is certified to meet the ISO 14001 Environmental Management System Standard. (CBR, 2010)

Based on the staff's review of the applicant's description of the applicant's written procedures and the review of such procedures during inspections, the staff determined that the applicant's proposed process for its written procedures is consistent with that used at the currently licensed facility (refer to Section 5.2.3 of NRC, 2012a). Staff previously found the applicant's process for its written procedures to be acceptable (NRC, 2012a). Therefore, based on that prior review, staff has reasonable assurance that the applicant's process for its written procedures is relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on the applicant's process for its written procedures and, as such, previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's process for its written procedures at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's process for its written procedures.

5.2.3.2 Non-Routine Work

According to the applicant, Radiation Work Permits (RWPs) are required for non-routine work where a potential exists for significant exposure to radioactive materials and for which no operating procedure exists (CBR, 2010). RWPs will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. RWPs are reviewed and approved in writing by the RSO prior to initiation of the work. (CBR, 2010)

The applicant may also utilize Standing Radiation Work Permits (SRWP's) for periodic tasks that require similar radiological protection measures (*e.g.*, maintenance work on a specified plant system) (CBR, 2010). The SRWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The SRWP shall be reviewed and approved in writing by the RSO (or qualified designee in the absence of the RSO) prior to initiation of the work.

As part of routine inspections, the staff reviews RWPs to ensure that the radiation protection procedures are being implemented properly. Based on the review of the applicant's description of non-routine work procedures, and the staff's inspection of RWPs and SRWPs at the currently licensed Crow Butte facility, the staff determined that the applicant's proposed process for addressing non-routine work procedures is consistent with that used at the currently licensed facility (refer to Section 5.2.3 of NRC, 2012a). Staff previously found the applicant's process for addressing non-routine work procedures acceptable (NRC, 2012a). Therefore, based on that prior review, staff has reasonable assurance that the applicant's proposed process for addressing non-routine work procedures is relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on the applicant's process for addressing non-routine work procedures and, as such, previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's proposed process for addressing non-routine work procedures at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's process for addressing non-routine work procedures.

5.2.3.3 Safety and Environmental Review Panel

The applicant discussed the Safety and Environmental Review Panel (SERP) in Section 5.2.3 of the application (CBR, 2010). The purpose of the SERP is to review various facility changes or tests that are allowed without a license amendment per the current performance-based license condition discussed below. The applicant identified satisfactory procedures for using the SERP, the areas of review undertaken for a particular SERP review, and the reporting requirements.

The applicant stated that it will implement the following review procedures for the evaluation of all appropriate changes to the facility operations as outlined in SHEQ MS, Volume II, *Management Procedures* (CBR, 2010). Per the procedures, the SERP will consider the following:

1. Current NRC License Requirements
2. Ability to Meet NRC Regulations
3. Licensing Basis
4. Financial Surety
5. Essential Safety and Environmental Commitments

According to the applicant, reports of SERP review results will be published and will document the findings, recommendations, and conclusions (CBR, 2010). SERP reports will include the following:

1. A description of the proposed change, test, or experiment (proposed action)
2. A listing of all SERP members conducting the review and their qualifications (if a consultant or other member not previously qualified)
3. The technical evaluation of the proposed action, including all aspects of the SERP review procedures listed above
4. Conclusions and recommendations
5. Signatory approvals of the SERP members
6. Any attachments, such as all applicable technical, environmental, or safety evaluations, reports, or other relevant information including consultant reports. (CBR, 2010)

The applicant commits to maintaining all SERP reports and associated records of any changes through termination of the NRC license. The applicant also commits to submitting an annual report to the staff that describes all changes, tests, or experiments, which will include a summary of the SERP evaluation of each change. Any page changes resulting from any SERP decisions will be submitted to the staff. (CBR, 2010)

The SERP procedures and documentation described by the applicant (CBR, 2010) are consistent with its license condition (the “Change, Test and Experiment License Condition”) for the currently licensed Crow Butte facility (refer to license condition 9.4 of NRC, 2010). NRC staff previously evaluated this information and found it acceptable (refer to Section 5.2.3 of NRC, 2012a, and NRC, 2012b). Staff has found nothing to invalidate previous findings herefore, the original findings stand and, as such, previous staff conclusions remain valid. License condition 9.4 will not change with this license amendment. Staff will continue to evaluate the applicant’s annual reports submitted pursuant to this license condition, as well as assess the

SERP records through onsite inspections. Based on the NTEA utilizing the same license condition as the currently licensed Crow Butte facility and in light of the operating history of the currently licensed facility, staff has reasonable assurance that the applicant's proposed SERP process is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to implementation of the SERP at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of SERP implementation.

5.2.3.4 Cultural Resources

The applicant is required at the currently licensed facility to complete a cultural resource inventory prior to engaging in any construction activity not previously assessed by NRC staff (refer to license condition 9.9 of NRC, 2010). This license condition will not change with this license amendment and will be applicable to operations at the NTEA. NRC staff recently evaluated this license condition and found it to continue to be acceptable (refer to Section 5.2.3 of NRC, 2012a). Since that time, staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Based on the NTEA utilizing the same license condition as the currently licensed Crow Butte facility, and in light of the operating history of the currently licensed facility relevant to this license condition, staff has reasonable assurance that the applicant's process for implementing the cultural resource license condition is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed concerns pertinent to implementation of this license condition at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's implementation of this license condition.

5.2.3.4 Records

The SHEQ MS Volume 2*, Management Procedures,* provides specific instructions for the proper maintenance, control, and retention of records associated with implementation of the program (CBR, 2010). According to the applicant, the following records will be maintained:

Survey records
Calibrations
Personnel monitoring
Bioassays
Transfers or disposal of source or byproduct material
Accidents
Decommissioning and reclamation
Spills, excursions, contamination events
Site characterization
Background radiation levels

These records will be maintained onsite until license termination. NRC staff routinely review these records during inspections to determine compliance with the license and regulations. The following License Conditions for the currently licensed facility discuss various aspects of the applicant's recordkeeping commitments:

License Condition 11.1 – injection and production flow rates, manifold injection pressure
License Condition 11.10 – Evaporation pond inspections
License Condition 9.10 – sampling, analysis, surveys, calibration, audits/inspections, training, reviews, investigations, corrective actions. Records must be maintained onsite until license termination.
License Condition 11.6 – spills, leaks, excursions, incidents/events (NRC, 2012a)

A comparison of the application and the above-referenced license conditions indicates that the records program proposed for use at the NTEA is consistent with the program used at the main facility. NRC staff previously evaluated this information and found it acceptable (refer to Section 5.2.3 of NRC, 2012a, and NRC, 2012b). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Staff will continue to evaluate the applicant's records program through onsite inspections. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, as well as its operating history, staff has reasonable assurance that the applicant's records program is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's records program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its records program.

5.2.4 Evaluation Findings

The staff reviewed the management control program of the proposed NTEA in accordance with Section 5.2.3 and Appendix A in NUREG-1569 (NRC, 2003). The applicant has described the actions that will be considered by the SERP. The applicant described the process that will be used to develop standard operating procedures. Prior to engaging in any construction activity not previously assessed by NRC staff, the applicant is required by license condition to complete a cultural resource inventory. Spills and contamination events will be will be documented by the applicant as required by 10 CFR 20, 10 CFR 40, and current license conditions addressing other events that may not otherwise require reporting under 10 CFR Parts 20 or 40.

Based upon the review conducted by the staff as indicated above, the information provided in the application, and as required by the current license, is consistent with the applicable acceptance criteria of Section 5.2.3 and Appendix A in NUREG-1569 (NRC, 2003) and the requirements of 10 CFR Part 20, Subpart L, Subpart M, 10 CFR 40.32(c) and 10 CFR 40.61. In addition, Staff finds that the applicant's record keeping and retention programs comply with 10 CFR 20.2103(b)(4), and 10 CFR 40, Appendix A, Criterion 8 and 8A.

5.2.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010. Redline Version of Replacement Pages, October 22, 2010, ADAMS Accession No. ML103010522.

NRC, 2012a. Safety Evaluation Report License Renewal of the Crow Butte Resources ISR Facility, Dawes County, Nebraska, Materials License No. SUA-1596, Docket No. 40-8943, December 28, 2012**,** ADAMS Accession No. ML103470470.

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2010. Crow Butte Resources, Inc., Materials License Amendment No. 25, April 20, 2010, ADAMS Accession No. ML100830012.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June, ADAMS Accession No. ML032250177.

NRC, 2002. License Amendment 12, Crow Butte Resources In Situ leach Facility, License No. SUA-1534, July 24, 2002, ADAMS Accession No. ML022060156.

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAMS

5.3.1 Regulatory Requirements

The staff will determine if the applicant has demonstrated that the proposed management audit and inspection program for the NTEA meet the requirements of 10 CFR 40.32 (b) and (c).

5.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 5.3.3 of NUREG-1569 (NRC, 2003).

5.3.3 Staff Review and Analysis

5.3.3.1 Radiation Safety Inspections

The applicant proposed to perform various inspections as part of its radiation safety program (CBR, 2010). The applicant commits to using radiation safety staff to conduct these inspections. However, the applicant also proposed allowing the RSO to delegate inspections and radiation survey requirements to properly trained, experienced, plant personnel. Such personnel would be familiar with operations and would have received the necessary radiation safety training, including hands-on training (*e.g.*, use of survey instruments for monitoring items removed from the restricted area) (CBR, 2010). However, NRC staff has determined that the applicant has not adequately identified personnel that will perform the daily inspections in the absence of the radiation safety staff. NRC staff has also determined that the applicant must identify their proposed alternate qualified personnel and provide sufficient health physics training (consistent with the qualifications for radiation safety staff in Regulatory Guide 8.31 (NRC, 2002)). The applicant previously committed to comply with Regulatory Guide 8.31(NRC, 2002) regarding the inspection duties for health physics personnel. This commitment was captured as a license condition for the currently operating CBR facility (refer to LC 9.12 of NRC, 2010). This license condition will be maintained for this amendment. This condition is presented in SER Section 5.3.4.

NRC staff previously evaluated this requirement and found it acceptable (NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. License condition 9.12 (NRC, 2010), requiring conformance with Regulatory Guide 8.31 regarding the inspection duties for health physics personnel, will not change with this license amendment. Staff will continue to evaluate the applicant's inspection results pursuant to this license condition through onsite inspections. Based on the fact that the license condition will not change and will be applicable to the NTEA and in light of the operating history of the currently licensed CBR facility relevant to the implementation of the license condition, staff has reasonable assurance that the applicant will implement a radiation safety inspection program at the NTEA in a manner consistent with Acceptance Criteria 5.3.3(1) of NUREG-1569 (NRC, 2003).

5.3.3.2 Evaporation Pond Inspections

Section 5.3.2 of the application discusses the pond inspection program (CBR, 2010). The applicant proposed using the same inspection program for evaporation ponds as implemented at the currently licensed facility. Pond inspection procedures are contained in the SHEQ MS, Volume VI, *Environmental Manual,* and are based on the guidance in NRC Regulatory Guide 3.11 (NRC, 2008). The applicant intends to implement daily, weekly, quarterly, and annual inspections of the evaporation ponds. Daily inspections will consist of observing the pond depth and embankment problems. Weekly inspection items include the perimeter fence, inlet pipes, underdrain measurements, pond sprays, pond liner, and the lead detection system. Quarterly inspections items include embankment settlement and slopes, seepage, slope protection, post-construction changes, and emergency lines. (CBR, 2010)

The applicant stated that it will perform a technical evaluation of the pond system on an annual basis that addresses the hydraulic and hydrologic capacities of the ponds, ditches, and the structural stability of the embankments (CBR, 2010). A survey of the pond embankments will also be performed annually, the results of which will be documented and incorporated into the annual inspection report. The applicant will review the survey for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes. (CBR, 2010)

The applicant's current practice at the licensed facility is to prepare an annual inspection report that presents the results of the technical evaluation of the pond system and the inspection data collected since the last report. This report includes the results of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in the State of Nebraska. A review of the pond monitor well sampling data is also included to identify potential pond seepage problems. This report will also be prepared for the NTEA ponds. The current license presents the applicant's required corrective actions in the event it detects a pond leak (refer to License Condition 11.4 of NRC, 2010) .

As discussed in SER Section 4.2.3.1.4, staff is revising an existing license condition for the applicant's evaporation pond onsite inspection program to require more frequent inspections of the pond leak detection system and to strengthen the applicant's corrective action program in regards to leaks discovered in the ponds (refer to Section 4.2.4 of NRC, 2012).

A review of the application and current license conditions indicates that the proposed pond inspection program is consistent with the pond inspection program used at the main facility. NRC staff previously evaluated the pond inspection program used at the main facility and found it acceptable (refer to Section 5.3.3 of NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Staff will continue to evaluate the applicant's pond inspection and corrective action program through onsite inspections. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's pond inspection and corrective action program is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's pond inspection and corrective action program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its pond inspection and corrective action program.

5.3.3.3 Annual ALARA Audit

The applicant proposed conducting audits of the radiation safety and ALARA programs. These audits are conducted by the SHEQ Manager, qualified personnel from other uranium recovery facilities, or outside radiation protection auditors. The ALARA audit includes a review of the following areas:

- Employee exposure records
- Bioassay results
- Inspection log entries and summary reports of mine and process inspections
- Documented training program activities
- Applicable safety meeting reports
- Radiological survey and sampling data
- Reports on any overexposure of workers
- Operating procedures that were reviewed during this time period

The ALARA report summarizes the following information:

- Trends in personnel exposures
- Proper use, maintenance and inspection of equipment used for exposure control
- Recommendations on ways to further reduce personnel exposures from uranium and its daughters

The NRC staff reviews the ALARA audit reports during routine inspections. Furthermore, the current license requires the applicant to describe the corrective actions taken when urinary uranium action levels have been exceeded (refer to license conditions 11.8 and 11.9 of NRC, 2010). The procedures identified by the applicant and contained in the current license have been proven effective during operations at the currently licensed Crow Butte facility.

A review of the application and current license conditions indicates that the proposed ALARA audit program is consistent with the ALARA audit program used at the main facility. NRC staff previously evaluated this information and found it acceptable (refer to Section 5.3.3 of NRC, 2012a, and NRC, 2012b). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Staff will continue to evaluate the applicant's ALARA audit program through onsite inspections. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility and in light of the operating history of the currently licensed CBR facility relevant to the implementation of the audit programs, staff has reasonable assurance that the applicant's ALARA audit program is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's ALARA audit program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its radiation safety and ALARA audit program.

5.3.4 Evaluation Findings

The NRC staff has completed its review of the management audit and inspection programs that provide frequency, types, and scopes of reviews and inspections; action levels; and corrective measures sufficient to implement the proposed actions. Based on the information provided in the application, current license conditions, and staff's review thereof, the applicant's management audit and inspection program meets the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b) and (c).

The staff reviewed the management audit and inspection program of the proposed NTEA in accordance with Section 5.3.3 of the standard review plan. The applicant described the various types of inspections, and their frequencies, that will be performed by the applicant's staff. The applicant described the personnel that will perform these inspections; however, the applicant proposed an approach that is not consistent with Regulatory Guide 8.31 and did not identify the qualifications or training required for personnel to perform daily inspections. Because the applicant did not provide this information, the staff is maintaining the current standard license condition committing the applicant to conform to Regulatory Guide 8.31 regarding the inspection duties for health physics personnel:

> The licensee shall follow the guidance set forth in NRC, Regulatory Guides (as revised) 8.22, "Bioassay at Uranium Recovery Facilities," and 8.30, "Health Physics Surveys in Uranium Recovery Facilities," and Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable (ALARA)" or NRC-approved equivalent.

Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented with the noted standard license condition is consistent with the applicable acceptance criteria of Section 5.3.3 of the standard review plan and the requirements of 10 CFR 40.32(b) and (c).

5.3.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010. Redline Version of Replacement Pages, October 22, 2010, ADAMS Accession No. ML103010522.

NRC, 2012a. Safety Evaluation Report License Renewal of the Crow Butte Resources ISR Facility, Dawes County, Nebraska, Materials License No. SUA-1596, Docket No. 40-8943, December 28, 2012**,** ADAMS Accession No. ML103470470.

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2010. Crow Butte Resources, Inc., Materials License Amendment No. 25, April 20, 2010, ADAMS Accession No. ML100830012.

NRC, 2008. Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities, Regulatory Guide 3.11, November, 2008.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June, ADAMS Accession No. ML032250177.

NRC, 2002. "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Regulatory Guide 8.31, Revision 1. Washington, DC: May.

5.4 QUALIFICATIONS FOR PERSONNEL CONDUCTING THE RADIATION SAFETY PROGRAM

5.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the personnel conducting the radiation safety program meet the requirements of 10 CFR Part 20.1101 and 10 CFR 40.32(b).

5.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria presented in Section 5.4.3 of the NUREG-1569 (NRC, 2003). Regulatory Guide 8.31 (NRC, 2002a) provides recommendations for technical qualifications of radiation safety staff. With respect to the currently licensed facility, the applicant is required by license condition (refer to condition 9.12 of NRC, 2002b) to follow the recommendations in Regulatory Guide 8.31 (NRC, 2002a).

5.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated.

This section describes the necessary qualifications of key personnel conducting the radiation safety program at the NTEA. With regard to the qualifications of these key personnel, the applicant must demonstrate that its radiation safety program complies with 10 CFR 20.1101, which defines the radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications. Regulatory Guide 8.31 (NRC, 2002a) provides recommendations for the technical qualifications of radiation safety staff, including the radiation safety officer (RSO) and health physics technician (HPT). The applicant is required by license condition (NRC, 2002b) to follow the guidance in Regulatory Guide 8.31 (NRC, 2002a). This license condition will be retained with this license amendment. NRC staff previously evaluated and approved of CBR's adoption of the recommendations of Regulatory Guide 8.31 (NRC, 2002a) for qualifications. Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid.

5.4.3.1 Radiation Safety Officer

In Section 5.4.1 of the TR (CBR, 2010), the applicant identified the requirements for an RSO. The proposed educational requirements for an RSO include a bachelor's degree in physical science, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in radiation protection related to uranium recovery.

Other minimum qualifications for the RSO identified by the applicant include health physics experience. Specifically, at least 1 year of work experience relevant to uranium recovery operations in applied health physics, radiation protection, industrial hygiene, or similar work. The applicant also identified specialized training for the RSO that will include at least 4 weeks of specialized classroom training in health physics specifically applicable to uranium recovery.

As described above, the applicant proposed qualifications for the RSO consistent with the qualification requirements of the RSO at its main facility. Staff previously concluded that the qualifications for the RSO were acceptable during the prior license renewal for the currently licensed facility (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's proposed qualifications for the RSO are relevant and effective for the NTEA. Staff has found nothing to invalidate these previous findings on RSO qualifications at the NTEA. Therefore, the original findings stand and previous staff conclusions remain valid. In addition, staff has not identified any safety-related concerns pertinent to RSO qualifications at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not reexamining this issue.

5.4.3.2 Health Physics Technician

In Section 5.4.2 of the TR (CBR, 2010) the applicant identified the minimum qualifications for a health physic technician (HPT) as satisfied by one or the other of the following alternative combinations of education, training, and experience. The first set of qualifications would include an associate degree or 2 or more years of study in the physical sciences, engineering, or a health related field; at least a total of 4 weeks of generalized training in radiation protection applicable to uranium recovery facilities; and 1 year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium recovery facility.

The second set of qualifications includes a high school diploma, a total of at least 3 months of specialized training in radiation protection relevant to uranium recovery facilities (up to one month may be on-the-job training), and 2 years of relevant work experience in applied radiation protection.

As described above, the applicant proposed qualifications for the HPT consistent with the qualifications of the HPT at its main facility. Staff previously concluded that the HPT qualifications were acceptable during the prior license renewal for the currently licensed facility (Refer to Section 5.4 of NRC, 2012). Therefore, staff has reasonable assurance that the applicant's proposed qualifications for the HPT are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on HPT qualifications at the NTEA. Therefore, the original findings stand and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to HPT qualifications at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not reexamining this issue.

5.4.4 Evaluation Findings

NRC staff reviewed the proposed qualification requirements for the personnel conducting the radiation safety program at the proposed NTEA in accordance with Appendix A of NUREG-1569 (NRC, 2003). Based on the information provided by the applicant and the review conducted by the staff as indicated above, the applicant has appropriately addressed the qualifications for the RSO and the HPT for the NTEA. NRC staff concludes that the qualifications of facility personnel conducting the radiation safety protection program are acceptable and are in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications.

5.4.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, “Domestic Licensing of Source Material”.

CBR, 2010. Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, October, ADAMS Accession No. ML103010525

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., May, ADAMS Accession No. ML072540671 (package)

NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 2002a. Regulatory Guide 8.31, Revision 1, “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Washington, DC: May.

NRC, 2002b. License Amendment 12, Crow Butte Resources In Situ Leach Facility, License No. SUA-1534, July 24, 2002, ADAMS Accession No. ML022060156.

5.5 RADIATION SAFETY TRAINING

5.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its radiation safety training program for the NTEA facility meets the requirements of 10 CFR 20.1101 and 40.32(b).

5.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20 and Part 40 using the acceptance criteria presented in Section 5.5.3 of NUREG-1569 (NRC, 2003).

5.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated.

The applicant's radiation safety program is contained in its SHEQ MS Volume VII, Training Manual (CBR, 2010). In Section 5.5 of the TR, the applicant stated (CBR, 2010) that it will administer the training program consistent with NRC Regulatory Guide 8.13 (NRC, 1999), NRC Regulatory Guide 8.29 (NRC, 1996), and NRC Regulatory Guide 8.31 (NRC 2002).

