

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before the Licensing Board:

G. Paul Bollwerk, III, Chairman
Dr. Richard E. Wardwell
Dr. Thomas J. Hirons

In the Matter of

CROW BUTTE RESOURCES, INC.

(Marsland Expansion Area)

Docket No. 40-8943-MLA-2

ASLBP No. 13-926-01-MLA-BD01

September 18, 2018

MEMORANDUM AND ORDER
(Request to Stipulate to Factual Background)

Based on the parties' prefiled submissions and the previous uncontested rulings of the licensing board in the pending Renewal Site proceeding,¹ the Licensing Board proposes the following background factual information be stipulated to by parties Oglala Sioux Tribe (OST), Crow Butte Resources, Inc. (CBR), and the Nuclear Regulatory Commission (NRC) staff.

¹ Crow Butte Res., Inc. (In Situ Leach Facility, Crawford, Neb.), LBP-16-13, 84 NRC 271 (2016), petition for Commission review pending. The citations to the prefiled submissions are provided in the expectation that the admissibility of those portions of the documents will not be contested and therefore provide the supporting basis for the stipulated information. To the degree the stipulated information is later incorporated into the Board's initial decision regarding admitted Contention 2, the citations would be updated to reflect the status of the documents as admitted exhibits. Also, in accord with the Board's previous direction, see Licensing Board Memorandum and Order (Providing Administrative Directives Associated with Evidentiary Hearing and Limited Appearance Session) (July 27, 2018) at 11 (unpublished), the page citations in this Board issuance are to the actual page numbers in the cited documents rather than the portable document format (.pdf) pagination of the prefiled exhibit.

I. PROPOSED STIPULATION

A. Mining Operations at the Marsland Expansion Area

The proposed Marsland Expansion Area (MEA) site is located in southwestern Dawes County, Nebraska, approximately 11 miles south-southeast of the original CBR in situ recovery (ISR) mining site,² which is currently the subject of a license renewal proceeding before the agency.³ The proposed MEA license area is approximately 4622 acres,⁴ which has the potential to encompass 11 mining units (MUs) with a total disturbed area of approximately 1754 acres based on applicant CBR's current knowledge of available reserves.⁵

Consistent with the renewal site configuration, wells within each MU will be arranged in 7-spot patterns with a central production well surrounded by six injection wells spaced at between 65 and 150 feet (ft.) from each other in a hexagonal pattern.⁶ Under the conditions of its existing license, which also apply to the MEA,⁷ CBR is authorized to inject lixiviant that

² Prefiled ex. CBR006, [CBR], Technical Report, [MEA] at 1-3 (June 2017) (consolidated) [hereinafter Tech. Rep.] (ADAMS Accession No. ML18229A259); Prefiled ex. NRC008, Division of Decommissioning, Uranium Recovery, & Waste Programs, Office of Nuclear Material Safety and Safeguards (NMSS), Safety Evaluation Report, License Amendment for the [CBR] [MEA] In-Situ Recovery Project, Dawes County, Nebraska at 19 (Jan. 2018) [hereinafter SER] (ADAMS Accession No. ML18229A331).

³ See Renewal Site, LBP-16-13, 84 NRC 271.

⁴ Prefiled ex. CBR005-R, [CBR], Application for Amendment of USNRC Source Materials License SUA-1534, [MEA], Crawford, Nebraska, Environmental Report at 1-3, tbl. 3.5-2 (rev. Apr. 25, 2014) (consolidated) [hereinafter ER] (ADAMS Accession No. ML18242A687); Prefiled ex. NRC006, Division of Fuel Cycle Safety, Safeguards & Environmental Review, NMSS, Environmental Assessment for the [MEA] License Amendment Application at 1-1, 2-5, 3-42 (Apr. 2018) [hereinafter EA] (ADAMS Accession No. ML18229A329).

⁵ ER at 1-3; EA at 2-5.

⁶ Tech. Rep. at 3-11; SER at 66.