The applicant stated (CBR, 2010) that all new workers, including supervisors, will be given instruction on the health and safety aspects of the specific jobs they will perform. The RSO or a qualified designee will conduct all radiation safety training. Training topics will include fundamentals of health protection, facility-provided protection, health protection measurements, radiation protection regulations, and emergency procedures. Each worker will be given a written test, including annual refresher training, and training records will be kept until license termination. HPTs will also receive on-the-job training. (CBR, 2010)

The applicant stated (CBR, 2010) that visitors not receiving training will be escorted by site personnel properly trained and knowledgeable about the hazards of the facility. Contractors having work assignments at the facility will be given appropriate radiation safety training. Contractors performing work on heavily contaminated equipment will receive the same training normally required of site workers. (CBR, 2010)

The applicant has proposed a radiation safety training program consistent with the radiation safety training program at its main facility. Staff previously found the applicant's radiation safety training program at its main facility to be acceptable (Refer to Section 5.5 of NRC, 2012). Therefore, with the exception that the applicant has not provided the qualifications of a designee for conducting radiation safety training (as discussed below), staff has reasonable assurance that the applicant's proposed radiation safety training program is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings regarding the radiation safety training program and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed-safety-related concerns pertinent to the radiation safety training program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's radiation safety training program.

To address the applicant's lack of a description of the designee's qualifications, staff is imposing a license condition to ensure a properly qualified individual is conducting the radiation safety training. The license condition is presented in SER Section 5.5.4.

5.5.4 Evaluation Findings

The staff reviewed the radiation safety training aspects of the proposed NTEA facility in accordance with Appendix A of NUREG-1569 (NRC, 2003). The proposed training program was found to be acceptable with the exception that the applicant did not provide the qualifications of the designee conducting radiation safety training. Therefore, staff is imposing the following license condition:

> The licensee shall submit to NRC staff for written verification the qualifications of a designee that will conduct radiation safety training. Until such verification is received by the licensee, only the RSO shall conduct radiation safety training.

Based on the information provided in the application and the detailed review conducted by the staff as indicated above, NRC staff concludes that the proposed radiation safety training program is acceptable and is in compliance with 10 CFR 20.1101, which defines radiation protection program requirements, and 10 CFR 40.32(b), as it relates to applicant qualifications through training.

5.5.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010. Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, October, ADAMS Accession No. ML103010525

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November, ADAMS Accession No. ML072540671 (package)

NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal December 28,_2011, ADAMS Accession NO. ML103470470.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

NRC, 2002. "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable," Regulatory Guide 8.31, Revision 1. Washington, DC: May.

NRC, 1999. “Instruction Concerning Prenatal Radiation Exposure,” Regulatory Guide 8.13, Revision 3. Washington, DC: June.

NRC, 1996. “Instruction Concerning Risks from Occupational Radiation Exposure,” Regulatory Guide 8.29, Revision 1. Washington, DC: February.

5.6 SECURITY

5.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed security measures for the NTEA meet the requirements of 10 CFR 20, Subpart I.

5.6.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria outlined in Section 5.6.3 of NUREG-1569 (NRC, 2003).

5.6.3 Staff Review and Analysis

5.6.3.1 Security Plan

The applicant stated that security measures are specified in the Security Plan and Security Threat chapter in Volume VIII of the Safety, Health, Environment, and Quality Management System (SHEQ MS) (CBR, 2010). 10 CFR 20, Subpart I requires licensees to maintain control over licensed material (*i.e.*, natural uranium ("source material") and byproduct material as defined in 10 CFR § 40.4). At the NTEA, licensed stored material will include loaded ion exchange resin contained in IX columns and byproduct material awaiting disposal. The following structures will contain pregnant and barren lixiviant: production pipelines in the well fields and header houses, production trunklines to the Satellite Facility, and piping in the satellite building. Loaded ion exchange resin will be placed in a transport truck and temporarily stored in the vehicle until the truck is filled and ready for delivery to the currently licensed Crow Butte facility. (CBR, 2010)

The applicant has proposed different security measures for restricted and unrestricted areas of the facility. The applicant has identified restricted and unrestricted areas of the NTEA in Figures 2.1-3 and 3.2-1 in the application (CBR, 2009). Restricted areas consist of the satellite plant area, evaporation ponds, and any area containing stored and non-stored source/byproduct material. Examples of non-stored licensed material include pregnant lixiviant solution, loaded IX resin, and byproduct material awaiting disposal. (CBR, 2010). Areas of stored and non-stored license material include pipelines, tanks, process vessels, and trucks containing loaded IX resin.

Security measures for these areas include fences, locking gates, and signs identifying these areas as radiation areas (CBR, 2010). Satellite plant doors can be locked to prevent unauthorized access. The satellite plant will routinely operate 24 hours per day, 7 days per week; therefore, the applicant's employees will normally be onsite except for occasional shutdowns. Areas of stored and non-stored licensed material will be controlled by fences and locked access gates. In addition to the aforementioned security features, the applicant will install a locking gate on the main access road and surveillance cameras monitoring the access road and satellite plant areas. Satellite plant operators will also inspect the facility at the beginning of each shift to ensure that licensed material is secured. (CBR, 2010)

The applicant stated that it will address visitors and trespassers in the following manner. The applicant's employees are instructed to report any unauthorized persons to plant supervisors, who will escort such persons off the premises (CBR, 2010). Visitors must register at the plant

office, and those who visit infrequently will be escorted around the site. Frequent visitors will be properly trained by the applicant and may enter controlled areas unescorted. (CBR, 2010)

The applicant proposed the following wellfield security measures. All wellfields will be fenced and posted with signs (CBR, 2010). Wellfield gates will be locked at times when operators or workers are not a particular wellfield. Header houses will be locked at all times to prevent unauthorized access to non-stored licensed source material. (CBR, 2010)

The applicant proposed to post radiation areas per 10 CFR 20.1902. However, the current license exempts the applicant, with respect to the licensed facility, from the requirements of 10 CFR 20.1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted in accordance with Section 20.1902(e) and with the words, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

The staff has reviewed the applicant's plant and facility security measures and determined that these measures are consistent with the acceptance criterion in Section 5.6.3 of NUREG-1569 (NRC, 2003). The applicant has demonstrated that it will maintain control of licensed source and byproduct material contained within restricted areas using fences, gates, signs, security cameras, and plant personnel. The applicant will also maintain control of licensed source material in unrestricted areas by locking header houses and enclosing wellfields with gates and fences. Therefore, the staff determined that the applicant's security measures comply with the requirements of 10 CFR Part 20, Subpart I.

5.6.3.2 Transportation Security

According to the applicant, transportation of licensed materials will be restricted to transferring ion exchange resin between the NTEA and the currently licensed Crow Butte facility, as well as transferring contaminated equipment between the NTEA and company facilities (CBR, 2010). The applicant currently maintains a security plan for its licensed facility to comply with 49 CFR Part 172, Subpart I, Security Plans, which address hazardous materials shipments. This security plan contains point-to-point security procedures and guidelines protecting drivers, vehicles, and cargo. (CBR, 2010)

Based on the staff's review of the applicant's proposed transportation security plan the staff has reasonable assurance that the applicant will safely transport licensed source and byproduct materials between the NTEA and the currently licensed area because of the following:

- The applicant will be transporting licensed materials over a short distance (approximately 10 km (6.2 mi)).
- Most of the proposed transport route will avoid major roads, and the area is sparsely populated resulting in very light traffic along the transport route.
- The applicant is experienced with transporting licensed byproduct materials near the proposed NTEA area due to ongoing activities at its currently licensed facility.
- The applicant developed acceptable procedures to protect shipments in unoccupied trucks.

5.6.4 Evaluation Findings

Based on the information provided in the application and the detailed review conducted by the staff of the security measures for the NTEA, the staff concludes that the security measures are consistent with the acceptance criteria in Section 5.6.3 of NUREG-1569 (NRC, 2003) because:

- The applicant's proposed plant and facility security measures will maintain control of licensed source and byproduct material contained within restricted and unrestricted areas.
- The applicant has proposed reasonable transportation security guidelines to minimize transportation over major roads, minimize the resin transportation distance, and protect cargo stored in unoccupied vehicles.

Therefore, the staff finds the applicant's security procedures comply with 10 CFR Part 20, Subpart I, which provides requirements for the security of stored material and control of material not in storage.

5.6.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

CBR, 2010. Replacement pages and response to NRC letters dated November 12, 2009 and March 24, 2010, Open Issues, NTEA License Amendment, Crow Butte Resources, Inc., Crawford Nebraska. ML103010530.

CBR, 2009. Response to Request for Additional Information for NTEA, February 27, 2009, ADAMS Accession No. ML090750428.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June, 2003.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

The purpose of this section is to evaluate the techniques the applicant proposes to use to monitor and minimize radiation exposures at the NTEA (NTEA) facility.

5.7.1 Standards

As part of its assessment, the staff will present certain standards with which the applicant must comply. These standards are listed below and referenced throughout the remaining portion of Section 5.7. These standards are as follows:

Guidance

- Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills", Revision 1, Issued April 1980
- Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment," Revision 2, issued July 2007
- Regulatory Guide 8.7, "Instructions for Recording and Reporting Occupational Radiation Exposure Data," Revision 2
- Regulatory Guide 8.15, Acceptable Programs for Respiratory Protection, Revision 1, issued October 1999
- Regulatory Guide 8.22, "Bioassay at Uranium Mills," Revision 1, issued August 1988
- Regulatory Guide 8.25, Air Sampling in the Workplace, Revision 1, issued June 1992
- Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, Revision 1, issued May 2002
- Regulatory Guide 8.31, Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable, May 2002.
- Regulatory Guide 8.34, "Monitoring Criteria and Methods To Calculate Occupational Radiation Doses," Revision 0, issued July 1992
- Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus," Revision 0, issued July 1992
- Regulatory Guide 8.37, "ALARA Levels for Effluents from Materials Facilities", July 1993.

Regulations

- 10 CFR 20, Subpart B - Radiation Protection Programs, § 20.1101
- 10 CFR 20, Subpart C – Occupational Dose Limits: 20.1201 – 1208
- 10 CFR 20, Subpart F – Surveys and Monitoring: 20.1501 and 20.1502
- 10 CFR 20, Subpart L – Records: 20.2101 – 20.2110
- 10 CFR 20, Subpart M – Reports: 20.2201 – 20.2207

Numerical Standards

- 10 CFR 20, Appendix B, Table 1 - Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage DAC, Natural Uranium Class W: - 3.0E-10 microcuries per milliliter (µCi/mL) DAC Natural Uranium Class D: - 5E -10 µCi/mL
- 10 CFR 20.1201 – Total Effective Dose Equivalent (TEDE): 5 rem, or the sum of the DDE and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem
- 10 CFR 20.1201 - Annual Limit to the Eye Lens: 15 rem
- 10 CFR 20.1201 - Annual Limits to the Skin of the Whole Body and Extremity 50 rem
- 10 CFR 20.1201(e) – 10 mg per week limit on intake of soluble uranium

5.7.2 Effluent Control Techniques

During the course of the review, the staff determined that the areas of review and acceptance criteria presented in Section 5.7.1 of NUREG-1569 (NRC, 2003), which addresses effluent control techniques, were covered in other sections of this SER. The staff's review of the applicant's proposed effluent control techniques can be found in Section 4.1 and Section 5.7.8 of this SER and are therefore not discussed here.

5.7.2.1 Reference

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

5.7.3 External Radiation Exposure Monitoring Program

This section discusses the external radiation exposure monitoring program. The purpose of this section is to describe the devices and methods the applicant will use to detect measure, calculate, and/or monitor external radiation exposures to workers.

5.7.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its external radiation exposure monitoring program for the NTEA facility meets the requirements of 10 CFR Part 20, Subpart B, 10 CFR 20 Subpart C, 10 CFR Part 20 Subpart F 10 CFR Part 20, Subpart L, 10 CFR Part 20, Subpart M, and 10 CFR 40.61.

5.7.3.2 Regulatory Acceptance Criteria

The staff reviewed the applicant's proposed external radiation exposure monitoring program for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria presented in Section 5.7.2.3 of NUREG 1569 (NRC, 2003). Regulatory Guides 8.30 (NRC, 2002a) and 8.31 (NRC, 2002b) provide guidance on how compliance with the regulations can be demonstrated.

5.7.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007) and as updated.

5.7.3.3.1 Surveys

The applicant proposed to conduct gamma surveys at the NTEA Satellite plant locations as shown in Figure 5.7-2 of the Technical Report (CBR, 2010).

The applicant plans to conduct external radiation surveys quarterly in designated radiation areas and semiannually in all other areas of the plant (CBR, 2010). The applicant will establish a designated "Radiation Area" if the gamma survey exceeds the action level of 5 mrem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates (CBR,2010).

The applicant indicated that the minimum specifications for survey equipment will include the lowest range which is 100 micro-roentgens per hour and the highest range to read at least 5 mill-roentgens per hour full scale (CBR, 2010). In addition, the applicant proposed external radiation survey equipment, including a Ludlum Model 3 meter with a Ludlum Model 44-38 GM detector, or equivalent (refer to Section 3.3 of CBR, 2009, 2010). Staff observes that this equipment is capable of measuring between 0 and 200 mR/hr (Ludlum 2006, 2011). The applicant indicated that the gamma exposure rate surveys will be performed in accordance with the guidance in NRC Regulatory Guide 8.30 (NRC, 2002a) and the instructions contained in its SHEQ MS, Volume IV, Health Physics Manual (CBR, 2010).

The applicant stated that beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake are recommended by Regulatory Guide 8.30 (NRC 2002a) and are performed in accordance with the instructions currently contained in SHEQ MS Volume IV, Health Physics Manual (CBR, 2010). The applicant stated that since elution, precipitation, and drying operations will be performed in the existing central plant, beta survey should not be necessary at the North Trend Satellite Plant (CBR, 2010). Staff observes that while beta exposure surveys may not be necessary at the NTEA, as dictated by actual plant conditions, staff imposed a standard license condition on the applicant during staff's review of the renewal application for the currently operating Crow Butte facility to account for beta-gamma contamination that could lead to internal and external exposure (refer to Section 5.7.7.3.1, and License Condition 11.10 in Appendix A, of NRC, 2012a). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

Based on the above description, the staff finds that the applicant's proposed external radiation survey program at the NTEA is consistent with the external radiation survey program in use at its main facility (refer to Section 5.7.3 of NRC, 2012a). Staff previously found the applicant's external radiation survey program at its main facility to be acceptable (NRC, 2012a). Based on the NTEA utilizing the same license conditions as the main facility, staff has reasonable assurance that the applicant's proposed external radiation survey program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's external radiation survey program. Therefore, the original findings stand and previous staff conclusions on the applicant's external radiation survey program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the proposed external

radiation survey program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of its external radiation survey program.

5.7.3.3.2 Personnel Dosimetry

The applicant indicated that personnel dosimetry will be issued to all process employees and exchanged on a quarterly basis (CBR, 2010). This will include process plant and wellfield operators. The applicant stated that the personnel dosimeters are provided by a vendor that is accredited by the National Voluntary Laboratory Accreditation Program. The applicant stated that the personnel dosimeters can range from 1 mR to 1000 R. According to the applicant, the results from the personnel dosimetry will be used to determine individual Deep Dose Equivalent for use in determining Total Effective Dose Equivalent. (CBR, 2010)

The staff finds that the applicant's proposed personnel dosimetry program at the NTEA is consistent with the personnel dosimetry program in use at its main facility (See Section 5.7.3 of NRC, 2012a). Staff previously found the applicant's personnel dosimetry program at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed personnel dosimetry program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's personnel dosimetry program. Therefore, the original findings stand and previous staff conclusions on the applicant's personnel dosimetry program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's proposed personnel dosimetry program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of its personnel dosimetry program.

5.7.3.3.3 Records and Reporting

The applicant described its records management program in Section 5.2 of its TR (CBR, 2010). With respect to the currently licensed facility, the applicant is required by license condition to document sampling, analyses and surveys or monitoring and to maintain this documentation for at least five years (refer to license condition 11.6 of NRC, 2012b). This license condition will not change except for the requirement to maintain these records until license termination unless otherwise specified in another license condition or NRC regulation (refer to Sections License Condition 9.10 in Appendix A of NRC, 2012a). As indicated in Section 5.1 of the application, the Vice President of Operations and SHEQ Director are responsible for compliance with all regulatory reporting requirements (CBR, 2010).

Staff finds that the applicant's proposed records and reporting program for external radiation exposure monitoring at the NTEA is consistent with the records and reporting program in use at its main facility (See Section 5.7.3 of NRC, 2012a). Staff previously found the applicant's records and reporting program for external radiation exposure monitoring at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed records and reporting program for external radiation exposure monitoring is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's records and reporting program for external radiation exposure monitoring. Therefore, the original findings stand and previous staff conclusions on the applicant's records and reporting program for external radiation exposure monitoring remain valid. In addition, staff

has not found any unreviewed safety-related concerns pertinent to the applicant's records and reporting program for external radiation exposure monitoring at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of its records and reporting program for external radiation exposure monitoring.

5.7.3.4 Evaluation Findings

NRC staff reviewed the applicant's external radiation exposure monitoring program in accordance with Appendix A of NUREG-1569 (NRC, 2003). This included a review of the gamma and beta survey and personnel external dosimetry programs. Based on the information provided in the license amendment application (CBR, 2007), as updated, and detailed reviews of the applicant's program at the NTEA, NRC staff has determined that these programs, as discussed above, meet the requirements in 10 CFR 20 Subpart B, and 10 CFR 20 Subpart F.

5.7.3.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010 Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No. ML103010530 (Package).

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

Ludlum, 2011. Ludlum Model 44-38 Beta-Gamma Detector Manual, Ludlum Measurements, Inc., June 2011 ADAMS Accession No. ML13086A183

Ludlum, 2006. Excerpts from Ludlum Model 3 Survey Meter Manual, Ludlum Measurements, Inc., January 2006 ADAMS Accession No. ML13086A176

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2012b. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

NRC, 2002a. Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, Revision 1, May.

NRC, 2002b. “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Regulatory Guide 8.31, Revision 1. Washington, DC: May.

5.7.4 In-Plant Airborne Radiation Monitoring Program

5.7.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed in-plant radiation monitoring program for the NTEA facility meets the requirements of 10 CFR Part 20, Subparts B and C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.4.2 Regulatory Acceptance Criteria

The staff reviewed the applicant's proposed in-plant airborne radiation monitoring program for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria presented in Section 5.7.3.3 of NUREG-1569 (NRC, 2003). Regulatory Guide 8.30 (NRC, 2002a) and Regulatory Guide 8.31 (2002b) provides guidance on how compliance with the regulations can be demonstrated.

5.7.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated.

The following sections describe and evaluate the in-plant airborne radiation monitoring program proposed by the applicant. The program consists of airborne uranium particulate monitoring, radon daughter concentration monitoring, and the respiratory protection program. The purpose of the in-plant airborne radiation monitoring program is to characterize the airborne uranium and radon daughter levels at various locations in the plant to ensure that workers are adequately monitored for internal radiation exposures and areas are adequately posted in accordance with the applicable sections of 10 CFR Part 20.

5.7.4.3.1 General Program Description

The staff observes that while the primary operations at NTEA will be wet operations (i.e., no handling of dried yellowcake product) and the lixiviant will be contained within its primary boundary (i.e., within processing piping and tanks), airborne radioactivity may result from spills, leaks, and maintenance activities. The in-plant airborne radiation monitoring program is designed to detect these contaminants if they escape the primary boundary. The applicant plans to conduct in-plant airborne radiation monitoring at the locations identified in NTEA application Figure 5.7-2 for airborne uranium and radon daughters (Cameco, 2013).

5.7.4.3.2 Airborne Particulate Uranium Monitoring

The applicant stated that locations of sample points are based, in part, on a determination of airflow patterns in areas where monitoring is needed (CBR, 2010). The applicant proposed that once the ventilation system is installed and operational, and prior to process operations, a portable anemometer would be used to assess the ventilation patterns (*i.e.*, direction and velocity) in the work areas (CBR, 2010). The applicant further stated that specific attention would be given to areas perceived as having a higher risk for releases. The applicant indicated that once the final design has been completed, an assessment would be made by the RSO and operations staff as to the most optimum locations of radiological sampling points (CBR, 2010). The applicant also indicated that once the facility is constructed and operational, another assessment would be made of the sampling points and results, and a determination made as to

the need for any changes to the monitoring points and frequency (CBR, 2010). NRC staff finds the applicant's proposed methods for establishing air particulate uranium sampling locations consistent with acceptance criteria 5.7.3.3(1) of NUREG-1569 (NRC, 2003) and therefore acceptable.

The applicant stated that the measurement of airborne uranium is performed by gross alpha counting of the air filters using an alpha scaler (CBR, 2010). Staff finds that the method for the measurement of airborne uranium by gross alpha counting is consistent with the air sampling program at the currently licensed facility (refer to Section 5.7.4.3.1 of NRC 2012a). In its recent review of that program, staff observed that the applicant did not demonstrate that gross alpha counting will differentiate all airborne radioactivity in air samples, including radionuclides that are not uranium, some which may not emit alpha particles and thus will not be detected. To address this deficiency, staff imposed a license condition (See Section 5.7.4.3.1, and Standard License Condition 10.8 in Appendix A, of, NRC, 2012a) which requires the applicant to measure and identify the radionuclides in airborne samples. Analytical results will be compared to mixture requirements in 10 CFR 20.1204(g) to ensure that the appropriate DAC is used. This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's proposed airborne particulate uranium sampling program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's proposed airborne particulate uranium sampling program. Therefore, the original findings stand and previous staff conclusions on the applicant's airborne particulate uranium sampling program remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's proposed airborne particulate uranium sampling program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the airborne particulate uranium sampling program.

The applicant proposed using inhalation class D for natural uranium at the NTEA (CBR, 2010). NRC staff finds that this inhalation class for yellowcake produced at the currently licensed Crow Butte facility from uranium derived from the NTEA is applicable for the following reasons: 1) the uranium is recovered from the same ore zone and aquifer as the main facility, 2) the applicant will use the same uranium extraction and recovery techniques, and 3) the applicant will utilize the same yellowcake drying temperatures. However, staff observes that yellowcake will not be produced at the NTEA (refer to SER Section 1.0). Therefore, an appropriate inhalation classification is required for other forms of natural uranium compounds encountered at the NTEA. To address this deficiency, staff imposed a license condition in the review of the Crow Butte license renewal application (See Section 5.7.4.3.1 of NRC, 2012a). This license condition requires the licensee to use inhalation class W for all uranium products encountered during operations that are neither assigned an inhalation classification (i.e., 10 CFR 20, Appendix B) nor have site-specific data available (refer to Section 5.7.4.3.1, and Standard License Condition 10.9 in Appendix A, of NRC, 2012a). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's proposed inhalation classification for airborne particulate uranium is relevant and effective for the NTEA. Staff finds nothing to invalidate staff's previous findings

on the applicant's proposed inhalation classification for airborne particulate uranium. Therefore, the original findings stand and previous staff conclusions on the applicant's proposed inhalation classification for airborne particulate uranium remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's proposed inhalation classification for airborne particulate uranium at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's proposed inhalation classification for airborne particulate uranium.

5.7.4.3.3 Radon Monitoring

The applicant's rationale for selecting radon monitoring locations is the same as discussed for uranium particulates in SER Section 5.7.4.3.2. The applicant provided a map depicting proposed radon sampling locations (refer to Figure 5.7-2 in Cameco, 2013). NRC staff finds the proposed locations for the radon daughter in-plant sampling program consistent with Regulatory Guide 8.25 (NRC, 1992) and acceptance criteria 5.7.3.3(1) in NUREG-1569 (NRC, 2003) and therefore acceptable.

The applicant stated that radon daughter in-plant air samples are collected with a low volume air pump and then analyzed with an alpha scaler, using the modified Kusnetz method (refer to Section 5.7.3.2 of CBR, 2010). Staff finds the applicant's proposed radon monitoring program at the NTEA consistent with the radon monitoring program in use at its currently operating facility (refer to Section 5.7.4.3.2 of NRC, 2012a). Staff previously found the applicant's radon monitoring program at its operating facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed radon monitoring program is relevant and effective for the NTEA. Staff finds nothing to invalidate previous findings on the applicant's radon monitoring program. Therefore, the original findings stand and previous staff conclusions on the applicant's radon monitoring program remain valid. In addition, staff has not found any unreviewed safety-related concerns pertinent to the applicant's radon monitoring program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its radon monitoring program.

5.7.4.3.4 Action Limits

According to NRC Regulatory Guide 8.30, an action limit is a level where the applicant should take action to identify the cause of a predetermined survey result and take corrective action if appropriate (NRC, 2002a). For airborne particulate uranium surveys, the applicant proposed setting an action level at 25 percent of the DAC for inhalation class D natural uranium (see Section 5.7.3.1 of CBR, 2010). If an airborne uranium sample exceeds this action level during routine monthly surveys, an investigation of the cause is performed and the sampling frequency is increased from monthly to weekly until the airborne uranium levels do not exceed the action level for four consecutive weeks (CBR, 2010). Staff observes that the applicant's proposed action limits for airborne particulate uranium are consistent with ALARA goals for ventilation systems in NRC Regulatory Guide 8.31 (NRC, 2002b).

The applicant considers the chemical toxicity of uranium and limits individual intakes of soluble uranium to 10 mg in a week (CBR, 2010). The applicant stated that when exposures led to an individual exceeding 25 percent of the weekly limit, the RSO will conduct an investigation and initiate corrective actions, as appropriate, to reduce future exposures (CBR, 2010).

The applicant plans to conduct radon daughter airborne sampling locations shown in Figure 5.7-2 of the TR (Cameco, 2013). The radon daughter airborne samples are collected monthly at each location (CBR, 2010). The applicant indicated that if the results are greater than 0.08 Working Levels (WL), which represents 25 percent of the DAC, then the monitoring frequency would increase to weekly until the levels are below the action level for four consecutive weeks (CBR, 2010).

Staff finds that the applicant's proposed action limits for airborne natural uranium and radon daughter concentrations at the NTEA are consistent with the action limits in use at the currently operating facility (See Section 5.7.4.3.3 of NRC, 2012a). Staff previously found the action limits for airborne natural uranium and radon daughter concentrations at its currently operating facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed action limits for airborne natural uranium and radon daughter concentrations are relevant and effective for the NTEA. Staff finds nothing to invalidate previous findings on the applicant's action limits for airborne natural uranium and radon daughter concentrations. Therefore, the original findings stand and previous staff conclusions on the applicant's action limits for airborne natural uranium and radon daughter concentrations remain valid. In addition, staff has not found any unreviewed safety-related concerns pertinent to the applicant's action limits for airborne natural uranium and radon daughter concentrations at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of its action limits for airborne natural uranium and radon daughter concentrations.

5.7.4.3.5 Records and Reporting

The applicant described its records management program in Section 5.2 of its TR (CBR, 2010). The applicant is currently required by license condition to document at its operating facility sampling, analyses and surveys, and monitoring and to maintain this documentation for at least five years (refer to license condition 11.6 of NRC, 2012b). This license condition will not change except for the requirement to maintain these records until license termination unless otherwise specified in another license condition or NRC regulation (refer to License Condition 9.10 in Appendix A of NRC, 2012a). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

As indicated in Section 5.1 of the application, the Vice President of Operations and SHEQ Director will be responsible for compliance with all regulatory reporting requirements at the NTEA (CBR, 2010).

Staff finds that the applicant's proposed records and reporting program for in-plant airborne radiation exposure monitoring at the NTEA is consistent with the records and reporting program in use at its currently operating facility (See Section 5.7.4.3.4 of NRC, 2012a). Staff previously found the applicant's records and reporting program for in-plant airborne radiation exposure monitoring at its currently operating facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed records and reporting program for in-plant airborne radiation exposure monitoring is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's records and reporting program for in-plant airborne radiation exposure monitoring. Therefore, the original findings stand and

previous staff conclusions on the applicant's records and reporting program for in-plant airborne radiation exposure monitoring remain valid. In addition, staff has not found any unreviewed safety-related concerns pertinent to the applicant's records and reporting program for in-plant airborne radiation exposure monitoring at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of its records and reporting program for in-plant airborne radiation exposure monitoring.

5.7.4.3.6 Respiratory Protection

The applicant stated that the respirator program is designed to implement the guidance contained in Regulatory Guide 8.15 (NRC 1999) and Regulatory Guide 8.31 (NRC 2002b) (CBR, 2010). In Section 5.7.3.1 of the TR, the applicant stated that precipitation, drying, and packaging operations will not be performed at the NTEA (CBR 2010) (refer also to SER Section 1.0). Therefore, the applicant indicated that typical operations at the NTEA are not expected to exceed action levels and thus, it is not expected that respirator use will be required for such "normal" operation of the satellite facility. However, the applicant indicated that anytime that the potential exists for elevated exposures to employees, respirators would be required. These conditions could be certain maintenance activities such as tank entry, disassembly of potentially contaminated piping and equipment, welding/grinding on contaminated piping/equipment, or the failure of the process building ventilation system. According to the applicant, these conditions could necessitate the use of respiratory protection.

Staff finds the applicant's proposed respiratory protection program consistent with the respiratory protection program in use at its currently operating facility (See Section 5.7.4 of NRC, 2012a). Staff previously found the applicant's respiratory protection program at the currently operating facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed respiratory protection program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's respiratory protection program. Therefore, the original findings stand and previous staff conclusions on the applicant's respiratory protection program remain valid. In addition, staff has not identified any safety-related concerns pertinent to the respiratory protection program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion on the respiratory protection program.

5.7.4.4 Evaluation Findings

NRC staff reviewed the in-plant airborne radiation monitoring program of the NTEA facility in accordance with NUREG-1569 (NRC, 2003). The applicant plans to conduct in-plant airborne monitoring consistent with Subpart B, "Radiation Protection Programs," of 10 CFR 20, which defines the radiation protection program. This program includes monitoring for the two primary contaminants and the instruments that it will use to collect and analyze the results of the air samples. The applicant has demonstrated that the proposed methods will be used to fully evaluate the in plant airborne radiation monitoring. The applicant has identified methods that will meet the occupational dose limit requirements of Subpart C of 10 CFR 20. If the applicant identifies that a "mixture" exists which does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC.

Based upon the review conducted by NRC staff as indicated above, the information provided in the application as supplemented by information submitted in accordance with the noted license conditions, meet the requirements of 10 CFR Part 20, Subparts B and C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.4.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

Cameco, 2013. E-mail from J. Schmuck, Cameco Resources, Cameco Corporation, to R. Burrows, U.S. NRC, North Trend replacement Figure 5.7-2, April 18, 2013, ADAMS Accession No. ML13116A128.

CBR, 2010 Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No. ML103010530 (Package).

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2012b. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

NRC, 2002a. Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, Revision 1, May.

NRC 2002b Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will be As Low As Reasonable Achievable", Revision 1, May 2002

NRC, 1999. Regulatory Guide 8.15, Acceptable Programs for Respiratory Protection, Revision 1, October.

NRC, 1992. Regulatory Guide 8.25, "Air Sampling in the Workplace,". Revision 1, June.

5.7.5 Exposure Calculations

This section discusses the exposure calculations to be performed by the applicant. Workers may be exposed to radioactive material in the air or loose surface contamination within the restricted area that may result in an intake of radioactive material into the body. In addition to exposure calculations, this section also addresses exposure calculations for female workers who declare pregnancy and the calculation of dose to the embryo/fetus.

5.7.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed exposure calculations for the proposed NTEA facility meet the requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include: 10 CFR 20.1201(e), 10 CFR 20.1204(f), 10 CFR 20.1204(g), and 10 CFR 20.1502.

5.7.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in Section 5.7.4.3 of NUREG-1569 (NRC, 2003).

5.7.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated.

Occupational workers may be exposed externally and internally to radioactive material in a number of ways. This may include radioactive material in the air, loose surface contamination, or radioactive material that may be stored or processed inside equipment or components. In addition to exposure calculations applicable to the all occupational workers, this section also specifically addresses exposure calculations for female workers who declare pregnancy and the associated calculation of radiation dose to the embryo/fetus. The following sections discuss the exposure calculations, which include internal and external occupational radiation dose as well as radiation doses to the embryo/fetus.

5.7.5.3.1 Exposure Calculations

The applicant stated that its exposure calculations based upon the intake and exposure calculation methods described in NRC Regulatory Guide 8.30 (NRC, 2002) for natural uranium and radon daughters (CBR, 2010). The Derived Airborne Concentration (DAC) for radionuclides is discussed in Section 5.7.4 of this SER. The applicant calculates the intakes for these radionuclides using the following equations:

Natural Uranium

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

where:

I_u = Uranium intake, ug or uCi
t_i = Time the worker is exposed to concentrations X_i in hours
X_i = Average concentration of uranium in breathing zone, ug/m^3, uCi/m^3, with "i" representing the number of sampling events for uranium

b = Breathing rate (1.2 m^3 per hour)
PF = Respirator protection factor, if applicable
n = Number of exposure periods during the week or quarter

Radon Daughters

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

where:

I_r = Radon daughter intake in working level months (WLM)
t_i = Time that the worker is exposed to the concentrations, W_i, in hours
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 = Respirator protection factor, if applicable
n = Number of exposure periods during the year

Routine worker exposures to both natural uranium and radon daughters will be based on actual hours worked for. This is considered to be 100 percent occupancy. For exposures during non-routine work, exposures are based on actual time. (CBR, 2010)

The applicant has stated that it will use the appropriate equations in Regulatory Guide 8.30 (NRC 2002) to estimate occupational worker internal dose (CBR, 2010). For example, the committed effective dose equivalent can be calculated from the equation below:

Natural Uranium and Radon Daughters

$H_{ie} = I_i/ALI_{ie} \times 5$ (rem)

where:

H_{ie} = The Committed Effective Dose Equivalent (CEDE) from radionuclide i, in rem.
I_i = The intake of radionuclide, I_i, by inhalation during the calendar year for uranium and I_i represents the Working Level Months (WLM) of Radon-222 and its associated progeny.
ALI_{ie} = The annual limit of intake. Value of the stochastic inhalation ALI for

Natural uranium or radon daughters as defined in 10 CFR Part 20 Appendix B, Table 1.

5 = Committed effective dose equivalent from intake of one ALI (expressed in rem) (CBR, 2010).

The staff finds the proposed exposure calculation program at the NTEA consistent with the exposure calculation program currently in use at the operating main facility (See Section 5.7.5 of NRC, 2012a). Staff previously found the applicant's exposure calculations at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed exposure calculation program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings regarding the applicant's exposure calculation program. Therefore, the original findings stand and previous staff conclusions on the exposure calculation program remain valid. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the exposure calculation program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003) staff is not re-examining the applicant's discussion of the exposure calculation program.

5.7.5.3.2 Prenatal and Fetal Dose

The applicant described its program for monitoring the exposure of a declared pregnant woman (refer to section 5.7.4.3 of CBR, 2010). The applicant explained that dosimeters for declared pregnant women are exchanged monthly until the end of gestation. If personal monitoring was not performed prior to notification of the pregnancy, the applicant will estimate the exposure using available information, such as surveys and area monitoring results. The applicant indicated that the exposure calculations for the embryo/fetus will be performed in accordance with NRC Regulatory Guide 8.36 (NRC, 1992). (CBR, 2010)

The staff finds that the applicant's exposure calculation program for prenatal and fetal dose is consistent with that currently used at its operating main facility (see section 5.7.5 of NRC, 2012a). Staff previously found the applicant's exposure calculation program for prenatal and fetal dose at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's exposure calculation program for prenatal and fetal dose is relevant and effective for the NTEA. Staff finds nothing to invalidate previous findings regarding the exposure calculation program for prenatal and fetal dose. Therefore, the original findings stand and previous staff conclusions on the exposure calculation program for prenatal and fetal dose remain valid. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the prenatal and fetal dose calculation program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the exposure calculation program for prenatal and fetal dose.

5.7.5.3.3 Records and Reporting

The applicant described its records management program in Section 5.2 of its TR (CBR, 2010). The applicant is currently required by license condition at its currently operating facility to document sampling, analyses and surveys or monitoring, and to maintain this documentation for at least five years (refer to license condition 11.6 of NRC, 2012b). This license condition will not change, with the exception that the applicant will be required to maintain these records until

license termination unless otherwise specified in another license condition or NRC regulation (refer to License Condition 9.10 in Appendix A of NRC, 2012a). As indicated in Section 5.1 of the application, the Vice President of Operations and SHEQ Director are responsible for compliance with all regulatory reporting requirements (CBR, 2010).

The staff finds that the applicant's proposed records and reporting program for exposure calculations at the NTEA is consistent with the records and reporting program in use at its main facility (See Section 5.7.5.3.3 of NRC, 2012a). Staff previously found the applicant's records and reporting program for exposure calculations at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed records and reporting program for exposure calculations is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's records and reporting program for exposure calculations. Therefore, the original findings stand and previous staff conclusions on the applicant's records and reporting program for exposure calculations remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's records and reporting program for exposure calculations at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its records and reporting program for exposure calculations.

5.7.5.4 Evaluation Findings

The staff reviewed the exposure calculations for the proposed NTEA facility in accordance with Appendix A of NUREG-1569 (NRC, 2003). The applicant has identified techniques for exposure calculations at the NTEA facility to determine intake of radioactive materials by personnel in work areas. Acceptable exposure calculations for natural uranium and airborne radon daughter exposure are provided in the application. NRC staff determined that the exposure calculation program meets the requirements of 10 CFR 20, Subpart C, F,L, and M.

5.7.5.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

CBR, 2010.Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Radioactive Source Material License No. SUA-1534, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession No. ML103010530 (Package)

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

NRC, 2012a, Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2012b. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 2002. Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, Revision 1, May.

NRC, 1992. Regulatory Guide 8.36, Radiation Dose to the Embryo/Fetus, Washington, DC: July.

5.7.6 Bioassay Program

This section discusses the applicant's proposed bioassay program. The bioassay program monitors and documents potential internal uptakes and radiation exposures, and confirms the results of the airborne uranium particulate monitoring program.

5.7.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its bioassay program for the NTEA facility meets the requirements of Subparts C, L, and M of 10 CFR Part 20.

5.7.6.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria presented in Section 5.7.5.3 of the NUREG-1569 (NRC, 2003). NRC Regulatory Guides 8.9 (NRC,1993), 8.22 (NRC, 1988), 8.30 (NRC,2002), and 8.34 (NRC,1992) provide guidance on meeting the applicable regulations.

5.7.6.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated.

The applicant stated that it will conduct a urinalysis bioassay program as described in NRC Regulatory Guide 8.22, Bioassay at Uranium Mills (NRC 1988) to detect uranium intake in employees who are regularly exposed to uranium (see Section 5.7.5 of CBR, 2010). Regulatory Guide 8.22 identifies the working conditions under which bioassays should be performed, the types of bioassay, frequency, actions based on bioassay results, time of specimen collection and availability of results, prevention of specimen contamination, quality control, and use of respiratory protection. The applicant's proposed bioassay program consists of the following:

- Requires all new employees to submit a baseline urinalysis prior to the start of employment at the facility.
- During operations, urine sample are collected from workers on a quarterly basis.
- During operations, urine samples are collected monthly from workers who have the potential to be exposed to dried yellowcake, or more frequently as determined by the RSO.
- The action levels for urinalysis are based on Table 1 in Regulatory Guide 8.22.
- Upon termination, an exit bioassay is required from all employees (CBR, 2010).

The applicant proposed continuing to conduct quality control on bioassay samples (CBR, 2010). The applicant's quality assurance requirements are based upon Regulatory Guide 8.22 (NRC, 1988). Elements of the quality assurance program include blind and spiked samples. (CBR, 2010)

Staff finds applicant's proposed bioassay program at the NTEA consistent with the bioassay program used at its currently operating main facility (see Section 5.7.6 of NRC, 2012a). Staff previously found the applicant's bioassay program at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's bioassay program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's bioassay program. Therefore, the original findings stand and previous staff conclusions on the applicant's bioassay program remain valid. In addition, staff has not identified any safety-related concerns pertinent to the applicant's bioassay program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of the bioassay program.

5.7.6.3.1 Records and Reporting

The applicant described its records management program in Section 5.2 of its TR (CBR, 2010). The applicant is currently required by license condition to document sampling, analyses and surveys or monitoring and to maintain this documentation for at least five years (refer to license condition 11.6 of NRC, 2012b). This license condition will not change except for the requirement to maintain these records until license termination unless otherwise specified in another license condition or NRC regulation (refer to License Condition 9.10 in Appendix A of NRC, 2012a). As indicated in Section 5.1 of the application, the Vice President of Operations and SHEQ Director are responsible for compliance with all regulatory reporting requirements (CBR, 2010).

The staff finds that the applicant's proposed records and reporting program for its bioassay program at the NTEA is consistent with the records and reporting program in use at its currently operating main facility (See Section 5.7.6.4 of NRC, 2012a). Staff previously found the applicant's records and reporting program for the bioassay program at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed records and reporting program for its bioassay program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings regarding the applicant's records and reporting program for its bioassay program. Therefore, the original findings stand and previous staff conclusions on the applicant's records and reporting program for its bioassay program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's records and reporting program for its bioassay program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its records and reporting program for its bioassay program.

5.7.6.4 Evaluation Findings

NRC staff reviewed the bioassay program for the North Trend Satellite Area facility in accordance with 10 CFR 20, Regulatory Guide 8.22 (NRC 1988), and the acceptance criteria in Appendix A of NUREG-1569 (NRC, 2003). Based on the information in the NTEA application (CBR, 2007), as updated, and the detailed review of the proposed bioassay program at the NTEA satellite facility as noted above, NRC staff concludes that the bioassay program is acceptable and is in compliance with 10 CFR 20.1204, which provides requirements for determining internal exposure, and 10 CFR Part 20, Subpart L, which specifies record keeping requirements.

5.7.6.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

CBR, 2010 Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No ML103010530 (Package)

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

NRC, 2012a, Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2012b. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2002. Regulatory Guide 8.30, Revision 1, “Health Physics Surveys in Uranium Recovery Facilities,” May 2002.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 1993, Regulatory Guide 8.9, Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program, Revision 1, July 1993.

NRC, 1992. Regulatory Guide 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” July 1992.

NRC, 1988. Regulatory Guide 8.22, Bioassay at Uranium Mills,” Revision 1. Washington, DC: August.

5.7.7 Contamination Control Program

The following sections discuss and evaluate the applicant's proposed contamination control program. This program is designed to detect radiological contaminants that have escaped the boundary of process equipment. Contamination can take the form of loose surface contamination and may be found on structures, materials, or personnel. The purpose of the program is to ensure that contamination is identified, confined, and monitored in known areas and prevent movement of contamination to unrestricted areas.

5.7.7.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that its proposed contamination control program for the NTEA facility meets the requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.7.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria presented in Section 5.7.6.3 of NUREG 1569 (NRC, 2003). NRC Regulatory Guide 8.30 (NRC, 2002a) and Regulatory Guide 8.31 (NRC, 2002b) provide guidance on how compliance with the applicable regulations can be demonstrated.

5.7.7.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in its application (CBR, 2007) and as updated. The applicant has stated (CBR,2010) that it will continue with the same contamination control program that is currently in use. Staff has determined that, as such, the applicant is not proposing any changes to its contamination control program in use at its currently operating facility.

Natural uranium refers to processed uranium (*i.e.*, uranium which has been separated from its longer half-life decay products by extraction of the uranium from the naturally occurring ore state). In terms of release levels for uranium recovery facilities, natural uranium is, therefore, considered to be composed of U-238, U-235, U-234 and the short half-life daughters of U-238 (i.e., Th-234, Pa234 and Pa-234m) in secular equilibrium with the U-238. Since these short half-life daughters are beta-gamma emitters, separate beta-gamma release limits apply to them. Separate alpha release limits throughout the uranium recovery process will also apply to other isotopes if they are present, such as Ra-226 and Th-230.