⁷ SER at 72.

contains either sodium carbonate or sodium bicarbonate and either oxygen or hydrogen peroxide at the renewal site, and CBR has not requested a different lixiviant composition for the MEA.⁸ From the MUs, CBR would extract uranium-bearing water from the subsurface via a production well and pipe the uranium-bearing water to the satellite facility located within the MEA for processing by loading the uranium onto ion exchange (IX) resins.⁹ The loaded resins would then be transported by tanker truck to the central processing facility (CPF) at the existing renewal site for elution, drying, and packaging as yellowcake.¹⁰ Barren resin would be returned to the MEA satellite building by tanker truck.¹¹ CBR would begin aquifer restoration activities in an active MEA MU when uranium recovery ceases in that wellfield.¹²

B. Undisputed Regional Geologic Setting

1. General Stratigraphic Units

Starting from the youngest to oldest and including the thickness of the unit underlying the MEA, the geologic units within the MEA are (1) the alluvium (less than 30 ft. thick); (2) the Upper Aquifer consisting of the Arikaree Group (40 to 160+ ft. thick) and the Brule Formation (350 to 550 ft. thick); (3) the Upper Confining Unit (UCU) consisting of the Upper and Middle Chadron Formations (360 to 450 ft. thick); (4) the Production Zone Aquifer at the Basal

⁸ Tech. Rep. at 3-3 (citing Prefiled ex. CBR009, Technical Report Tables at tbl. 3.1-5 (ADAMS Accession No. ML18229A265)); SER at 16.

⁹ Tech. Rep. at 3-29; SER at 16; EA at 1-2. "Satellite facility" as used in this EA refers to the 1.8-acre (0.73 hectare (ha)) area shown in EA figure 1-1. EA at 1-3, fig. 1-1, 4-26.

¹⁰ Tech. Rep. at 1-5.

¹¹ Id. at 1-5, 3-22; SER at 16.

¹² Tech. Rep. at 1-8 (citing Prefiled ex. CBR008-R, Technical Report Figures at fig. 6.1-1 (ADAMS Accession No. ML18242A688) [hereinafter Tech. Rep. Figs.]); SER at 77.

Chadron/Chamberlain Pass Formation (BC/CPF) (20 to 90 ft. thick);¹³ and (5) the Lower Confining Unit (LCU) consisting of the Pierre Shale formation (750 to greater than 1000 ft. thick).¹⁴ The White River Group, which is referenced in the parties' testimony, includes, from youngest to oldest, the Brule Formation overlying the Upper and Middle units of the Chadron Formation, and the BC/CPF.¹⁵

These geologic units are consistent with regional units.¹⁶ Further details of the stratigraphic information for each formation is provided below starting with the youngest and ending with the oldest deposits.

A strata's hydraulic conductivity (a.k.a. permeability) is a measure of the ease or difficulty for groundwater to flow through the porous geologic media and determines to some extent the potential impact of ISR activities at the MEA.¹⁷ As such, the stratigraphic units are subdivided or combined into "hydrostratigraphic" units based on their transmissivity (hydraulic conductivity multiplied by thickness of the unit).¹⁸ Hydrostratigraphic units that can transmit sufficient quantities of water of sufficient quality to provide beneficial use are described as

¹³ Consistent with the Renewal Site proceeding, rather than using the historic terminology of the "Basal Chadron" for this formation or the more recent name of "Chamberlain Pass Formation," this formation will be referred to as the "Basal Chadron/Chamberlain Pass Formation." See Renewal Site, LBP-11-13, 84 NRC at 288–89 n.43; see also id. at 399–403 (indicating parties' experts agreed to use of this nomenclature, recognizing that its use did not affect the operation of the mine nor was there any disagreement that adopting the BC/CPF label did not change the hydrogeologic characterization of the strata).

¹⁴ Tech. Rep. at 2-43 to -55; SER at 29–33.

¹⁵ Prefiled ex. OST004, Testimony of Mike Wireman at 3 (ADAMS Accession No. ML18230A869); Tech. Rep. at 2-45; SER at 28.