Regulatory Guide 8.30 (NRC, 2002a) is the guidance used by the NRC staff to evaluate proposed alpha contamination control for personnel monitoring and releasing material for unrestricted use. The NRC staff is currently revising Regulatory Guide 8.30. When Regulatory Guide 8.30 (NRC, 2002a) is revised, a draft revision will be issued for public review and comment. If the alpha contamination control limits are revised in the update to Regulatory Guide 8.30, the standard license condition, discussed in Section 5.3.4 of this SER, as accepted by the applicant, will require the applicant to adopt the revised limits.

5.7.7.3.1 Area Contamination Survey

The applicant stated that surveys for surface contamination are conducted in the operating and clean areas of the facilities in accordance with guidance in NRC Regulatory Guide 8.30 (NRC, 2002a) (CBR, 2010). Surveys for alpha contamination in clean areas, such as lunch rooms, change rooms, and offices, are conducted weekly (CBR, 2010). Staff observes that during its review of the Crow Butte license renewal application, staff imposed a license condition to require the applicant to account for the different types of isotopic contamination that may be found at the site (refer to Section 5.7.7.3.1 and License Condition 11.10 in Appendix A of NRC, 2012a).

The applicant's proposed area contamination survey program at the NTEA is consistent with the area contamination survey program currently in use at its main facility (refer to Section 5.7.7.3.1 of NRC, 2012a). Staff previously found the applicant's area contamination survey program at its main facility to be acceptable (NRC, 2012). Based on the NTEA utilizing survey program, including the same license conditions, as the currently operating main facility, staff has reasonable assurance that the proposed area contamination survey program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings regarding the applicant's area contamination survey program. Therefore, the original findings stand and previous staff conclusions on the applicant's area contamination survey program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's area contamination survey program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its area contamination survey program.

5.7.7.3.2 Contamination Surveys of Skin and Personal Clothing

The applicant stated that all personnel leaving the restricted area are required to perform and document alpha contamination monitoring (see Section 5.7.6 of CBR, 2010). Personnel who come in contact with potentially contaminated solutions outside a restricted area, such as the wellfields, are required to monitor themselves prior to leaving the area (CBR, 2010). All contamination on skin and clothing is considered removable and the limit of 1000 dpm/100 cm^2 is applied. The applicant stated that quarterly unannounced spot checks of personnel are conducted to verify the effectiveness of the surveys for personnel contamination.(CBR, 2010). Staff observes that during its review of the Crow Butte license renewal application, staff imposed a license condition that requires the applicant to account for beta and gamma contamination on skin and personal clothing (refer to Section 5.7.7.3.2 and license condition 11.10 in Appendix A of NRC, 2012a).

Staff finds the applicant's proposed personnel contamination program at the NTEA consistent with the personnel contamination program used at its main facility, as modified by the license conditions implemented as part of that prior review (See Section 5.7.7.3.2 of NRC, 2012a). Staff previously found the applicant's personnel contamination program at its main facility, as modified by a new license condition, to be acceptable (NRC, 2012a). Based on the NTEA utilizing the same program, including the same license conditions, as the currently operating main facility, staff has reasonable assurance that the proposed personnel contamination program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's personnel contamination program. Therefore, the original findings

stand and previous staff conclusions on the applicant's personnel contamination program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's personnel contamination program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its personnel contamination program.

5.7.7.3.3 Contamination Surveys for Items Released from Restricted Areas

The applicant stated that the release limits for beta-gamma contamination are 0.2 mrad average and 1.0 mrad maximum at 10 cm consistent with the NRC-endorsed "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials" (CBR, 2010). NRC staff has determined that the release limits described by the applicant are not technically correct. The units identified by the applicant are absorbed dose (CBR, 2010). The units described in the "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials"(the Guidelines) (NRC, 1993), are identified as absorbed dose rate (*i.e.*, 0.2 mrad/hr and 1.0 mrad/hr). In addition, the applicant incorrectly stated the distance at which the absorbed dose rate should be evaluated. The correct distance is 1 cm, not 10 cm as stated by the applicant.

NRC-endorsed survey terms and distances are identified in the Guidelines (NRC, 1993). In addition, the Guidelines provide maximum surface contamination levels for beta-gamma emitters (NRC, 1993). Staff observes that the applicant is required to comply with the Guidelines in accordance with the terms of the current license (refer to license condition 9.6 of Appendix A of NRC, 2012a).

The applicant stated that personnel are allowed to conduct contamination surveys of small hand-carried items (CBR, 2010). For all other items, the applicant stated that the RSO, radiation safety staff, and properly trained employees can survey all items from the restricted area. The qualified person for conducting these surveys would be the Lead Operator or a Plant/Wellfield operator. The applicant stated that the Lead Operator and the Plant/Wellfield operator will receive operator training, general radiation safety training, and hands-on training for the survey instrument and procedures. (CBR, 2010)

During its review of the Crow Butte license renewal application, staff determined that the applicant's proposed use of personnel, other than the RSO and radiation safety staff, to release items from both unrestricted and restricted areas was not consistent with NRC Regulatory Guide 8.31 (NRC, 2002b) and Inspection and Enforcement Circular 81-07 (NRC, 1981). In addition, staff imposed a license condition to ensure that only individuals meeting the qualifications as either a HPT or RSO, as defined in Regulatory Guide 8.31, are allowed to release items from restricted areas or for unrestricted use (refer to Section 5.7.7.3.3 and License Condition 9.6 of NRC, 2012a). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

Based on the analysis above, staff finds the applicant's proposed release program for potentially contaminated items at the NTEA is consistent with the release program for potentially contaminated items used at its main facility (See Section 5.7.7.3.3 of NRC, 2012a). Staff previously found the applicant's release program for potentially contaminated items at its main facility to be acceptable (NRC, 2012a) with certain license conditions. Based on the NTEA utilizing the same license conditions as the main facility, staff has reasonable assurance that the proposed release program for potentially contaminated items is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's release program for potentially contaminated items. Therefore, the original findings stand and previous staff conclusions regarding the applicant's release program for potentially contaminated items remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's release program for potentially contaminated items at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its release program for potentially contaminated items.

5.7.7.3.4 Instrumentation for Contamination Surveys

The applicant identified the following equipment, or equivalent, for total surface activity:

- Ludlum Model 2241 Scaler with a Model 43-65 or Model 43-5 Alpha Scintillation Probe
- Ludlum Model 177 Ratemeter with a Model 43-65 or Model 43-5 Alpha Scintillation Probe
- Portable GM survey meter with a beta/gamma probe with an end window thickness not to exceed 7 mg/cm^2
- Ludlum Model 3 survey meter with a Ludlum 44-38 probe

The applicant stated that survey equipment will be calibrated annually or at the manufacturer's recommended frequency, whichever is more frequent and surface contamination instruments are checked daily when in use (CBR, 2010). Alpha survey meters for personnel monitoring are response checked before each use with other checks performed weekly (CBR, 2010). Staff observes that the applicant is required by license condition to follow the guidance in NRC Regulatory Guide 8.30 (NRC, 2002a) which contains guidance on the calibration of survey instruments. Regulatory Guide 8.30 (NRC, 2002a) recommends that all survey instruments be checked for constancy of operation with a radiation check source prior to each usage, which may be more frequent than daily. During its review of the Crow Butte license renewal application, staff imposed a license condition to require the applicant to provide the detection sensitivity of its instrumentation used for contamination surveys (refer to Section 5.7.7.3.4 and License Condition 11.10 of Appendix A in NRC, 2012a). This license condition will not change with this license amendment and will be applicable to operations at the NTEA.

The staff finds the applicant's proposed instrumentation for contamination surveys at the NTEA consistent with the instrumentation for contamination surveys used at its main facility (See Section 5.7.7.3.4 of NRC, 2012a). Staff previously found the applicant's instrumentation for contamination surveys at its main facility to be acceptable (NRC, 2012a). Based on the NTEA utilizing the same license conditions as the main facility, staff has reasonable assurance that the proposed instrumentation for contamination surveys are relevant and effective for the NTEA.

Staff has found nothing to invalidate previous findings on the applicant's instrumentation for contamination surveys. Therefore, the original findings stand and previous staff conclusions on the applicant's instrumentation for contamination surveys remain valid. In addition, staff has not found any unreviewed safety-related concerns pertinent to the applicant's instrumentation for contamination surveys at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's instrumentation for contamination surveys.

5.7.7.3.5 Records and Reporting

The applicant described its records management program in Section 5.2 of its TR (CBR, 2010). The applicant is currently required by license condition to document sampling, analyses and surveys or monitoring and to maintain this documentation for at least five years (refer to license condition 11.6 of NRC, 2012b). This license condition will not change except for the requirement to maintain these records until license termination unless otherwise specified in another license condition or NRC regulation (refer to License Condition 9.10 in Appendix A of NRC, 2012a). As indicated in Section 5.1 of the application, the Vice President of Operations and SHEQ Director are responsible for compliance with all regulatory reporting requirements (CBR, 2010).

The staff finds that the applicant's proposed records and reporting program for its instrumentation for contamination surveys at the NTEA is consistent with the records and reporting program in use at its main facility (See Section 5.7.7.3.5 of NRC, 2012a). Staff previously found the applicant's records and reporting program for the instrumentation for contamination surveys at its main facility to be acceptable (NRC, 2012a) with certain license conditions. Therefore, staff has reasonable assurance that the applicant's proposed records and reporting program for its instrumentation for contamination surveys is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings on the applicant's records and reporting program for its instrumentation for contamination surveys. Therefore, the original findings stand and previous staff conclusions regarding the applicant's records and reporting program for its instrumentation for contamination surveys remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's records and reporting program for its instrumentation for contamination surveys at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its records and reporting program for its instrumentation for contamination surveys.

5.7.7.4 Evaluation Findings

The staff reviewed the contamination control program for the proposed North Trend Project in accordance with Appendix A of NUREG-1569 (NRC, 2003). The applicant has identified controls for preventing contamination from leaving a restricted area using appropriate survey equipment and instrumentation. Contamination surveys will be conducted in clean areas and personnel and equipment exiting the restricted area will be monitored. Furthermore, the range and calibration of monitoring equipment will protect the health and safety of employees during the full scope of facility operations.

Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented by information submitted in accordance with the noted license conditions, NRC staff concludes that the applicant meets the requirements of Subparts B,C, and F of 10 CFR Part 20.

5.7.7.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, “Standards for Protection Against Radiation.”

CBR, 2010 Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No ML103010530 (Package)

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2012b. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 2002a. Regulatory Guide 8.30, Health Physics Surveys in Uranium Recovery Facilities, Revision 1, May.

NRC 2002b Regulatory Guide 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will be As Low As Reasonable Achievable”, Revision 1, May 2002

NRC, 1993. “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,” U.S. Nuclear Regulatory Commission, April 1993, ADAMS Accession NO. ML003745526.

NRC, 1981, “IE Circular No. 81-07: Control of Radioactively Contaminated Material,” U.S. Nuclear Regulatory Commission, May 14, 1981, ADAMS Accession No. ML082490470.

5.7.8 Airborne Effluent and Environmental Monitoring Program

The following sections discuss and evaluate the applicant's proposed airborne effluent and environmental monitoring program. This program includes radiation monitoring outside of the plant area during operations and environmental monitoring around the facility.

5.7.8.1 Regulatory Requirements

The staff will determine if the applicant has demonstrated that the proposed airborne effluent and environmental monitoring program for the NTEA meets the requirements of 10 CFR 20.1003, 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 20.1101(d), 10 CFR 20.1501 10 CFR 40.65, and Criteria 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.8.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria presented in Section 5.7.7.3 of NUREG-1569 (NRC, 2003). Regulatory Guide 4.14 (NRC, 1980) provides guidance on how compliance with the applicable regulations can be demonstrated.

5.7.8.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007) and as updated. This section discusses the applicant's proposed airborne effluent and environmental monitoring program. This section focuses on radiation monitoring outside of the plant area during operations. The applicant is required to demonstrate how it will comply with 10 CFR 40, Appendix A, Criterion 7 which states, "Throughout the construction and operating phases of the mill, an operational monitoring program must be conducted to measure or evaluate compliance with applicable standards and regulations; to evaluate performance of control systems and procedures; to evaluate environmental impacts of operation; and to detect potential long-term effects".

The applicant is also required to demonstrate compliance with 10 CFR 40.65. Specifically, it must report "…the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents…." In addition, the applicant is required to demonstrate compliance with 10 CFR 20 Subpart B, 10 CFR 20 Subpart D, 10 CFR 20 Subpart F, 10 CFR 20, Subpart L, and 10 CFR 40 Appendix A, Criterion 8.

5.7.8.3.1 Airborne Effluent Monitoring

There are several sources of airborne radiological effluents associated with in situ recovery operations. Generally, these sources can be classified as point sources and fugitive, or diffuse, sources. Point sources include those operations which have their exhaust confined in a stack, duct, pipe, etc., prior to atmospheric release. Point sources can include yellowcake vacuum dryer vents and process tank vents. Fugitive sources are not confined prior to being released to the atmosphere. Fugitive sources can include, among other things, pump seals, losses from

container loading not captured in ventilation systems, airborne contamination from dried spills, and pressure relief devices. Fugitive sources include radon emanating from the wellfield.

Aside from the reporting requirements in 10 CFR 40.65 discussed above, an applicant must provide details on how they will perform surveys sufficient to demonstrate compliance with 10 CFR 20.1302. 10 CFR 20.1302 addresses compliance with dose limits for individual members of the public. An applicant must also demonstrate compliance with 10 CFR 20.1501 which, in summary, requires surveys that are reasonable under the circumstances to evaluate concentrations or quantities of radioactive materials and the potential radiological hazards.

In demonstrating compliance with 10 CFR 1302(a), applicants must demonstrate that they will either calculate or measure effluent quantities or concentrations released to unrestricted and controlled areas as specified in the requirement. For point sources (*e.g.*, a defined stack or pipe), the release point will generally be the effluent discharge point (*i.e.*, where the uncontrolled effluent is released to the air). If the effluent is discharged to a restricted area, the applicant may propose measuring or calculating the effluent quantities or concentrations at the effluent discharge point (and use this undiluted value, or may use appropriate modeling to estimate the concentrations to which people are exposed) or at the unrestricted/controlled area boundary. For dose calculations, the applicant may also propose taking direct measurements at the unrestricted area boundary.

Although calculations are allowed in meeting the requirements of 10 CFR 20.1302 and 10 CFR 40.65, the NRC staff expects the applicant to propose monitoring to such an extent as to be able to confirm its operating basis (*e.g.*, no discharge from vacuum dryers) and the validity of calculations used for estimating effluent concentrations and calculating dose. This concept applies to point sources, as well as fugitive sources, such as radon released in the wellfield. Regulatory Guide 8.37 (NRC, 1993) provides additional guidance on airborne radioactive effluent monitoring.

As discussed in Sections 1.6 and 3.1.4 of the TR, the applicant will not be drying and packaging yellowcake material at the NTEA (CBR, 2010). Uranium will be loaded onto ion exchange resin and transported offsite to the currently licensed Crow Butte facility. Therefore, during normal operations, the major radioactive effluent for NTEA operations would be radon (CBR, 2010).

The applicant did not propose conducting any radon (or radon daughter) effluent monitoring (CBR, 2010). In Sections 4.1 and 5.7.7 of the TR, the applicant describes the sources of radon effluent (CBR, 2010). These sources originate from two places: inside the plant and out in the wellfield. In the plant, the applicant is proposing to use pressurized downflow vessels in the ion exchange circuit (CBR, 2010). Nonpressurized process tanks and vessels such as resin transfer and wastewater tanks will be vented to the atmosphere outside the building via a stack by forced air ventilation (CBR, 2010). According to the applicant, areas with the potential for radon exposure include: solution sampling and spills, filter changes, ion exchange resin transfer, and reverse osmosis system operation during ground water restoration, and maintenance activities (CBR, 2010). In addition to tank-specific ventilation, a general area ventilation system will displace air in the plant by blowing it outside (CBR, 2010). Refer to SER Section 4.1 for a more detailed discussion on plant ventilation.

Outside the plant, radon will be released occasionally from the mine unit wells as gas is vented from the injection wells, which are generally closed and pressurized. (CBR, 2010). Production wells will be continually vented, but venting should be minimal (for calculational purpose. It is assumed that 25 percent of the radon in the production fluid is released in the wellfield) and some venting will also occur at the wellhouses (CBR, 2010).

The applicant stated that monitoring of radon gas releases from the satellite facility building and discharge points is not practicable (CBR, 2010). The applicant also stated that because of the nature of the pressurized downflow ion exchange columns, radon gas is not routinely released except during resin transfer and column backwashing (CBR, 2010). Therefore, the resulting stack emission of radon would not be expected to have a consistent flow rate (CBR, 2010). NRC staff evaluated the applicant's rationale for not monitoring radon (or radon daughter) effluent and does not agree with the applicant's argument for not conducting any type of monitoring to confirm its licensing basis as modeled by MILDOS (for a general discussion of this software, see Appendix D of NRC, 2003). Staff observes that the applicant has not presented any data on technologies evaluated to make a complete determination on practicality of radon monitoring. In addition, Regulatory Guide 8.37 (NRC 1993) recommends that unmonitored effluents should not exceed 30 percent of the total estimated effluent releases. During its review of the Crow Butte license renewal application, staff imposed a standard license condition to obtain more relevant data to assess occupational and public dose throughout the license area and to verify compliance with 10 CFR 40.65 reporting requirements (refer to Section 5.7.8.3.1 and License Condition 11.11 of NRC, 2012).

Staff finds the applicant's proposed airborne effluent monitoring program at the NTEA consistent with the airborne effluent monitoring program used at its main facility (see Section 5.7.8.3.1 of NRC, 2012). Staff previously found the airborne effluent monitoring program at its main facility to be acceptable (NRC, 2012) with certain license conditions. Based on the NTEA utilizing the same license conditions as the main facility, staff has reasonable assurance that the proposed airborne effluent monitoring program is relevant and effective for the NTEA. Staff has found nothing to invalidate previous findings regarding the applicant's airborne effluent monitoring program. Therefore, the original findings stand and previous staff conclusions on the applicant's airborne effluent monitoring program remain valid. In addition, staff has not found any un-reviewed safety-related concerns pertinent to the applicant's airborne effluent monitoring program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's airborne effluent monitoring program.

5.7.8.3.2 Environmental Monitoring

5.7.8.3.2.1 Air Particulate Sampling

Regulatory Guide 4.14, Table 2 (NRC 1980), suggests that air particulate sampling locations should be at or near the site boundaries and in different sectors that have the highest predicted concentrations of airborne particulates, as well as one at the nearest residence or occupiable structure(s), and one control location, which should be in the least prevalent wind direction from the site. The air particulate sampling should be continuous with weekly filter changes and quarterly composite by location for natural uranium, Ra-226, Th-230, and Pb-210 analysis. The following factors should be considered in determining the sampling locations: (1) average meteorological conditions (*i.e.*, wind speed, wind direction, atmospheric stability), (2) prevailing

wind direction, (3) site boundaries nearest to mill, (4) direction of nearest occupiable structure, and (5) location of estimated maximum concentrations of radioactive materials.

The applicant stated that as a "wet facility" negligible particulate emissions are expected at the NTEA and, based on upon experience at the central processing facility and the MILDOS Area simulation, air particulate monitoring is not contemplated as part of the airborne effluent and environmental monitoring program for NTEA operations (CBR, 2010). In addition, the applicant stated that this conclusion is further supported by the current license which only requires particulate monitoring when the yellowcake dryer is in operation (CBR, 2010).

NRC staff agrees that the operations at NTEA are generally "wet". However, NRC staff also recognizes that spills, leaks, and maintenance activities occur in the plant and the radioactive material (*i.e.*, uranium and uranium daughter products, and radon and radon daughter products) released from these activities have the potential to escape the system and become airborne in the plant. NRC staff is concerned with the potential air particulate released in the plant escaping into unrestricted areas.

NRC staff disagrees with the applicant's explanation for not conducting any environmental air particulate monitoring during operations. The environmental monitoring program, as described in Regulatory Guide 4.14 (NRC, 1980), is needed by NRC staff for the following purposes:

- To estimate maximum potential annual radiation doses to the public resulting from effluent releases
- To ascertain whether the regulatory requirements of the NRC (including 10 CFR Part 20 dose limits, release limits, and the "as low as is reasonably achievable" requirement) facility license conditions, and the requirements of 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," have been met
- To evaluate the performance of effluent controls
- To evaluate the environmental impact of operations, both during operations and after decommissioning

As described in SER Section 5.7.8.3.1, staff found the applicant's airborne effluent and environmental monitoring program for the currently licensed Crow Butte facility was not sufficient to demonstrate compliance for determining occupational and public dose obtained throughout the entire license area or to verify compliance with 10 CFR 40.65 reporting requirements. Therefore, staff imposed a standard license condition to address this deficiency (refer to Section 5.7.8.3.1 and License Condition 11.11 of NRC, 2012). This license condition applies to all facilities within the scope of the applicant's license, including operations at the NTEA.

As a result, staff has determined that the applicant's lack of an operational air particulate sampling program is not consistent with acceptance criteria 5.7.7.3(1) and 5.7.7.3(2) of NUREG-1569 (NRC, 2003). While staff acknowledges that the applicant may propose an alternative monitoring plan that is not necessarily consistent with Regulatory Guide 4.14 (with sufficient justification) (refer to Paragraph A of NRC, 1980), staff is imposing a preoperational

license condition to address this inconsistency. This license condition is presented in Section 5.7.8.4 of this SER.

5.7.8.3.2.2 Radon Gas Sampling

Regulatory Guide 4.14 (NRC 1980) suggests that radon sampling during operations be conducted at the same locations as air particulate locations and the locations should be the same as those for preoperational air samples.