¹⁶ SER at 29; see also id. at 28.

¹⁷ EA at 3-6.

¹⁸ Id.

aquifers.¹⁹ Hydrostratigraphic units of low transmissivity are termed “aquitards,” which, as described in greater detail below, may act as confining units.²⁰ Definitions of the aquifer parameters are as follows:²¹

- K: hydraulic conductivity (a.k.a. permeability) – measure of the ease or difficulty for groundwater flow expressed as distance/time (e.g., ft./day, centimeter/second (cm./sec.))
- T: transmissivity – unit rate of water flow calculated as the product of the hydraulic conductivity and aquifer thickness with units of distance squared per time (ft.²/day)
- Q: groundwater flow quantity – hydraulic conductivity multiplied by the hydraulic gradient and cross-sectional area (ft.³/day)
- S: storativity – describes the volume of water released from storage per unit change in hydraulic head per unit area in a confined aquifer (dimensionless number)
- Sy: specific yield – volume of water that an unconfined aquifer releases from storage for a unit drop in the water table level (dimensionless number)
- S_s: specific storage – calculated as the storativity divided by aquifer thickness (dimensionless number)
- i: hydraulic gradient – slope of the water table or potentiometric surface calculated as the difference in water level elevation over a unit distance (dimensionless number)
- φ: porosity – ratio of volume of void space and the total volume of the aquifer (dimensionless number)
- φ_h: hydraulic porosity – applies to turbulent flow in porous media, which is not significant in the operational setting of this application
- φ_e: effective porosity – percentage of void space within a rock matrix that is interconnected and allows fluid to flow through it, noting that the remaining porosity consists of isolated or unconnected pores (dimensionless number)

¹⁹ Id.

²⁰ Id.

²¹ EA at 4-16 to 4-17; Prefiled ex. NRC001, NRC Staff’s Initial Testimony at 19–20 (ADAMS Accession No. ML18229A318).

2. Upper Aquifers

Surficial alluvium, discontinuous within the MEA, consists of fragments of locally outcropping sedimentary rocks, sand, gravel, and sandy soil horizons and may include weathered portions of the Arikaree Group.²² Where present, these alluvial deposits for the MEA range from less than 3 ft. to approximately 30 ft. in thickness.²³

The Arikaree Group (Arikaree), the surficial strata at the MEA where the alluvium is absent, overlies the Brule Formation (Brule).²⁴ The Arikaree consists of numerous interbedded channel and floodplain deposits along with windblown layers.²⁵ Based on grain size analysis of core samples, the interbedded layers within the unit include coarse to fine-grained sandstones with mudstones and siltstones.²⁶ Over the MEA, the Arikaree Group generally ranges between 40 ft. to over 160 ft. in thickness, with an average thickness of 105 ft. and increasing in thickness from south to north.²⁷ The coarse- to fine-grained sandstones represent locally water-bearing units that are interbedded with low-permeability mudstone units and vary widely in extent, ranging between 10 ft. to several hundred feet wide and up to 50 ft. thick.²⁸

The Brule Formation in the region overlies the Chadron Formation and, in turn, is overlain by sandstones of the Arikaree Group.²⁹ The Brule consists of an uppermost brown

²² Tech. Rep. at 2-42; SER at 33.

²³ Tech. Rep. at 2-42; SER at 33 (citing Tech. Rep. Figs. at figs. 2.6-3a to -3n).

²⁴ Tech. Rep. at 2-43; SER at 33.

²⁵ Tech. Rep. at 2-43; Tech Rep. Figs. at figs. 2.6-3a to -3n; SER at 33.

²⁶ Tech. Rep. at 2-43; SER at 33.

²⁷ Tech. Rep. at 2-43; Tech. Rep. Figs. at fig. 2.6-6; SER at 33.

²⁸ Tech. Rep. at 2-80; SER at 33.