The applicant stated that environmental radon samples will be taken at the same locations that were used for preoperational radon concentrations. The applicant identified these locations in Figure 5.7-3 of the TR (CBR, 2010). Staff observes that the monitoring station numbers depicted in this figure do not match the monitoring station numbers stated in the text of the TR (refer to Section 5.7.7 of CBR, 2010). In any case, during its review of the preoperational air sampling program, staff found insufficient justification and clarity for the placement of air monitoring stations AM-22, AM-23, AM-24, and AM-25 and imposed a license condition to require the applicant to demonstrate that the air sampling stations are located consistent with Acceptance Criteria 2.9.3(1) of NUREG-1569 (NRC, 2003) (refer to SER Section 2.6.3.1). Accordingly, staff has determined that the operational radon sampling program is not consistent with acceptance criteria 5.7.7.3(1) of NUREG-1569 (NRC, 2003). Therefore, staff is imposing a license condition to obtain sufficient justification and clarity for the placement of operational air monitoring stations AM-22, AM-23, AM-24, and AM-25. This license condition is presented in Section 5.7.8.4 of this SER.

The applicant stated that monitoring will be performed using Track-Etch radon cups on a semiannual basis in order to achieve the required lower limit of detection of 2×10^{-10} uCi/ml (CBR, 2010). NRC staff observes that the applicant will collect radon air samples at a frequency that is longer than what is suggested in Regulatory Guide 4.14 (NRC 1980). As described in its review of the Crow Butte license renewal, staff previously evaluated this exchange rate and found it acceptable (Refer to Section 5.7.8.3.1 of NRC, 2012). Staff has found nothing to invalidate previous findings. Therefore, the original findings stand and previous staff conclusions on the exchange rate remain valid.

5.7.8.3.2.3 Soil Sampling

Regulatory Guide 4.14 (NRC, 1980) suggests that soil sampling be conducted annually in five or more locations that are the same as for air particulate sampling and analyzing for natural uranium, Ra-226, and Pb-210.

Instead, the applicant proposed that surface soil samples would be taken at the monitoring locations AM-9 through AM-14 and at the plant location following conclusion of operations and will be compared to the results of the preoperational monitoring program (CBR, 2010). The applicant also stated in a response to a Request for Additional Information (RAI) that the absence of “dry” activities at the NTEA satellite facility combined with the CBR commitment to remove field spill soil above 10 CFR Part 40, Appendix A, release criteria obviates any need for operational environmental soil sampling (refer to RAI response #3 on page 11 of 16 of CBR, 2010).
NRC staff does not agree with the applicant’s rationale for not collecting any operational soil sampling. Staff acknowledges that the applicant may propose an alternative monitoring plan

that is not necessarily consistent with Regulatory Guide 4.14 (with sufficient justification) (refer to Paragraph A of NRC, 1980). However, during its review of the Crow Butte license renewal application, staff determined that without reviewing soil samples taken throughout the operating phase of the applicant's facility, staff does not have the ability to confirm the applicant's ability to comprehensively evaluate environmental impacts or detect potential long-term effects of its operations as required by 10 CFR Part 40, Appendix A, Criterion 7 (refer to Section 5.7.8.3.3 of NRC, 2012).

In addition, during its review of the applicant's gamma action level for surface soil cleanup verification at the NTEA, staff imposed a license condition to require the applicant to provide justification for the proposed gamma action level (refer to SER Section 6.4.3.2). Without sufficient justification for the use of the gamma action level for surface soil cleanup, staff does not have adequate assurance that spills will be properly evaluated. Staff also observes that, as stated in SER Section 5.7.8.3.2.2, the monitoring station numbers depicted in Figure 5.7-3 of the TR (*i.e.*, AM-22 through AM-26) do not match the monitoring station numbers stated in the text of the TR (*i.e.*, AM-9 through AM-14) (refer to Section 5.7.7 of CBR, 2010).

For the reasons stated above, staff is imposing a license condition to require the applicant to provide an operational soil sampling program. This license condition is presented in SER Section 5.7.8.4.

5.7.8.3.2.4 Sediment Sampling

Regulatory Guide 4.14 (NRC 1980) suggests that sediment sampling be conducted as an annual grab sample from each water body identified for surface water sampling and analyzed for natural uranium, Th-230, Ra-226, and Pb-210.

The applicant stated that sediment samples will be collected at the sample locations that have been established for surface water sampling as shown in Figure 2.9-5 of the TR (CBR, 2010). The applicant indicated that the samples will be collected at the frequency described in the applicant's preoperational monitoring plan (refer to Section 2.9.9.2 of CBR, 2010) and analyzed for natural uranium, Ra-226, and Pb-210.

During its review of the preoperational sediment sampling plan, staff identified a license condition regarding the number of sediment sampling locations (refer to SER Section 2.6.3.6). For the preoperational monitoring program, the applicant identified 4 sediment sampling locations for the White River in the application text (refer to Section 2.9.9.2 of CBR, 2010), but only identified 2 sediment sampling locations for the White River in Figure 2.9-5 of the TR (CBR, 2010). In addition, staff determined that the applicant identified sediment (and surface water) sampling location W-2 that is not in a location consistent with Regulatory Guide 4.14 (NRC, 1980) (refer to SER Section 2.6.3.6). The noted license condition requires the applicant to provide further justification for sediment (and surface water) sampling location W-2 or relocate sediment (and surface water) sampling location W-2 to a location consistent with Regulatory Guide 4.14 (NRC, 1980), and identify the location in Figure 2.9-5 for the other two sediment samples.

The applicant proposed not monitoring for Th-230 (CBR, 2010). Staff observes that this approach is not consistent with Acceptance Criterion 5.7.7.3(1) of NUREG-1569 (NRC, 2003).

As part of its rationale for this approach, the applicant stated in its response to staff's RAI that there does not appear to be a fate and transport mechanism that would lead to deposition in the White River (refer to RAI response # 4 on page 12 of 16 of CBR, 2010). This statement is based on the applicant's interpretation of statements regarding thorium on page 5-39 of NUREG-1569 (NRC, 2003). Staff observes that the applicant's interpretation of the thorium discussion in NUREG-1569 (which is also discussed on page 2-24) (NRC, 2003) is not technically correct. The text referred to by the applicant discusses baseline water quality as it relates to restoration. During operations, however, NUREG-1569 (NRC, 2003) clearly states that, based on studies, Th-230 is mobilized by bicarbonate-laden leaching solutions. These are the same types of solutions (*i.e.*, lixiviant) used by the applicant (refer to SER Section 3.1.3.5.4 and Section 3.1.3.5.5 and License Condition 10.1 of Appendix A of NRC, 2012). Therefore, staff concludes that there is a need to monitor for Th-230 during operations.

For the reasons stated above, staff is imposing a license condition to require the applicant to provide an operational sediment sampling program that is consistent with Acceptance Criterion 5.7.7.3(1) of NUREG-1569 (NRC, 2003). This license condition is presented in SER Section 5.7.8.4.

5.7.8.3.2.5 Vegetation, Food and Fish Sampling

Where a significant pathway to man is identified, Regulatory Guide 4.14 (NRC 1980) suggests analyzing three of each type of crop, livestock, *etc.*, raised within 3 km of the mill site. Samples should be collected at the time of harvest or slaughter and analyzed for Ra-226 and Pb-210. Note (o) in Table 2 of Regulatory Guide 4.14 (NRC 1980) clarifies that an exposure pathway should be considered important if the predicted dose to an individual would exceed 5% of the applicable radiation protection standard. Individual members of the public are subject to the dose limits in 10 CFR 20.1301. For purposes of this analysis, the dose limit is 100 mrem/yr total effective dose equivalent (TEDE). Therefore, an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 mrem/yr TEDE.

In Section 2.2.2.2 of the TR (CBR, 2010) the applicant stated that the primary land use in the NTEA is cropland, primarily for the production of wheat with a small amount of land being used for the production of alfalfa. In addition, within the NTEA and the surrounding 2.25-mile review area, the applicant identified that raising livestock is the primary land use (CBR, 2010). Lastly, in Section 7.2.7.10 of the TR (CBR, 2010), the applicant identified portions of Spring Creek and the White River, both of which cross the proposed site boundary, as suitable habitats for fish.

The applicant indicated (CBR, 2010) that it will not perform operational sampling of vegetation at the NTEA based on the environmental sampling program at its main facility. Staff observes, however, that each site is evaluated on a case-by-case basis (NRC, 1980) and has determined that the applicant has not provided sufficient justification for not collecting operational vegetation samples consistent with acceptance criterion 5.7.7.3(1) of NUREG-1569 (NRC, 2003). For example, the applicant refers to the exception in Note (o) (see above) in Table 2 of Regulatory Guide 4.14 (NRC 1980) but does not provide a clear analysis that demonstrates that this exception applies to its operations at the NTEA.

The applicant stated that it will develop and implement a fish sampling program if the results of sediment and surface water sampling indicate upward trends in contaminant concentrations.

Staff acknowledges that the applicant may propose an alternative monitoring plan that is not necessarily consistent with Regulatory Guide 4.14 (with sufficient justification) (refer to Paragraph A of NRC, 1980). However, staff observes the applicant's proposed alternative lacks any specificity that it can evaluate. For example, the applicant does not provide specific statistical parameters that would indicate an upward trend in sediment and surface water sampling results. In addition, the applicant does not specify the details of the fish sampling plan if one was implemented based on the sediment and surface water sampling results. Lastly, the applicant provides no correlation between sediment and surface water contaminant concentrations and fish contaminant concentrations to allow staff to evaluate the technical adequacy of this proposal.

The applicant did not address sampling of food sources during operations (CBR, 2010). Staff observes that food to be evaluated for operational sampling include crops, livestock, *etc.*, raised within three kilometers of the mill site (NRC 1980).

Therefore, staff is imposing a license condition to require the applicant to provide staff with a vegetation, food, and fish sampling program that is consistent with Acceptance Criterion 5.7.7.3(1) of NUREG-1569 (NRC, 2003) or sufficient justification for an alternate program. This license condition is presented in SER Section 5.7.8.4.

5.7.8.3.2.6 Direct Radiation

Regulatory Guide 4.14 (NRC 1980) suggests five or more passive integrating radiation devices at the same locations as air particulate sampling. The passive integrating radiation devices should be changed out on a quarterly basis and measured for gamma exposure rate.

The applicant stated that environmental gamma radiation levels will be monitored continuously at the air monitoring stations AM-9 through AM-14. As staff observed in SER Sections 5.7.8.3.2.2 and 5.7.8.3.2.3, the monitoring station numbers depicted in Figure 5.7-3 of the TR (*i.e.*, AM-22 through AM-26) do not match the monitoring station numbers stated in the text of the TR (i.e., AM-9 through AM-14) (refer to Section 5.7.7 of CBR, 2010). In SER Section 5.7.8.3.2.2, staff imposed a license condition to obtain sufficient justification and clarity for the placement of operational air monitoring stations AM-22, AM-23, AM-24, and AM-25. Therefore, staff is imposing a license condition to require the applicant to provide staff with an operational direct radiation program that is consistent with Acceptance Criterion 5.7.7.3(1) of NUREG-1569 (NRC, 2003) or sufficient justification for an alternate program. This license condition is presented in Section 5.7.8.4 of this SER.

5.7.8.3.2.7 Ground water and Surface Water

The ground water and surface water environmental monitoring program is presented in Section 5.9 of this SER.

5.7.8.4 Evaluation Findings

The staff reviewed the airborne effluent and environmental monitoring program of the proposed NTEA ISR Project in accordance with Section 5.7.7.3 of NUREG-1569 (NRC, 2003).

Staff has determined that the applicant has not demonstrated that its proposed effluent and environmental monitoring radon and air particulate monitoring program for releases from the facility provide sufficient information for staff to determine regulatory compliance for effluent releases and public dose. Therefore, staff will utilize a standard license condition imposed during the review of the Crow Butte license renewal application (refer to Section 5.7.8.3.1 and License Condition 11.11 of NRC, 2012) to ensure that an adequate effluent and environmental monitoring program is in place consistent with Regulatory Guide 4.14 (NRC, 1980).

Staff has determined that the applicant has not adequately justified the air monitoring locations consistent with the sampling location criteria as identified in Regulatory Guide 4.14 (NRC, 1980). The location of the air monitoring stations also affects the sampling location for air radon, soil and direct radiation. Staff also determined that the surface water and sediment sampling locations are not consistent with the acceptance criteria 5.7.7.3(1) of NUREG-1569 (NRC, 2003). Finally, staff has determined that the applicant has not provided sufficient information for not collecting operational vegetation, food, or fish sampling consistent with acceptance criteria 5.7.3.3(1) of NUREG-1569 (NRC, 2003). Therefore, staff is imposing the following license condition. This license condition also includes staff's finding from SER Section 5.7.9.3.2 regarding surface water monitoring.

> At least 60 days prior to the preoperational inspection, the licensee shall submit an operational radiological environmental monitoring program for NRC review and written verification that will include air particulate, air radon, direct radiation, soils, vegetation, food, fish, sediments, and surface water as described in Regulatory Guide 4.14 to comply with 10 CFR Part 40, Appendix A, Criterion 7. The report shall include the location of each sampling media, frequency of sampling, and frequency and type of analysis in accordance with Regulatory Guide 4.14. Sediment samples shall be analyzed for Th-230 in accordance with Regulatory Guide 4.14.

Based upon the review conducted by the staff as discussed above, the information provided in the application (CBR, 2007), as supplemented by the information to be submitted in accordance with the noted license conditions, meets the applicable acceptance criteria of Section 5.7.7.3 of NUREG-1569 (NRC, 2003) and the requirements of 10 CFR Part 20 and 40.

5.7.8.5 References

10 CFR Part 20. Code of Federal Regulations, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010 Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, October 22, 2010, ADAMS Accession No ML103010530.

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML071760343 (Package)

NRC, 2012, Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December_28, 2012, ADAMS Accession No. ML103470470.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

NRC, 1998. Environmental Assessment for Renewal of Source Material License No. SUA-1534, Crow Butte Resources, Incorporated Crow Butte Uranium Project, Dawes County, Nebraska, February 1998, ADAMS Accession No. ML071520242.

NRC 1993. Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities”, July 1993.

NRC, 1980. Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills”, Revision 1, Washington, DC, April.

5.7.9 Ground water and Surface Water Monitoring Programs

5.7.9.1 Regulatory Requirements

In this section, the staff determines if the applicant has demonstrated that the ground water and surface water monitoring program for the proposed NTEA facility meets the requirements of 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), and 10 CFR Part 40, Appendix A, Criterion 5D.

5.7.9.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria for wellfield monitoring presented in Section 5.7.8.3 and for environmental monitoring in Section 5.7.7.3 of NUREG-1569 (NRC, 2003).

5.7.9.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and drawings submitted by Crow Butte Resources in its NTEA application (CBR, 2007) and, as updated.

The application described ground water and surface water monitoring programs to be implemented at the NTEA facility during operations. Preoperational monitoring, which was conducted as part of the site characterization or mine unit baseline data acquisition, is discussed in Chapter 2 of this SER. Restoration monitoring, which is conducted during ground water restoration of a mine unit, is discussed in Section 6.1 of this SER. The following sections address mine unit operational ground water monitoring, new mine unit hydrologic packages, and license area ground water and surface water environmental monitoring programs.

5.7.9.3.1 Mine Unit Operational Ground water Monitoring

The applicant indicated the operational monitoring program for all mine units will consist of excursion monitoring at designated wells in the surrounding perimeter monitoring well ring and in the overlying aquifer (CBR, 2010). The purpose for the perimeter monitoring well ring is to provide early detection of the movement of production fluids (horizontal excursion) from the mineralized zone (*i.e.*, Basal Chadron Sandstone) in the wellfield. The purpose for the monitoring wells in the overlying aquifer is the early detection of movement of production fluids (vertical excursion) from the mineralized zone. The applicant has designated the Brule Formation as the overlying aquifer. (CBR, 2010)

Consistent with its practice at the currently licensed Crow Butte facility, the applicant does not plan to install monitoring wells in the underlying aquifer at the NTEA due to the presence of a thick and effective confining layer (Pierre Shale) below the ore-bearing aquifer (CBR, 2010). Staff observes that the NTEA has the same stratigraphy as the nearby currently licensed Crow Butte facility (refer to SER Section 2.3). Staff previously found the applicant's inclusion of the overlying aquifer and ore aquifer perimeter operational monitoring, and the exclusion of underlying aquifer operational monitoring, at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's proposed operational ground water monitoring program is relevant and effective for the NTEA given the noted similarities in

stratigraphy between the facilities. Staff finds nothing to invalidate the previous findings on the exclusion of monitoring wells from the underlying aquifer and previous staff conclusions remain valid. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the proposed operational ground water monitoring program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's proposed operational ground water monitoring program.

In accordance with standard license condition 10.16 (NRC, 2010), the proposed operational monitoring program includes the installation of Basal Chadron perimeter monitoring wells spaced no further than 122 meters (400 feet) apart and no further than 91 meters (300 feet) from the well field boundary for early detection of potential horizontal excursions of lixiviant. As required by standard license condition 10.4 (NRC, 2010), the applicant will also install one monitoring well per every 0.4 hectares (5 ac) at the NTEA in the overlying Brule Formation for the detection of potential vertical excursions.

The applicant stated that well development, and ground water and surface water sampling activities will be performed in accordance with detailed instructions contained in the SHEQ MS, Volume VI, Environmental Manual (CBR, 2010). These instructions are used by the applicant at the currently licensed Crow Butte facility. During an inspection of the currently licensed Crow Butte facility, NRC staff reviewed a sample of the Standard Operating Procedures (SOPs) within this manual and found the SOPs to be acceptable for the proposed use at the NTEA (NRC, 2012b).

5.7.9.3.1.1 Baseline Monitoring and Hydrologic Testing

The discussion of the establishment of baseline ground water quality, which is required by license condition, is provided in SER Section 6.1.3.2. Generally, the license condition requires baseline water quality to be established in the ore zone, overlying aquifer and perimeter ring monitoring wells in a mine unit for all constituents listed in the license condition consistent with 10 CFR Part 40, Appendix A, Criterion 5B(5), and established in a statistically rigorous manner. Four samples will be collected at least 14 days apart from each well. The minimum sampling well density will be: one ore zone well per four acres, one upper aquifer monitoring well per five acres of mine unit area, and all perimeter monitoring wells.

Per license condition 10.4 (NRC, 2010), the upper control limits (UCLs) for the excursion monitoring program will be established by collecting four samples from each designated monitoring well at a minimum density of: 1) one upper aquifer monitoring well per 0.4 hectares (5 ac) of mine unit area, and 2) all perimeter monitoring wells. These samples will be collected at least 14 days apart. The samples will be analyzed for the indicator parameters: chloride, conductivity, and total alkalinity. Representative background concentrations will be established on a parameter-by-parameter basis using either the mine unit or well-specific mean value. The UCLs will be calculated for each indicator parameter, in each monitoring well, as equal to 20 percent above the maximum concentration measured for that parameter, among the three baseline samples. For those indicator parameters with baseline concentrations that average 50 mg/L or less, the UCL for that parameter may be calculated as equal to 20 percent above the maximum baseline concentration, the baseline average plus five standard deviations, or the baseline average plus 15 mg/L (NRC, 2010). Staff has determined that this standard license condition will not change with the NTEA license amendment.

The applicant indicated that pumping tests will also be performed for each wellfield to establish that the production and injection wells are hydraulically connected to the perimeter horizontal excursion monitor wells and are hydraulically isolated from the vertical excursion monitor wells to demonstrate hydraulic containment above the production zone, and to further evaluate the Basal Chadron hydrologic properties (refer to Section 3.1.3 of CBR, 2009). NRC staff found the wellfield test procedures to be consistent with the acceptance criteria in Section 5.7.8.3 of NUREG-1569 (NRC, 2003), and therefore acceptable.

In accordance with the standard license condition described in the CBR License Renewal SER, the applicant is required to submit all mine unit hydrologic test packages to the NRC for review (refer to Appendix A of NRC, 2012a). Staff observes that the procedures used in this standard license condition to establish Commission approved background concentrations will require the NRC to also provide written verification of all mine unit hydrologic test package submittals in accordance with 10 CFR Part 40, Appendix A, Criterion 5B(5)(a). Thus, staff is updating this standard license condition to add the words, “and written verification” to the end of the standard license condition. The updated standard license condition is provided in SER Section 5.7.9.4. This updated standard license condition will be applicable to all facilities under the Crow Butte Resources license including the NTEA.

Based on NTEA utilizing the same standard license condition provided in the CBR License Renewal SER with the added requirement for NRC verification, staff has reasonable assurance that the requirement for the applicant to submit all mine unit hydrologic test packages to the NRC for review and written verification is relevant and effective for the establishment of baseline ground water quality at the NTEA. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the establishment of baseline ground water quality at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the establishment of baseline ground water quality at the NTEA.

5.7.9.3.1.2 Ground water Excursion Monitoring and Corrective Action

The applicant stated that excursion monitoring will be conducted for chloride, conductivity, and total alkalinity (CBR, 2010). The applicant also stated that monitoring wells will be sampled for these excursion indicators on a biweekly basis during operations (CR, 2010). If two UCLs are exceeded in a well, or if a single UCL is exceeded by 20 percent, a confirming water sample will be taken within 48 hours after the results of the first analyses are received and the applicant will analyze the sample for the indicator parameters. If the second sample does not indicate an exceedance of the UCLs, a third sample will be taken and analyzed in a similar manner within 48 hours after the second set of samples was acquired. If neither the second nor the third sample indicates an exceedance of the UCLs, the first sample will be considered in error (refer to LC 11.2 in NRC, 2010). In accordance with the license condition described in CBR Renewal License SER Section 5.7.9 (NRC, 2012a), if the resampling verifies UCL exceedance, the well will be placed on excursion status and the NRC Project Manager will be contacted by e-mail or telephone within 24 hours and in writing within 7 days.

The applicant stated that upon verification of an excursion, it will take corrective actions appropriate to the specific circumstances and using the following approach (though not necessarily in this order) (CBR, 2010):

- Preliminary investigation of the probable cause;,
- Adjustments as needed to increase the recovery in the vicinity of the monitoring well and hydraulic gradient toward the production zone;, and
- Enhancement of recovery through extraction at individual wells.