²⁹ Tech Rep. at 2-45; Tech. Rep. Figs. at fig. 2.6-1; SER at 49.

siltstone underlain by siltstones with isolated beds of sandstone and volcanic ash.³⁰ Beneath this upper siltstone layer of the Brule are other clayey siltstones, claystones, sandstones and volcanic ashes.³¹ At the MEA, the Brule Formation is predominated by the uppermost brown siltstone layer.³² This layer is underlain by thick, fine to medium-grained sandstones across the entire MEA.³³ These sandstones constitute the first overlying aquifer above the production zone.³⁴

The overall thickness of the Brule Formation in the MEA ranges from approximately 350 to 550 ft., generally thinning from north to south across the MEA.³⁵

3. Upper Confining Units (UCU)

The Brule Formation is separated from the underlying BC/CPF by the Middle and Upper Chadron confining units.³⁶ The Middle Chadron is clay-rich with interbedded bentonitic clay and sand,³⁷ while the Upper Chadron is a bentonitic clay grading downward to green and red clay, with some interbedded sandstone intervals.³⁸ The contact between the Upper and Middle Chadron is difficult to ascertain due to similarities in grain size and geophysical log responses.³⁹

³⁰ Tech. Rep. at 2-45 to -46; SER at 32.

³¹ Tech. Rep. at 2-46; SER at 32.

³² Tech. Rep. at 2-45; SER at 32.

³³ Tech. Rep. at 2-45; SER at 32.

³⁴ Tech. Rep. at 2-46; SER at 32.

³⁵ Tech Rep. Figs. at figs. 2.6-3a to -3n (cross section), 2.6-7 (isopach map).

³⁶ Tech. Rep. at 2-41; SER at 48.

³⁷ Tech. Rep. at 2-48; SER at 31.

³⁸ Tech. Rep. at 2-48; SER at 31.

³⁹ Tech. Rep. at 2-49; SER at 31.

The thickness of the Upper and Middle Chadron units range from approximately 360 to 450 ft. and generally thins toward the south across the MEA.⁴⁰ Geophysical logging indicates that the Middle and Upper Chadron units are laterally continuous throughout the MEA.⁴¹

The X-ray diffraction (XRD) analyses of both the Upper Chadron and Middle Chadron core samples and grain size analysis from the MEA indicated the Upper/Middle Chadron samples are classified as siltstone, with more than 50 percent of the sample grain sizes reported to fall in the silt-clay fraction range, indicating the low-permeability nature of these units.⁴² XRD analyses indicate that the chemical compositions of core samples from the Middle Chadron are highly similar to the Pierre Shale (e.g., predominantly mixed-layered illite/smectite or montmorillonite with quartz), which would be expected if the Pierre Shale was a contributing source of materials for the overlying Middle Chadron.⁴³

4. Basal Chadron/Chamberlain Pass Formation (BC/CPF)

This layer, which overlies the thick Pierre Shale and hosts the uranium production zone in localized channels, is a coarse-grained sandstone interbedded with thin silt and clay beds of varying thickness.⁴⁴ BC/CPF is laterally continuous throughout the MEA, ranges in depth from approximately 850 to 1200 ft. below ground surface (bgs) and varies from approximately 20 to

⁴⁰ Tech. Rep. at 2-49; see also Tech. Rep. Figs. at fig. 2.6-8; SER at 31.

⁴¹ SER at 31; Tech Rep. Figs. at figs. 2.6-3a to -3n.

⁴² Tech. Rep. at 2-47 to -49; SER at 31-32.

⁴³ Tech. Rep. at 2-84.

⁴⁴ Tech. Rep. at 2-49; SER at 30.