The applicant stated that injection adjacent to the monitoring well may be suspended and the monitor well will be sampled weekly while on excursion status (CBR, 2010). In accordance with license condition 11.5 described in CBR Renewal License SER Appendix A (NRC, 2012a), a written report describing the excursion event, corrective actions taken, and the corrective action results will be submitted to the NRC within 60 days of the excursion confirmation.

In accordance with license condition 11.5 described in CBR Renewal License SER Appendix A (NRC, 2012a), if an excursion is not corrected within 60 days of confirmation, the applicant will either: (a) terminate injection of lixiviant within the production area until the excursion is corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The surety increase will remain in force until the NRC has verified that the excursion has been corrected and cleaned up. For all wells that remain on excursion after 60 days, the licensee will provide further status updates in quarterly reports required by license condition.

In accordance with its current license (refer to LC 11.2 of NRC, 2010), once the monitoring well does not exceed excursion criteria for three consecutive weeks, the monitoring well is taken off excursion status.

As discussed in CBR Renewal License SER Section 5.7.9, staff revised an existing license condition to require the above-referenced excursion reporting requirements and actions after an excursion is not corrected within 60 days of confirmation (NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the above-referenced excursion reporting requirements and required actions are relevant and effective for the NTEA. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the above-referenced excursion reporting requirements and required actions at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the above-referenced excursion reporting requirements and required actions.

5.7.9.3.2 Environmental Ground water and Surface Water Monitoring Program

The applicant stated that in addition to wellfield monitoring, all private wells will be sampled on a quarterly basis for natural uranium and radium-226 within two km (1.2 mi) of the well field area boundaries. Wells will be only be sampled with the landowner's consent. Staff observes that the applicant did not propose baseline monitoring to establish background water quality concentrations in private wells within two km (1.2 mi) of the well field area boundaries. Therefore, staff is imposing a license condition to achieve the necessary background water quality concentrations. This license condition is presented in SER Section 5.7.9.4.

The applicant proposed collecting surface water samples from the surface sampling points identified in Figure 2.9-5 in the TR (CBR, 2010). As discussed in Sections 2.5.3.1, 2.6.3.6 (the preoperational monitoring program), and 5.7.8.3.2.4 (operational monitoring program), staff imposed a license condition to provide clarification on the surface water sampling locations and justification for location W-2 identified in Figure 2.9-5 in the TR (CBR, 2010). Staff is including surface water in the license condition specified in SER Section 5.7.8.4 to provide staff with this clarification and justification for surface water monitoring locations.

The applicant proposed collecting the surface water samples quarterly and analyzing for dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210, and Po-210. Staff finds the proposed surface water sample analyses and sample frequency consistent with Table 2 of Regulatory Guide 4.14 (NRC, 1980) and therefore acceptable.

However, the applicant also stated that if Th-230 is not detected above background in the first year of operational monitoring, Th-230 will be eliminated as an operational surface water analyte. While staff acknowledges that the applicant may propose an alternative monitoring plan that is not necessarily consistent with Regulatory Guide 4.14 (with sufficient justification) (refer to Paragraph A of NRC, 1980), the applicant provided no justification for the one-year period. In accordance with the license condition specified in 5.7.8.4, the applicant is required to submit an operational surface water monitoring program consistent with Regulatory Guide 4.14 (NRC, 1980) or sufficient justification for an alternate program.

As discussed in SER Section 2.5.3.1, NRC staff determined that the applicant will not have private surface water impoundments at or within the license boundary, nor are there any offsite surface impoundments subject to direct drainage from potentially contaminated areas consistent with Regulatory Guide 4.14 (NRC, 1980). Therefore, no operational surface water samples from impoundments are required.

5.7.9.4 Evaluation Findings

The staff reviewed the ground water and surface water monitoring programs of the proposed North Trend ISR Project in accordance with Section 5.7.8.3 of NUREG-1569 (NRC, 2003). The applicant has defined a sampling program that addresses the following areas:

- Surface water bodies that lie within the facility boundary, including downstream sampling locations.
- Well field baseline water quality sampling, including the number and sampling interval, constituents sampled, and statistical methods.
- Operational ground water monitoring including identification of: appropriate well spacing for monitoring, excursion parameters, UCL computational methods, excursion notification requirements, and corrective actions for excursions.

As discussed in SER section 5.7.9.3.1.1, the staff is updating the standard license condition concerning the submittal of all mine unit hydrologic test packages to NRC for review as described in the CBR License Renewal SER (refer to Section 1 of NRC, 2012a). Staff is updating the license condition to include NRC's written verification of all mine unit hydrologic test package submittals. The license condition is as follows.

> The licensee shall submit all mine unit hydrologic test packages to the NRC for review and written verification.

As discussed in SER section 5.7.9.3.2, the staff is imposing the following license condition related to the establishment of background water quality concentrations in private wells within two km (1.2 mi) of the well field area boundaries.

> Prior to the preoperational inspection, the licensee shall submit monitoring results to the NRC for review and written verification of each well within two kilometers of the proposed NTEA production area monitoring well ring that is or could be used for drinking water, livestock, and crop irrigation. The minimum sampling frequency shall be quarterly. Samples shall be analyzed for the UCL parameters and for natural uranium and radium-226.

Based upon the review conducted by the staff as indicated above, the information provided in the application, as supplemented by the noted license conditions, the NRC staff concludes that the ground water and surface water monitoring programs are consistent with the applicable acceptance criteria of Section 5.7.8.3 of NUREG-1569 (NRC, 2003) and are in compliance with the following regulations:

- 10 CFR 40.32(c), which requires the applicant's proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life and property;
- 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license;
- 10 CFR Part 40, Appendix A, Criterion 5B(5), which provide concentration limits for hazardous constituents;
- 10 CFR Part 40, Appendix A, Criterion 5D, which requires a ground water corrective action program; and
- 10 CFR Part 40, Appendix A, Criterion 7A, which requires a detection monitoring program.

5.7.9.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2010, Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession No. ML103010530 (Package).

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession No. ML090750430 (Package).

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2010, License Amendment No. 25- Revised Surety Estimate for Crow Butte Resources, Inc., April 20, 2010, ADAMS Accession No. ML100830012.

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

5.7.10 Quality Assurance

5.7.10.1 Regulatory Requirements

In this section, the Staff determines if the applicant has demonstrated that the proposed quality assurance program for the NTEA facility meets the requirements of 10 CFR 20.1101, and 10 CFR 20 Subparts L and M.

5.7.10.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria presented in Section 5.7.9.3 of NUREG-1569 (NRC, 2003). Regulatory Guide 4.15 (NRC, 2007) provides guidance on demonstrating compliance with the applicable regulations.

5.7.10.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information and data submitted by CBR in its application (CBR, 2007) and as updated. Specifically, staff reviewed the applicant's proposed quality assurance (QA) and quality control (QC) programs for radiological and non-radiological monitoring activities. QA comprises all those planned and systematic actions that are necessary to provide adequate confidence in the assessment of monitoring results. QC, which is included in QA, comprises those actions that provide a means to measure and control the characteristics of measurement equipment and processes to meet established standards. QA is necessary to ensure that all radiological and non-radiological measurements that support the radiological and non-radiological monitoring programs are reasonably valid and of a defined quality.

The applicant stated that a quality assurance program will be in place at the NTEA for all relevant operational monitoring and analytical procedures (CBR, 2010). As discussed in Section 5.7.10.4 of the CBR Renewal License SER (NRC, 2012), the licensee is required by standard license condition to submit a Quality Assurance Program (QAP) for radiological and non-radiological activities to the NRC for review and approval. The QAP will address the topics recommended in Regulatory Guide 4.15 (as revised) (NRC, 2007). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Staff continues to evaluate the applicant's QAP through onsite inspections. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's QAP is relevant and effective for the NTEA. In addition, staff has not identified any un-reviewed safety-related concerns pertinent to the applicant's QAP at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of its QAP.

5.7.10.4 Evaluation Findings

The staff reviewed the quality assurance program for the NTEA in accordance with Section 5.7.9.3 of NUREG-1569 (NRC, 2003). The applicant is required by standard license condition (NRC, 2012a) to provide adequate documentation of the elements of a QA program as outlined in Regulatory Guide 4.15 (NRC, 2007).

Based upon the review conducted by the staff as indicated above and the information provided in the application, as supplemented by information submitted in accordance with the noted license condition, the NRC staff has reasonable assurance that the QAP will be consistent with the applicable acceptance criteria of Section 5.7.9.3 of NUREG-1569 (NRC, 2003) and will meet the requirements of 10 CFR 20.1101, 10 CFR 20 Subpart L, and Subpart M.

5.7.10.5 References

CBR, 2010, Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession No. ML103010530 (Package).

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2007. "Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment," Revision 2, Regulatory Guide 4.15, Washington, DC: July 2007.

NRC, 2003. "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report," NUREG–1569, June 2003, ADAMS Accession No. ML032250177.

6.0 GROUND WATER QUALITY RESTORATION, SURFACT RECLAMATION, AND FACILITY DECOMMISSIONING

6.1 PLANS AND SCHEDULES FOR GROUND WATER QUALITY RESTORATION

6.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans and schedules for ground water quality restoration for the NTEA meet the requirements of 10 CFR 40.32(c), 10 CFR Part 40.42, and Criterion 5B(5) of Appendix A to 10 CFR Part 40.

6.1.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 6.1.3 of NUREG-1569 (NRC, 2003a).

6.1.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by CBR in their application (CBR, 2007) and as updated. This section discusses plans for the ground water quality restoration activities at the NTEA. The plans include proposed restoration standards, baseline water quality evaluation, restoration methods, restoration stability monitoring, historical activities, and the proposed restoration schedule.

6.1.3.1 Restoration Standards

After uranium extraction is terminated, ground water quality (i.e., concentrations of hazardous constituents) must be restored to the standards identified in Criterion 5B(5) of Appendix A to 10 CFR Part 40. According to Criterion 5B(5), the concentration of each hazardous constituent may not exceed (a) the background concentration, (b) the maximum values for ground water protection in the Criterion 5C Table, if the constituent is listed in the table and if the background level is lower that the value in the table, or (c) an alternate concentration limit (ACL) proposed by a licensee and established by the NRC in accordance with Criterion 5B(6) of Appendix A to 10 CFR Part 40.

As stated above, the applicant may request to use ACLs as the ground water restoration standard. In order for a licensee to receive approval to use ACLs, the applicant must first demonstrate that for the constituents of concern in the wellfield being restored, it has made a reasonable effort to return those constituents to pre-operational baseline levels or to the respective Appendix A Table 5C value (if applicable), whichever level is higher. To establish ACLs, the licensee must request a license amendment, which is subject to a safety and environmental review. A licensee can only propose ACLs that present no significant hazards for NRC's consideration. The NRC may establish a wellfield-specific ACL for a constituent only if it finds that the proposed limit is ALARA, after considering practicable corrective actions, and that the proposed limit would not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. The factors that the NRC must consider in reviewing an ACL license amendment request are set forth in 10 CFR Part 40, Appendix A, Criterion 5B(6). For ISR facilities located in Nebraska, the State's "class of use" standard is one

factor, among several, that is considered in evaluating ACL requests, in accordance with Criterion 5B(6)(a)(v-vi) and (b)(vi-vii).

As discussed in the CBR Renewal License SER Section 6.1.3.1, staff revised an existing license condition to require the applicant's restoration standards to be consistent with Criteria 5B(5) and 5(B)6 of Appendix A to 10 CFR Part 40 (NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's restoration standards are relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the restoration standards at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of its restoration standards.

6.1.3.2 Baseline Water Quality

The guidance in NUREG-1569 (NRC, 2003a) recommends the applicant evaluate the pre-operational (baseline) ground water quality of the ore zone, overlying aquifer, underlying aquifer and perimeter monitoring well ring. The ore zone baseline ground water quality is used to establish the standards under Criterion 5B(5) to which the ground water in the mine unit ore zone must be restored. The overlying aquifer and perimeter monitoring well ring baseline water quality is used to establish the ground water quality standards that must also be met under 10 CFR 40, Appendix A, Criterion 5B(5) if the ground water in these aquifers is impacted by excursions or spills and restored. To establish the mine unit baseline water quality of the ore zone, staff observes that the applicant committed to sampling a minimum of one baseline restoration well for each four acres, but no less than six wells total for each mine unit (CBR, 2010).

As discussed in SER Section 6.1.3.2 of the CBR Renewal License SER (NRC, 2012a), staff revised the existing standard license condition for the establishment of baseline ground water quality. Staff has determined that the constituents listed in this standard license condition to establish baseline ground water quality concentrations will also require the measurement of gross alpha in accordance with 10 CFR Part 40, Appendix A, Criterion 5. Thus, staff is updating this standard license condition to add gross alpha to the constituents listed in the standard license condition. The updated portion of the standard license condition is provided in SER Section 6.1.4. This updated standard license condition will be applicable to all facilities under the Crow Butte Resources license, including the NTEA. Staff finds the establishment of baseline ground water quality as required by standard license condition at the NTEA to be consistent with the acceptance criteria in Section 5.7.8.3 of the NUREG-1569 (NRC, 2003) and therefore acceptable.

6.1.3.3 Restoration Methods

The applicant stated that the ground water restoration program will consist of two stages: (1) the ground water restoration phase and (2) the stability ground water monitoring phase (refer to Application Section 6.1.3 of CBR, 2010). The applicant's stability ground water monitoring phase is evaluated in SER Section 6.1.3.6.

The applicant stated that the ground water restoration stage will consist of the following phases: 1) ground water transfer, 2) ground water sweep, 3) ground water treatment, and 4) ground water recirculation (CBR, 2010). The first phase, ground water transfer, consists of the exchange of ground water between a new mine unit and that of a mine unit at the end of production. The second phase, ground water sweep, consists of pumping ground water from the mine unit without any corresponding injection back into the mine unit under restoration. This purpose of this phase is to more aggressively draw in impacted ground water from the perimeter of the wellfield. The applicant stated in Section 6.1.4.2 of the application that the duration of the sweep phase depends upon the presence of mine units along the mine unit perimeter, capacity of the wastewater disposal system and success of the transfer phase to lower the total dissolved solids concentration. The third phase is the ground water treatment phase, which consists of pumping ground water from a mine unit, treating the ground water to remove the constituents mobilized during the production, and injecting some or all the treated water back to the mine unit. The treatment consists of ion exchange (IX), reverse osmosis (RO) or electro Dialysis Reversal (EDR). The last phase the applicant may employ is ground water recirculation, which is simply recirculating water pumped from the aquifer back into the aquifer to homogenize the ground water quality. (CBR, 2010)

The applicant stated that the degree to which a restoration phase is incorporated into the restoration process for a particular mine unit will be determined based on operating experience and waste water system capacity (CBR, 2010). Additionally, the applicant stated that during the treatment phase, reductants may be added to the injected water to improve the restoration performance (CBR, 2010). NRC staff observes that chemical reductants change the oxidation/reduction potential of the ground water in the wellfield to induce precipitation of uranium and other constituents to lower their concentration in the ground water.

Staff observes that the proposed use of restoration phases and reductants at the NTEA are consistent with that at the currently licensed facility (refer to Section 6.1.3.3 of NRC, 2012a). Staff previously found the applicant's use of restoration phases and reductants at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's use of restoration phases and reductants is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the use of restoration phases and reductants and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the use of restoration phases and reductants at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's use of restoration phases and reductants.

Staff observes that the applicant committed to maintaining a hydrologic bleed until the ground water restoration stage is complete to prevent the lateral migration of fluid in the recovery zone (CBR, 2010). As discussed in CBR Renewal License SER Section 3.1.3.4.3, staff added a license condition to require the applicant to maintain an overall inward hydraulic gradient with the perimeter monitor well starting when lixiviant is first injected in the production zone and continuing until the initiation of the stabilization period (NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the above-referenced inward hydraulic gradient license condition is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the inward hydraulic gradient

license condition at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of inward hydraulic gradient during the ground water restoration phase

The applicant performed a pilot study using bioremediation to improve restoration performance. Bioremediation is the injection of organic compounds in the ground water in the wellfield to induce biological reduction to change the oxidation/reduction potential of the ground water in the wellfield to induce precipitation of uranium and other constituents. The bioremediation test was initiated on December 17, 2008, and the study is now complete. NRC reviewed the results of this study during an inspection (NRC, 2012b). The applicant has committed to submitting a request for a license amendment to the NRC if it were to seek to use bioremediation as a restoration alternative (CBR, 2010).

6.1.3.4 Pore Volume Estimates

In the applicant's recent annual surety estimate (CBR, 2011), it estimated the pore volume (PV) for restoration as the product of affected ore zone area, average well completed thickness, flare factor, and porosity. The value reported in the application for NTEA for the estimated volume of water associated with the total PV of all wellfields within the proposed licensed area is 3,774,055,548 L (997,000,000 gal) based on the calculated aerial extent of the wellfields of 2,846,214 m^2 (30,636,400 ft^2). The value of porosity used for estimating pore volume for both license areas was 0.29 (CBR, 2010). The staff concludes that this value of porosity and the average well completed thickness are acceptable, as they are consistent with the hydrological description evaluated in SER Section 2.4. Staff also observes that the flare factor was previously approved by NRC (NRC, 2012c). The staff finds this PV estimate to be appropriate as it is consistent with the recent staff finding for the recent annual surety update. (NRC, 2012c).

In application Section 6.1.4.2, the applicant proposed a restoration process to meet the restoration goals (CBR, 2010). The applicant estimated that three PVs through the IX treatment phase, six PVs through the RO treatment and two PVs for recirculation would be displaced during ground water restoration, for a total of 11 PVs (CBR, 2010). The applicant indicated the nine pore volumes were used to restore Mine Unit 1 at the currently licensed Crow Butte facility. The applicant used this experience to support the pore volumes estimate for NTEA (CBR, 2010). NRC staff agrees that Mine Unit 1 was successfully restored using the proposed restoration methods (NRC, 2003b). Staff finds the ISR production aquifer of the current Crow Butte license area is demonstrated to be a satisfactory analog to that of the NTEA. Based on this analysis, the staff finds this initial estimate of restoration pore volumes to be acceptable and is consistent with acceptance criteria presented in Section 6.1.3 of NUREG-1569 (NRC, 2003a).

6.1.3.5 Restoration Wastewater Disposal

Using the estimated PVs required for restoration of each mine unit, the average PV per mine unit, and the restoration schedule in Application Figure 3.1-5 (CBR, 2010), the staff calculates that the pumping rate per mine unit would be approximately 2,396 Lpm (633 gpm). Although the schedule indicates that two mine units will typically be in restoration at any one time, the schedule shows there will be as many as three. Assuming a 25 percent brine generation, the total disposal rate for the brine generated from the three mine units is estimated at approximately 1,798 Lpm (475 gpm). Combining this rate with the bleed from mine units in production yields a potential maximum disposal capacity of 2,063 Lpm (545 gpm). Staff

evaluated disposal capacities for typical deep disposal wells and limits on storage for typical evaporation ponds. The staff calculates that the proposed one disposal well and three evaporation ponds are insufficient to meet the restoration liquid effluent disposal requirements, especially if one component was out of service for an extended period of time.

Staff observes that the existing flow rate of deep disposal well No. 1 at the currently licensed Crow Butte facility is estimated to be between 1,136 to 1,514 Lpm (300 to 400 gpm) (NRC, 2012a). Staff also observes that adequate disposal capacity is critical for ISR operations and restoration. To ensure adequate capacity for deep disposal of byproduct material, the staff will require a license condition. This license condition is presented in SER Section 3.1.4. In the license condition, the applicant will be required to demonstrate that the installed disposal well provide adequate deep well capacity to dispose of the projected liquid volume under normal operating conditions during production and restoration phases.

6.1.3.6 Restoration Stability Monitoring

The applicant reported that during restoration, ground water monitoring will be conducted in accordance with the program described in Application Sections 5.7.8 and 5.7.9. As discussed in SER Section 5.7.9, NRC found this monitoring strategy to be acceptable. Staff observes the applicant would begin a ground water stabilization monitoring program for a mine unit upon completion of restoration stage within that mine unit. The monitoring program would include the sampling of the ground water samples from restoration wells and any monitor wells on excursion status during recovery operations (CBR, 2010).

As discussed in SER Section 6.1.3.4 of the CBR Renewal License SER, staff revised an existing license condition to require sampling of all constituents of concern on a quarter year basis during restoration stability monitoring (NRC, 2012a). The sampling shall include the specified ore zone aquifer wells. The applicant shall continue the stability monitoring until the data show the most recent four consecutive quarters indicate no statistically significant increasing trend for any of the constituents of concern that would lead, if uninterrupted, to a concentration of one or more constituents above the respective Criterion 5B(5) standard (NRC, 2012a). Staff has found nothing to invalidate previous findings; therefore, the original findings stand and previous staff conclusions remain valid. Based on the NTEA utilizing the same license conditions as the currently licensed Crow Butte facility, staff has reasonable assurance that the applicant's stability monitoring program is relevant and effective for the NTEA. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the applicant's stability monitoring program at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's discussion of its stability monitoring program.

6.1.3.7 Well Plugging and Abandonment

The applicant indicated that after ground water restoration is completed, it will remove pumps and piping from the wellfields (CBR, 2009). All drill holes and production, injection, and monitor wells will be abandoned in accordance with NDEQ rules and regulations (CBR, 2010). Staff observes that the proposed plans to conduct well plugging and abandonment at the NTEA will be consistent with that at the currently licensed facility (refer to Section 6.2.3 of NRC, 2012a). Staff previously found the applicant's plans to conduct well plugging and abandonment at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's plans to conduct well plugging and abandonment is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the applicant's plans to conduct well plugging and abandonment and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the plans to conduct well plugging and abandonment at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003a), staff is not re-examining the applicant's plans to conduct well plugging and abandonment.

6.1.3.8 Restoration Schedule

A preliminary wellfield restoration schedule was provided in Application Table 3.1-5 (CBR, 2009). The applicant reported it will take approximately two years to restore each mine unit at the NTEA. While NRC has no regulations which specify the time in which restoration must be completed, the applicant was informed by NRC that it is required to meet the requirements in 10 CFR 40.42(h)(1), which states the applicant must complete decommissioning within 24 months of initiating decommissioning or submit an alternate schedule for decommissioning for NRC review and approval in accordance with 10 CFR 40.42(i) (NRC, 2008). For an ISR facility, NRC defines that decommissioning begins when the applicant permanently ceases the injection of lixiviant in a wellfield (NRC, 2008). NRC staff finds that the applicant's schedule for restoration is consistent with 10 CFR 40.42 and is therefore acceptable.

6.1.4 Evaluation Findings

The staff reviewed the plans and schedules for ground water quality restoration of the proposed NTEA in accordance with Section 6.1.3 of NUREG-1569 (NRC, 2003a). The applicant provided an approach that includes a mix of ground water transfer and ground water treatment to restore ground water quality. The applicant has committed to adopt wellfield ground water restoration standards that are consistent with the requirements of 10 CFR Part 40, Appendix A, Criteria 5B(5).

The applicant's method for estimating wellfield pore volume is acceptable, taking into account the estimated porosity of the contaminated region and the lateral and vertical extent of contamination. With respect to the methodology for undertaking restoration, the applicant provided an acceptable approach that includes a mix of ground water sweep, ground water transfer, and ground water treatment and recirculation. The wellfield-specific mix of these approaches will be determined as part of the ground water restoration plan for each individual wellfield. The staff will include a standard license condition in SER Section 4.2 to ensure that the adequate disposal capacity is in place at the facility.

As discussed in SER section 6.1.3.2, the staff is updating the standard license condition concerning the establishment baseline ground water quality as described in the CBR License Renewal SER (Section 6.1.4 of NRC, 2012a). Staff is updating the license condition to include the baseline ground water quality measurement of gross alpha. The updated portion of the license condition is as follows.

> The samples shall be analyzed for ammonia, arsenic, barium, cadmium, calcium, chloride, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrate, pH, potassium, radium-226, selenium, sodium, sulfate, total carbonate, total dissolved solids, uranium, vanadium, zinc, and gross alpha.

The applicant presented an acceptable list of indicator constituents to be monitored and has specified acceptable criteria to determine the success of restoration. The applicant's post-restoration stability monitoring program is acceptable. The applicant has committed to an acceptable schedule for complete restoration for any wellfield after ore extraction ceases. The methods proposed for abandoning wells and sealing them are acceptable.

Based upon the review conducted by the staff as indicated above, the information provided in the application, as supplemented by the noted license conditions, is consistent with the applicable acceptance criteria of Section 6.1.3 of NUREG-1569 (NRC, 2003a) and meets the requirements of 10 CFR 40.32(c), 10 CFR Part 40.42, and Criterion 5B(5) of Appendix A to 10 CFR Part 40.

6.1.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2011. 2011 Surety Revised Estimate, Cameco Resources Crow Butte Operation, August 26, 2011,. ADAMS Accession No. ML11255A131

CBR, 2010, Responses to NRC Open Issues, North Trend Expansion Area License Amendment Request, Source Material License SUA-1534, Crow Butte Resources, Inc., Crawford, Nebraska, Crow Butte Resources, Inc., October 22, 2010, ADAMS Accession Nos. ML103010522 and ML103010525.

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

EPA, 2009. Statistical Analysis of Ground water Monitoring Data at RCRA Facilities, Chapter 5, Establishing and Updating Background, EPA 530-R09-007, March 2009.

NRC, 2012a. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2012b. NRC Inspection Report 040-08943/12-001, July 13, 2012, ADAMS Accession No. ML12195A073.

NRC, 2012c. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320362 (Package).

NRC, 2008. NRC letter to Crow Butte Resources, Inc., Compliance with 10CFR40.42's Timely Decommissioning Requirements, July 7, 2008, ADAMS Accession No. ML081480259.

NRC, 2003a. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." June.

NRC, 2003b. License Amendment 15, Crow Butte Resources *in Situ L*each Facility, License No. SUA-1534, Wellfield #1 Restoration Acceptance, February 12, 2003, Accession No. ML030440055

6.2 PLANS FOR RECLAIMING DISTURBED LANDS

6.2.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has demonstrated that the proposed plans for reclaiming disturbed lands for the Crow Butte NTEA facility will meet the requirements of 10 CFR 40.42 and Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.2.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria presented in Section 6.2.3 of NUREG-1569 (NRC, 2003).

6.2.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by CBR in its application (CBR, 2007) and as updated.

The applicant described general surface reclamation procedures involving topsoil replacement, backfilling and contouring of disturbed lands, revegetation, facility site reclamation, evaporation and pond decommissioning, and well field decommissioning including well plugging and abandonment (CBR, 2009). The applicant noted that it has no plans for treating and discharging the evaporation pond water under a National Pollutant Discharge Elimination System permit. The applicant indicated that pond water will be disposed by evaporation, treatment and deep well disposal, or transported to a licensed disposal facility. (CBR, 2009)

The applicant commits to surveying and sampling all facilities and processing related equipment and materials onsite to determine contamination levels and to identify the potential for personnel exposure during decommissioning (CBR, 2009). At the end of decommissioning, the applicant will survey and release uncontaminated materials and equipment for reuse. Contaminated materials will be relocated and disposed at a licensed disposal facility. In Section 6.4 of the application, the applicant has committed to surveying excavation areas for contamination and to perform a final site soil radiation survey. (CBR, 2009)

The applicant noted that records of information important to CBR's decommissioning will be maintained in the office of the onsite radiation safety officer (CBR, 2009). The applicant is required by CBR's license (SUA-1534) to submit a detailed decommissioning plan for NRC approval at least 12 months before final decommissioning begins (refer to license condition 12.5 of NRC, 2012a). Decommissioning will be accomplished in accordance with an approved decommissioning plan and license provisions and amendments in effect at the time of the decommissioning activity.

NRC staff finds the plans for reclaiming disturbed lands proposed by the applicant for the NTEA are consistent with the plans for the currently licensed facility (refer to Section 6.2 of NRC, 2012b). Staff previously found the applicant's plans for reclaiming disturbed lands at its main facility to be acceptable (NRC, 2012b). Therefore, staff has reasonable assurance that the applicant's plans for reclaiming disturbed lands are relevant and effective for the NTEA. Staff

finds nothing to invalidate the previous findings on the plans for reclaiming disturbed lands and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the plans for reclaiming disturbed lands at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's plans for reclaiming disturbed lands.

6.2.4 Evaluation Findings

The staff reviewed the plans for reclaiming disturbed lands of the proposed NTEA project (CBR, 2009) for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 6.2.3 of NUREG-1569 (NRC, 2003). In application Section 6.2, the applicant described various aspects of reclamation activities at the site on a general, site-wide basis (CBR, 2009). The staff considers this current level of detail, the financial assurance information provided, and the commitment to providing a final decommissioning plan at least 12 months before decommissioning to be sufficient and acceptable. Based on the information provided in the NTEA application, NRC staff concludes that the plans for reclaiming disturbed lands meet the applicable acceptance criteria of Section 6.2.3 of NUREG-1569 (NRC, 2003) and the requirements of 10 CFR 40.42 and Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.2.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2009. Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

NRC, 2012a. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2012b. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012 ADAMS Accession No. ML103470470

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.", June.

6.3 REMOVAL AND DISPOSAL OF STRUCTURES, WASTE MATERIAL, AND EQUIPMENT

6.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed plans for removal and disposal of structures, waste material and equipment for the proposed NTEA facility meet the requirements of 10 CFR 40.42.

6.3.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 6.3.3 of NUREG-1569 (NRC, 2003).

6.3.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007) and as updated.

The applicant stated that that all surfaces of premises, equipment, or scrap likely to be contaminated but that cannot be measured will be assumed to be contaminated in excess of limits and will be treated accordingly, and the applicant plans to conduct a comprehensive radiation survey (for alpha and beta contamination) to establish that any contamination is within limits specified before the release of the premises, equipment, or scrap (Refer to Section 6.3 of CBR, 2009). For a discussion of the applicant's general contamination control program, refer to SER Section 5.7.7. As discussed in SER Section 4.2, the applicant maintains an agreement for disposal of byproduct material with a licensed byproduct disposal facility.

The applicant committed (CBR, 2009) to submit a final and detailed decommissioning plan for structures and equipment to the NRC for review and approval at least 12 months before the planned commencement of decommissioning of such structures and equipment. Staff observes that submittal of a detailed decommissioning plan is a current license requirement (refer to license condition 12.5 of NRC 2012a) and this requirement will be retained with this amendment.

6.3.4 Evaluation Findings

Based on the staff's review of information provided in the application, and the requirements of the current license, the staff finds that the applicant's proposed plans for removal and disposal of structures, waste material and equipment for the NTEA (refer to Section 6.3 of CBR, 2009) is consistent with its plans for removal and disposal of structures, waste material and equipment at its main facility. Staff previously found the applicant's plans for removal and disposal of structures, waste material and equipment at its main facility to be acceptable (refer to Section 6.3 of NRC, 2012b). Therefore, staff has reasonable assurance that the applicant's proposed plans for removal and disposal of structures, waste material and equipment will be relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the proposed plans for removal and disposal of structures, waste material and equipment and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the proposed plans for removal and disposal of structures, waste material

and equipment at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the proposed plans for removal and disposal of structures, waste material and equipment.

6.3.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2007. Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML 71760343 (Package).

CBR, 2009. Response to Letter Received November 20, 2008-Request for Additional Information, License Amendment for the North Trend Expansion Area, Crow Butte Resources, Inc., Crawford, Nebraska Replacement Pages for Section 2.7 Hydrology, February 27, 2009, ADAMS Accession No. ML090750428.

NRC, 2012a. License Amendment N. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012.

NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal December 28, 2012, ADAMS Accession No. ML103470470.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.", June.

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING SURVEYS

6.4.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has demonstrated that the proposed methodologies for conducting post reclamation and decommissioning radiological surveys for the proposed NTEA facility will meet the requirements of Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.4.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 6.4.3 of NUREG-1569 (NRC, 2003).

6.4.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information, data, and maps submitted by CBR in their application (CBR, 2007) and as updated.

This section addresses the post-reclamation and decommissioning of soils, intended to remain in place and be released as unrestricted areas, that are contaminated with source material, byproduct material, and/or 11e(2) material. Soils that may have residual contamination must meet the standards of 10 CFR 40, Appendix A, Criterion 6(6). This section does not address equipment or structures. Refer to SER Section 6.3 for a discussion on equipment and structures.

6.4.3.1 Cleanup Criteria and ALARA Goals

The applicant identified the cleanup limit and goal in Table 6.4.1 of the TR (CBR, 2009) (see SER Table 6.4-1 below). For Ra-226 at surface and subsurface, the limit is 5 pCi/g and 15 pCi/g, respectively. The applicant established a goal for Ra-226 in surface and subsurface at 5 pCi/g and 10, respectively (CBR, 2009). For natural uranium at surface and subsurface, the limit is 230 pCi/g for both (CBR, 2009). The applicant established a goal for natural uranium in surface and subsurface at 150 and 230 pCi/g, respectively (CBR,2009).

The applicant stated that the Benchmark Dose was modeled using RESRAD (Version 6.22) (DOE, 2001). The applicant indicated that the result shows that a concentration of 537 pCi/g for natural uranium in the top 15 cm of soil for the resident farmer scenario is equivalent to the benchmark dose derived from a concentration of 5 pCi/g of Ra-226.

Table 6.4-1 Surface and Subsurface Soil Cleanup Criteria and Goals

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

The applicant indicated (CBR, 2009) that spills of process solutions are not likely to contain substantial amounts of Th-230 and therefore the development of a soil cleanup criterion for Th-230 is not appropriate at this time. However, in the event that Th-230 is present in significant quantities, a cleanup criterion will be developed using the radium dose benchmark method and submitted to NRC for approval. Additional NRC reviews would be conducted on the decommissioning plan submitted to NRC by the applicant, as required.

Based on the staff's review of information provided in the application, and the requirements of the current license, the staff finds that the applicant's proposed surface and subsurface soil cleanup criteria and ALARA goals for the NTEA (refer to Section 6.4 of CBR, 2009) are consistent with those proposed for its main facility. Staff previously found the applicant's proposed surface and subsurface soil cleanup criteria and ALARA goals at its main facility to be acceptable (refer to Section 6.4 of NRC, 2012). Therefore, staff has reasonable assurance that the applicant's proposed surface and subsurface soil cleanup criteria and ALARA goals are relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the proposed surface and subsurface soil cleanup criteria and ALARA goals and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the proposed surface and subsurface soil cleanup criteria and ALARA goals at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the proposed surface and subsurface soil cleanup criteria and ALARA goals.

6.4.3.2 Surface Soil Cleanup Verification and Sampling Plan

In Section 6.4.2 of the TR (CBR, 2009), the applicant stated that it will use 17,900 counts per minute (cpm) as its gamma action level using a NaI detection system held at 1 meter (18 inches) above ground level. The applicant indicated that to meet the cleanup criterion, each of the sampled grid blocks must satisfy the unity rule which is defined as follows:

$\Sigma\ C_i/C_c < 1$

where C_i is the concentration of the constituent and C_c is the concentration of the constituent that is equivalent to the benchmark dose (CBR, 2009).

NRC staff determined that the gamma action level for the NTEA is not sufficiently justified by the applicant. In its response (CBR, 2010) to NRC staff's RAI (NRC, 2009, NRC, 2010) regarding the gamma action level, the applicant committed to derive a correlation for the NTEA during

preoperational soil sampling and gamma surveys. It is the NRC's position that the applicant must demonstrate how the gamma action level count rate (17,900 counts per minute) derived from the main facility correlates with preoperational soil sampling isotopic analysis as it relates to NTEA and demonstrate that the gamma action levels are at or below the radium benchmark dose. In addition, background levels for radionuclides such as uranium have not been established. As such, NRC staff is imposing a preoperational license condition to enable the staff to review and verify the applicant's proposed gamma action level for use during its interim reclamation and decommissioning steps. This license condition is presented in SER Section 6.4.4.

The applicant stated that the surface soil cleanup verification and sampling plan will divide those few areas where there are known spills and potentially small spills near wellheads. These areas will be divided into 100 m^2 (1076.4 ft^2) blocks and the applicant will evaluate all grid blocks containing gamma count rates that exceed the gamma action level. In addition to the gamma action level, the applicant will collect and composite soil samples from five locations within each grid and analyze those samples at an offsite laboratory for Ra-226 and natural uranium. NRC staff has determined that the use of this sampling plan, including the use of the gamma action level, is acceptable, provided that the applicant uses this sampling plan, including the action level, only for interim decommissioning steps as it previously stated (CBR, 2004) and not for any final decommissioning steps, such as a final status survey. Use of this sampling plan, including the proposed action level, for any final decommissioning steps, such as a final status survey, will require NRC approval.

The applicant indicated that to meet the cleanup criterion, each of the sampled grid blocks must satisfy the unity rule which is defined as follows:

$\Sigma\ C_i/C_c < 1$

where C_i is the concentration of the constituent and C_c is the concentration of the constituent that is equivalent to the benchmark dose.

NRC staff has determined that the inequality equation, also known as the unity rule or sum of fractions, is consistent with 10 CFR Part 40 Appendix A, Criterion 6(6) and is therefore acceptable.

6.4.3.3 Subsurface Soil Cleanup Verification and Sampling Plan

The applicant stated that for subsurfaces, it will adopt different survey and sample protocols, depending on the type and size of the excavation (CBR, 2009). The applicant will rely more on sampling for Ra-226 and natural uranium analysis over surveying to verify cleanup of subsurface excavations (CBR, 2009). NRC staff notes that the applicant is required by a license condition to submit a detailed decommissioning plan to NRC for review and approval at least 12 months prior to the planned shutdown of mine unit extraction operations.

Based on the staff's review of information provided in the application, and the requirements of the current license, the staff finds that the applicant's proposed subsurface soil cleanup verification and sampling plan for the NTEA (refer to Section 6.4 of CBR, 2009) is consistent

with the subsurface soil cleanup verification and sampling plan proposed for the main facility. Staff previously found the applicant's proposed subsurface soil cleanup verification and sampling plan at its main facility to be acceptable (refer to Section 6.4 of NRC, 2012). Therefore, staff has reasonable assurance that the applicant's proposed subsurface soil cleanup verification and sampling plan will be relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the proposed subsurface soil cleanup verification and sampling plan and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the proposed subsurface soil cleanup verification and sampling plan at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of the proposed subsurface soil cleanup verification and sampling plan.

6.4.4 Evaluation Findings

The staff reviewed the methodologies for conducting post-reclamation and decommissioning radiological surveys for the NTEA facility in accordance with NUREG-1569 (NRC, 2003). The applicant has developed methodologies for verification of cleanup (final status survey plan) that will verify that the radium concentration will not exceed 5 pCi/g in the upper 15 cm (5.9 inches) of soil and will not exceed 15 pCi/g in subsequent 15-cm (5.9-inch) layers. However, the applicant has not provided acceptable surface soil cleanup verification criteria. In order to determine if the cleanup of radium and other residual radionuclides in soil will meet the criteria developed by the radium benchmark dose approach for the NTEA, including a demonstration of ALARA and the application of the unity test of Criterion 6(6) of Appendix A to 10 CFR Part 40, where applicable, NRC staff is imposing the following license condition:

> Prior to the preoperational inspection, the licensee shall submit a gamma action level to be used for soil cleanup related to Ra-226 and natural uranium for NRC staff review and written verification.

Staff has determined that the proposed methodologies for conducting post-reclamation and decommissioning surveys at the NTEA are similar to those observed at the currently licensed Crow Butte facility that staff has previously reviewed (CBR, 2005). Based upon the review conducted by the staff as indicated above, the information provided in the application as supplemented by information to be collected in accordance with the license condition prior to operations, the staff finds that the information is consistent with the applicable acceptance criteria of Section 6.4.3 and Appendix A of NUREG-1569 (NRC, 2003a), where noted, and the requirements of Criterion 6(6) of Appendix A to 10 CFR Part 40.

6.4.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40 Appendix A, "Domestic Licensing of Source Material"

CBR, 2010. Replacement pages and response to NRC letters dated November 12, 2009 and March 24, 2010, Open Issues, North Trend Expansion Area License Amendment, Crow Butte Resources, Inc. ADAMS Accession No. ML103010530.

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Inc., Crawford, Nebraska Replacement pages for Section 2.7 Hydrology, February 27, 2009, ADAMS Accession No. ML090750428.

CBR, 2007. Application for Renewal of Source Material License No. SUA-1534, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML073480264 (Package).

CBR, 2005. Wellfield Decommissioning Plan Review (TAC LU0053), January, 10, 2005, ADAMS Accession No ML050110170.

CBR, 2004. Withdrawal of License Amendment Request, Source Materials License SUA-1534, Docket Number 40-8943, Crow Butte Resources, Inc., August 10, 2004, ADAMS Accession No. ML042310506.

DOE, 2001. "User's Manual of License for RESRAD Version 6." ANL/EAD-4. Washington D.C.: US Department of Energy. July 2001. http://web.ead.anlgov/resrad/documents/resrad6.pdf, accessed December 14, 2011.

NRC, 2012. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470.

NRC, 2010. Summary of March 8, 2010, teleconference regarding open issues, Crow Butte Resources, Inc., North Trend Expansion Area license amendment, March 24, 2010 ADAMS Accession No. ML100680217.

NRC, 2009. Minutes from October 5, 2009, teleconference regarding open issues, Crow Butte Resources, Inc., North Trend Expansion Area license amendment, November 12, 2009, ADAMS Accession No. ML093060326.

NRC, 2005. Letter from J. Lusher (U.S. NRC) to M. Griffin (Crow Butte Resources, Inc.), Wellfield Decommissioning Plan Review, January 10, 2005, ADAMS Accession No. ML050110170.

NRC, 2003. NUREG–1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.", June.

6.5 FINANCIAL ASSURANCE

6.5.1 Regulatory Requirements

The purpose of this section is to determine whether the applicant has demonstrated that the proposed financial assurance for the Crow Butte NTEA facility meets the requirements of Criterion 9 of Appendix A to 10 CFR Part 40.

6.5.2 Regulatory Acceptance Criteria

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for consistency with applicable regulations of 10 CFR Part 40 using the acceptance criteria presented in Section 6.5.3 of NUREG-1569 (NRC, 2003).

6.5.3 Staff Review and Analysis

Unless otherwise stated, the information reviewed in this section is from information submitted by the applicant in their application (CBR, 2007) and as updated.

The applicant has maintained a financial surety arrangement for the CBR's license (SUA-1534) that is consistent with 10 CFR 40, Appendix A, Criterion 9 (refer to Section 6.5 of NRC, 2012b). The applicant maintains an irrecoverable standby letter of credit issued by the Bank of Montreal in favor of the State of Nebraska in the present amount of $35,398,802 to cover ground water restoration, decontamination and decommissioning, and surface reclamation costs for all areas affected by the milling plan (CBR, 2010, NRC, 2012a). The financial surety amount has been revised annually in accordance with the applicant's license. Each annual revision to the surety amount have been based on an annual detailed cost estimate provided by the applicant and approved by the NRC. Staff observes that NRC's previous approval of the applicant's annual surety estimates have demonstrated that the applicant has maintained sufficient funds in the surety for completion of the above-referenced activities by an independent contractor (NRC, 2012a).

The applicant has committed to maintaining the above-referenced surety instrument to also cover NTEA estimated costs of ground water restoration, decontamination and decommissioning and surface reclamation costs for all areas to be affected by the milling plan (CBR, 2009). CBR's license (SUA-1534) requires that at least 90 days prior to beginning construction associated with any planned expansion or operational change, which was not included in the annual surety update, the licensee shall provide, for NRC approval, an updated surety to cover the expansion or change (refer to license condition 9.5 of NRC, 2012a). Thereafter, the applicant will be required to provide annual surety updates to the NRC to include estimated annual costs for the NTEA project of each year in accordance with requirements of its license (CBR, 2009, NRC, 2012a).

Previous annually surety estimates for the currently licensed CBR facility covered activities discussed in the CBR Renewal License SER Sections 6.1 to 6.4 (CBR, 2011 and NRC 2012b). Staff observes that future annual surety estimates under CBR's license SUA-1534 will also cover activities discussed in NTEA SER Sections 6.1 to 6.4, which are consistent with activities in CBR Renewal License SER Sections 6.1 to 6.4 (CBR, 2009 and NRC, 20012b). Staff

observes that the previous methodology of estimating surety costs for the above-referenced activities at the currently licensed Crow Butte facility will also be used for NTEA (CBR, 2009 and NRC, 20012b). Staff previously found the applicant's methodology of estimating surety costs at its main facility to be acceptable (NRC, 2012a). Therefore, staff has reasonable assurance that the applicant's methodology of estimating surety costs is relevant and effective for the NTEA. Staff finds nothing to invalidate the previous findings on the methodology of estimating surety costs and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to the methodology of estimating surety costs at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's methodology of estimating surety costs.

6.5.4 Evaluation Findings

The applicant has committed to maintaining their financial surety with sufficient funds that would be available for completion of the NTEA project (ground water restoration, decontamination and decommissioning, and surface reclamation) by an independent contractor (CBR, 2009). The applicant has committed to updating the financial surety amount under CBR's license SUA-1534 to cover estimated NTEA project costs in accordance with the requirements of the CBR's license SUA-1534 (CBR, 2009 and NRC, 2012b). Based staff's review of the existing financial surety under CBR's license (SUA-1534) and information provided in the NTEA application, which will be supplemented by information to be submitted in accordance with Crow Butte license (SUA-1534), NRC staff concludes that the financial surety and its methods of estimation to cover the NTEA project are acceptable and consistent with requirements of 10 CFR Part 40, Appendix A, Criterion 9.

6.5.5 References

10 CFR Part 40. Code of Federal Regulations, Title 10, Energy, Part 40, "Domestic Licensing of Source Material".

CBR, 2011. Letter to Nebraska Department of Environmental Quality, 2011 Surety Revised Estimate, Class III Underground Injection Control Permit Number NE 0122611, Class I Underground Injection Control Permit Number NE 0210457, August 26, 2011, ADAMS Accession No. ML11255A131.

CBR, 2010. Letter to Nebraska Department of Environmental Quality, Crow Butte Resources, Inc., Crow Butte Operation Irrevocable Standby Letter of Credit, Request for Cancellation, March 5, 2010, ADAMS Accession No. ML100770407.

CBR, 2009, Responses to NRC Request for Additional Information, Technical Report Application for Amendment of NRC Source Material License SUA-1534, North Trend Expansion Area, Crow Butte Resources, Inc., February 27, 2009, ADAMS Accession Nos. ML090750428 and ML090750429.

CBR, 2007, Application for Amendment of USNRC Source Materials License SUA-1534 North Trend Expansion Area Technical Report, Crow Butte Resources, Inc., November 27, 2007, ADAMS Accession No. ML072540671 (Package).

NRC, 2012a. Letter to Crow Butte Resources, Inc., License Amendment No. 26, 2011 Surety Update, Crow Butte Resources, Inc., Crawford, Nebraska, Source Materials License SUA-1534, March 6, 2012, ADAMS Accession No. ML110320358 (Package).

NRC, 2012b. Safety Evaluation Report, Cameco Resources, Inc., Crow Butte Operation License Renewal, December 28, 2012, ADAMS Accession No. ML103470470

NRC, 2003. NUREG–1569, “Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report.” June.

7.0 ACCIDENTS

7.1 REGULATORY REQUIREMENTS

In this section, the staff determines if the applicant has addressed potential accidents at the proposed North Trend Expansion Area (NTEA) Project and has demonstrated that the facility will meet the requirements of 10 CFR 40.32(c). This regulation requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

7.2 REGULATORY ACCEPTANCE CRITERIA

Unless specifically stated otherwise, changes to the current licensing basis were reviewed for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in Section 7.5.3 of the standard review plan (NRC, 2003).

7.3 STAFF REVIEW AND ANALYSIS

This section addresses potential accidents that could occur at the NTEA facility, the designs and measures proposed by the applicant to prevent those accidents, and the plans (including training) proposed by the applicant to cope with the possible occurrence of those accidents. Unless specifically stated otherwise, the information reviewed for this section consist of the narrative and data submitted by Crow Butte Resources in Section 7.5 of the application (CBR, 2010a).

In the application, the applicant provided information on the potential accidents that could occur at the NTEA facility, including potential health and safety impacts should an accident occur involving radiological and non-radiological materials. In the application, the applicant also identified the procedures and training programs to mitigate or lessen the likelihood of one or more identified accidents. The following sections address specific information on impacts due to chemical accidents, radiological release accidents, transportation accidents, fires and explosions, and natural disasters.

7.3.1 Chemical Accidents

The applicant stated that the use of chemicals at the satellite plant will be limited to carbon dioxide, sodium bicarbonate, oxygen, and sodium sulfide (CBR, 2010a). No other chemicals will be needed since loaded resins will be transported to the currently licensed Crow Butte facility for elution and further processing. Oxygen is a primary ignition source for the NTEA. If the oxygen storage tank explodes, damage to the plant and subsequent radiological releases could occur. However, the applicant stated that the oxygen storage facility would be located a safe distance from the plant to minimize potential damage (refer to Section 3.2.2 in CBR, 2009a). The applicant stated that the oxygen storage facility is installed by the supplier, and that all equipment is cleaned of grease, oil, and other combustibles per Compressed Gas Association standards. Emergency response instructions for spills and fires involving oxygen are contained in the applicant's Safety, Health, Environment, and Quality Management System

(SHEQ MS) Program Volume VIII, Emergency Manual (the Emergency Manual) (refer to application Section 7.5.1.1). (CBR, 2010a)

In Section 3.2.2 in the application, the applicant stated that it will use sodium sulfide as a reductant during the restoration process (CBR, 2010a). To minimize potential impacts to radiological safety, the applicant stated that it will store sodium sulfide bags or sacks outside of process areas in a cool, dry, and clean area to prevent contact with acids, oxidizers, or other potentially reactive materials. The applicant also stated that it may use hydrogen sulfide as a reductant, if necessary, and that proper safety precautions will be taken to minimize impacts of hydrogen sulfide on radiological safety. (CBR, 2010a)

Based on representations made by the applicant, the staff considers sodium sulfide to be the approved reductant for the NTEA. Inversely, the staff does not approve of the use of hydrogen sulfide as a reductant for the NTEA because the applicant did not sufficiently discuss storage and handling procedures to prevent impacts to radiological and worker safety in the application. Therefore, if the applicant desires to use hydrogen sulfide as a reductant during restoration, the applicant would need to seek an amendment to its license.

In Section 5.1.8 of the application (CBR, 2012), the applicant stated that the safety supervisor is responsible for the health and safety programs not related to radiation safety. The safety supervisor is responsible for the development and implementation of health and safety programs for compliance with OSHA, including the training of new and existing employees and maintaining records (CBR, 2012).

The applicant will be using chemicals consistent with those used at its main facility (see Section 7.3.1 of NRC, 2012). Staff previously found the applicant's analyses of chemical accidents at its main facility, including consequences and mitigating measures, acceptable (NRC, 2012). Therefore, based on that prior review, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, for chemical accidents are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on chemical accidents and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to chemical accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of chemical accidents.

7.3.2 Radiological Release Accidents

The applicant identified tank and plant pipe failures as potential accidents that could pose a radiological risk (refer to Section 7.5.2 in CBR, 2010a). The applicant stated that the NTEA satellite plant building structure and concrete curbs will contain spills from tanks and satellite plant pipe leaks. The floor sump system will direct liquids back into the plant process circuit or waste disposal system. (CBR, 2010a)

Outside the satellite plant, wellfield houses will be equipped with building alarms to detect the presence of liquids in the floor sumps caused by piping leaks (refer to Section 3.3 in CBR, 2010a). Injection and production flows and pressures will be monitored with sensors in the wellfield houses and by a central computer system at the satellite control room. In addition to the monitoring system, wellfield operators will inspect wellfields to detect pipeline leaks (see

Section 7.5.4 of CBR, 2010a), and responses to leaks are addressed in the applicant's Emergency Manual (see Section 5.7.1.3, CBR, 2010a). If a leak occurs, any affected soil will be surveyed and reclaimed as appropriate. (CBR, 2010a)

The applicant described scenarios under which an injection or recovery line in a wellfield or trunkline between the satellite plant and the wellfield ruptures releasing barren or pregnant llxiviant (refer to Section 7.5.4 in CBR, 2010a). According to the applicant, such a release could contaminate the ground and subsurface soil. Such releases are detected and mitigated by pressure and flow monitors that will be installed in the wellhouses and monitored in the control room. Furthermore, the applicant will use roving wellfield operators performing periodic inspections to find smaller leaks. The applicant's past experience, based on surveying and sampling, indicates that small leaks typically occur in the injection system and seldom result in contamination. (CBR, 2010a)

Contamination from spills will be isolated from surface water due to the construction of berms around the wellfields (refer to Section 7.2.6.2 of CBR, 2010a). Furthermore, the applicant will prepare and implement a Spill Prevention, Control, and Countermeasures plan to remediate soil contamination by spills. The applicant also cites its Emergency Manual for spill response procedures, as well (refer to Section 7.5.2). Potential contamination of the uppermost aquifer by spills would be detected by the shallow ground water monitoring network, which includes 1 well per 4 acres. Detections of contaminants would be classified as excursions, and would be addressed accordingly per Section 5.7.8.2 in the application. (CBR, 2010a)

The applicant stated that response procedures for radiological risks from the previously mentioned releases are contained in its Emergency Manual (CBR, 2010a). This manual also contains notification requirements pursuant to 10 CFR 20.2202 and 20.2203 (CBR, 2010a). .

The staff has reviewed the applicant's analysis of, and procedures for, addressing radiological release accidents at the NTEA and concludes that the applicant's analyses and procedures are consistent with those used at its main facility (see section 7.3.2 of NRC, 2012). Staff previously found the applicant's analysis of, and procedures for, addressing radiological release accidents at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, of radiological release accidents are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on radiological release accidents and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to radiological release accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of radiological release accidents.

7.3.3 Ground water Contamination

The applicant stated that excursions of lixiviant could potentially contaminate adjacent aquifers with radioactive and trace elements (CBR, 2010a). Section 7.5.3.1 of the application discusses these occurrences, potential causes, and general monitoring requirements. The applicant proposed using the same excursion monitoring program approved for the main facility at the NTEA (See Section 5.8.8.2 of CBR, 2009b, 2012 and Section 5.7.8 of CBR, 2010a). Excursions occur vertically or horizontally. The monitoring well ring is used to detect horizontal

excursions that could result from injection or production imbalances, or both, as well as preferential flow paths. Monitoring well patterns above and below the extraction zone are used to detect vertical excursions that could occur from well casing failures, poor well construction, or confining layer fractures, or leaks. (CBR, 2010a)

The following current license conditions (NRC, 2010) will address the potential for ground water contamination at the NTEA:

- License Condition 10.2 – well construction and integrity testing
- License Condition 10.3 – pre-operational baseline water quality
- License Condition 10.4 – upper control limit calculation
- License Condition 10.16 – perimeter monitoring well spacing
- License Condition 11.2 – monitoring well sampling

The staff determined that by implementing these conditions at the currently licensed facility, the applicant has properly calculated baseline ground water concentrations and upper control limits and has demonstrated that it has the ability to identify well casing failures and excursions. In addition to the wellfield sampling discussed in the application and required by license condition 11.2 (NRC, 2010), the applicant committed to sampling all private wells within one kilometer of the wellfield area boundary quarterly with the landowner's consent (CBR, 2010a). Ground water samples are collected in accordance with the instructions contained in SHEQ MS Program Volume VI, *Environmental Manual.* Samples are analyzed for natural uranium and radium-226 (refer to Section 5.7.8.2 of CBR, 2010a). The staff determined that this commitment adds an additional layer of protection against exposure to ground water contamination, if such contamination were to occur due to activities at the NTEA.

The staff has reviewed the applicant's analysis of, and procedures for, addressing ground water contamination accidents at the NTEA and concludes that the applicant's analyses and procedures are consistent with those used at its main facility (see section 7.3.2 of NRC, 2012). Staff previously found the applicant's analysis of, and procedures for, addressing ground water contamination accidents at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, of ground water contamination accidents are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on ground water contamination accidents and previous staff conclusions remain valid. In addition, staff has not identified any unreviewed safety-related concerns pertinent to ground water contamination accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of ground water contamination accidents.

7.3.4 Pond Failures

The applicant will maintain solar evaporation ponds (evaporation ponds, or ponds) onsite to manage liquid byproduct material in conjunction with a deep disposal well (CBR, 2009a). These ponds will be constructed in the same manner as those at the currently licensed Crow Butte facility, and will include primary liners, leak detection systems, and secondary liners, per the criteria found in Regulatory Guide 3.11 (NRC, 2008) (refer to Section 4.2.1.1.2 of CBR, 2009a). Inspections will be performed on a regular basis as described in Section 4.2.1.1.2 of CBR, 2009a, 2010a (see also SER Section 4.2.3.1.1).

Staff observes that pond leaks have occurred at the currently licensed Crow Butte facility. These leaks were all in the primary liner and were caused by weather-related cracking or by abrasions from the floating sprinkler system. These leaks were detected by the leak detection system, and no leaks have occurred in the secondary liner. Consequently, primary liner leaks have not impacted ground water quality based on samples collected from monitoring wells surrounding the evaporation ponds (CBR, 2010b). The staff has also reviewed the compliance history of the evaporation ponds at the currently licensed facility, which is documented in the SER for the license renewal review (refer to Section 4.2 of NRC, 2012). This review also indicated that primary liner leaks have not contaminated ground water at the site (NRC, 2012).

The current license requires a pond inspection program and mandates certain actions in the event of a detected release (refer to License Condition 11.4 of NRC, 2010). Such actions include reducing pond water levels by transferring contents to another pond, repairing the liner, and then sampling the detection system to ensure that the repair is sufficient.

Based on the staff's review of information provided in the application, the applicant's past experience with evaporation ponds, and the requirements of the current license, the staff concludes that the applicant's analyses of credible pond accident scenarios, and procedures to address them, are consistent with those used at its main facility (see section 7.3.2 of NRC, 2012). Staff previously found the applicant's analyses of credible pond accident scenarios, and procedures to address them, at its main facility to be acceptable (NRC, 2012). Therefore, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, of pond failure accidents are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on pond failure accidents and previous staff conclusions remain valid. In addition, staff has not identified any safety-related concerns pertinent to pond failure accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of pond failure accidents.

7.3.5 Transportation Accidents

7.3.5.1 Chemical and Byproduct Material

The applicant considered the potential for transportation accidents involving shipments of process chemicals and fuel from suppliers and radioactive waste from the site to a licensed facility (CBR, 2010a). The applicant states that it will receive approximately 150 shipments of chemicals per year. For process chemicals, the applicant states that accident risk will not increase by operating the NTEA, because those operations are essentially replacing those that are decreasing at the currently licensed Crow Butte facility. Regarding byproduct material waste, the applicant states that the impact of an accident is minimal since the activity of these materials is low. (CBR, 2010a)

The NRC regulates shipments of chemicals only to the extent that such shipments can affect radiological health and safety. The staff considers the oxygen shipments to be the primary chemical shipment hazard that could affect radiological health and safety. This is due to its combustion potential during an accident. However, as stated in SER Section 7.3.1, the applicant will store oxygen at a safe distance from the NTEA satellite plant. Therefore, the effects of combustion accidents on the containment of uranium-loaded resin or lixiviant (barren or pregnant) are minimized.

Staff also observes that the applicant is required to ship byproduct material to a licensed disposal facility per license condition. The applicant must comply with the NRC's regulations in 10 CFR Part 71 and the U.S. Department of Transportation (DOT) regulations in 49 CFR Part 173 when shipping byproduct material to a disposal facility. Currently, the applicant routinely ships byproduct material as Low Specific Activity (LSA) material under DOT regulations, which indicates that the expected byproduct material from the NTEA will be low activity and will not pose a significant risk in the event of an accident.

The staff concludes that the applicant's analysis of chemical and byproduct material transportation accidents is consistent with their analysis of these accidents at the main facility. Staff previously found the applicant's analysis of chemical and byproduct material transportation accidents acceptable for its main facility (see section 7.3.2 of NRC, 2012). Therefore, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, of chemical and byproduct material transportation accidents are relevant and effective for the NTEA. Staff finds nothing to invalidate these previous findings on chemical and byproduct material transportation accidents and previous staff conclusions remain valid. In addition, staff has not identified any safety-related concerns pertinent to chemical and byproduct material transportation accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), staff is not re-examining the applicant's discussion of chemical and byproduct material transportation accidents.

7.3.5.2 Resin Transfer

Transportation accidents involving resin transfers to and from the main facility and the NTEA is an additional risk that was not previously evaluated (CBR, 2010a). For accidents involving resin transfer trucks, the applicant stated that one 4,000-gallon tanker trailer will transport loaded resin to the currently licensed Crow Butte facility and return with regenerated resin on a daily basis. The planned route will occur on county and private roads, avoiding travel onto US Highway 20 and Nebraska Highway 2/71; however, the trucks will cross these roads. Resin shipments will be shipped as LSA material per NRC's regulations in 10 CFR Part 71. The applicant outlined its procedures for transporting the resins and included commitments to adhere to NRC and US DOT regulations. The applicant's emergency response plan for yellowcake and other transportation accidents to or from the NTEA is contained in its Emergency Manual. (CBR, 2010a)

To address resin shipment accidents the applicant summarized its emergency procedures in Section 7.5.5.3 of the application (CBR, 2010a). The applicant stated that the worst case scenario is a loss of truck contents; however, the uranium is adsorbed to the resin and is wet. Therefore, the lost resin is unlikely to migrate far from the spill site. The primary means of remediating an accident is physical removal of the resin and potentially affected soil. (CBR, 2010a)

The staff has determined that the applicant's description of resin transfer accidents is consistent with the acceptance criteria in Section 7.5.3 of NUREG-1569 (NRC, 2003) and therefore acceptable. The applicant described credible resin transfer accident scenarios and procedures for remediating such accidents.

7.3.6 Natural Disasters

Consistent with NUREG/CR-6733 (Mackin et al., 2001), the applicant analyzed the risk from an earthquake and a tornado at the proposed NTEA (CBR, 2010a). The applicant determined that the primary hazards are resin dispersion from a tornado strike and failure of chemical storage facilities and process chemical reaction from either earthquakes or tornados. The proposed facility is within seismic risk Zone 1, and only minor damage is expected from earthquakes in this zone, according to the applicant. The facility is in an area that is subject to tornados. Such events are addressed in its Emergency Manual, which provides response and mitigation instructions for releases associated with natural disasters. (CBR, 2010a)

In addition to the previously mentioned natural disasters, the staff analyzed the potential for wildfires to impact CBR's proposed operations. In July 2006, a wildfire occurred east of the currently licensed Crow Butte facility (CBR, 2006). In response to this event, the applicant called the NRC's Emergency Operations Center and the NRC project manager to provide notification of a potential evacuation. NRC staff inspected the applicant's program for responding to wildfires and found it acceptable (NRC, 2006).

Staff reviewed the applicant's plans for emergency preparedness, fire protection, and emergency procedures during inspections in 2006 (NRC, 2006) and 2011 (NRC, 2011) at its main facility. During these inspections, staff determined that CBR's emergency procedures were adequate for emergencies that could involve natural events. Staff previously found the applicant's program for responding to natural disasters at its main facility acceptable (see Section 7.3.5 of NRC, 2012). Therefore, staff has reasonable assurance that the applicant's analyses, including consequences and mitigating measures, of natural disasters are relevant and effective for the NTEA. Staff finds nothing to invalidate previous findings on natural disasters and previous staff conclusions on this topic remain valid. In addition, staff has not identified any safety-related concerns pertaining to natural disasters at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), NRC is not reexamining the applicant's discussion of natural disasters.

7.4 Evaluation Findings

The staff reviewed potential accidents that could occur at the NTEA in accordance with acceptance criteria in Section 7.5.3 and Appendix A of NUREG-1569 (NRC, 2003). Accident scenarios included chemical accidents, radiological releases, ground water contamination, pond failures, transportation accidents, and natural disasters. Based on the information provided in the application and the detailed review conducted by the staff as indicated above, and the results of the staff's onsite inspection program (NRC, 2006, 2011), the applicant has appropriately addressed credible accident scenarios and demonstrated the ability to prevent and mitigate the effects of accidents at the NTEA through actions performed at the currently licensed Crow Butte facility. Therefore, the applicant's accident analyses and resulting procedures are consistent with Section 7.5.3 and Appendix A of NUREG-1569 (NRC, 2003) and staff has reasonable assurance that the applicant's proposed equipment, facilities and procedures will be adequate to protect health and minimize danger to life or property, as required by 10 CFR 40.32(c).

As discussed above, for accidents not associated with transportation accidents involving resin transfers, staff finds nothing to invalidate previous findings on accidents and previous staff conclusions on this topic remain valid (see Section 7 of NRC, 2012). In addition, staff has not identified any unreviewed safety-related concerns pertaining to accidents at the NTEA. In accordance with Appendix A of NUREG-1569 (NRC, 2003), NRC is not reexamining the applicant's discussion of accidents not associated with transportation accidents involving resin transfers.

7.5 References

CBR, 2012. Cameco response to NRC revisions to the Draft License Crow Butte License Renewal, February 8, 2012, ADAMS accession No. ML120450518 (Package).

CBR, 2010a. Response to Open Issues – Replacement Pages, October 22, 2010, ADAMS Accession No. ML103010522.

CBR, 2010b. 2010 Annual Pond Inspection Report, ADAMS Accession No. ML103400066.

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