90 ft. in thickness.⁴⁵ MEA production zone is a roll front deposit with uranium mineral species present at concentrations ranging from 0.11 percent to 0.33 percent triuranium octoxide (U_3O_8), with an average ore grade of 0.17 percent.⁴⁶ Based on the similar regional deposition of the currently licensed renewal site with the MEA (whereby the ore bodies in the two areas are within the same geologic unit and have the same mineralization source), the MEA ore body is expected to be similar mineralogically and geochemically to that of the ore body at the currently licensed CBR facility.⁴⁷

5. Pierre Shale Lower Confining Unit (LCU)

The Pierre Shale is a thick, homogenous black marine shale with low permeability that represents one of the most laterally extensive formations of northwest Nebraska. It ranges in depth from approximately 870 to 1290 ft. bgs (based on the depth and thickness of the BC/CPF),⁴⁸ and can be up to 1500 feet thick in the Dawes County area.⁴⁹ The regional estimates of the Pierre Shale's hydraulic conductivity is of 10^{-7} to 10^{-12} cm./sec.⁵⁰ and there has been no observed transmissivity between vertical fractures in the Pierre Shale (which appear to be short and not interconnected).⁵¹ During the Renewal Site proceeding, there was no dispute among the parties that the very low permeability of the Pierre Shale in the LCU prevents mining

⁴⁵ Tech. Rep. at 2-50; Tech Rep. Figs. at figs. 2.6-3a to -3n, 2.6-9; SER at 67.

⁴⁶ Tech. Rep. at 2-55; SER at 31.

⁴⁷ Tech. Rep. at 2-55; SER at 31.

⁴⁸ Tech. Rep. at 2-50; SER at 52.

⁴⁹ Tech. Rep. at 2-52.

⁵⁰ Id. at 2-53.

⁵¹ Id.; ER at 3-43.

liquids from flowing downward from the base of the BC/CPF Aquifer, and as an undisputed regional hydrogeologic condition, the base of the BC/CPF Aquifer is the low-permeability Pierre Shale that acts as an LCU for the BC/CPF.⁵²

C. Undisputed Regional Hydrogeologic Conditions in the MEA

1. Surface Water Resources

The Niobrara River flows easterly through a point approximately 0.4 miles south of the southernmost MEA mine unit (MU-F).⁵³ The Niobrara River originates in eastern Wyoming near Manville, in Niobrara County, and flows in an east-southeast direction into western Nebraska.⁵⁴ The river flows across Sioux County in Nebraska, east through the Agate Fossil Beds National Monument, passing the town of Marsland to the south of the proposed MEA, continuing through the southern boundary of the MEA, and through the 1600 acre Box Butte Reservoir approximately three miles to the east of the southeast corner of the MEA license boundary.⁵⁵ There are no apparent direct drainages from the MEA to the reservoir.⁵⁶ While the primary purpose of the reservoir is to facilitate irrigation, the Box Butte Reservoir has altered the hydrology of the Niobrara River by diverting water for irrigation.⁵⁷

⁵² Renewal Site, LBP-16-13, 84 NRC at 296–97.

⁵³ Tech. Rep. at 2-77; EA at 3-18.

⁵⁴ Tech. Rep. at 2-77; EA at 3-19.

⁵⁵ Tech. Rep. at 2-77 to -78; EA at 3-19.

⁵⁶ Tech. Rep. at 2-78.

⁵⁷ EA at 3-19.

From the reservoir, the river flows east across northern Nebraska, and joins the Snake River approximately 13 miles southwest of Valentine, Nebraska.⁵⁸ The Niobrara River is a small size stream of limited areal extent with an average flow rate of 29 cubic feet per second (cfs).⁵⁹

The annual average stream flows at four gaged Niobrara River sites are decreasing over time.⁶⁰ While stream data indicates that the Niobrara River is gaining water from west to east, the mean flows have decreased with time.⁶¹ Groundwater is the primary source of flow into the Niobrara River in the vicinity of the MEA and, in this area of the river, the discharge of the river is steady and persistent, with overbank flooding uncommon except during winter ice jams.⁶²

2. Subsurface Water Resources

Descriptions of the regional hydrostratigraphic units underlying the MEA and the region are provided for both the aquifers and confining units underlying the MEA.⁶³ The regional aquifers relevant to this safety evaluation are the Arikaree Group and Upper Brule Formation (both of which are unconfined, surficial aquifers), and the deeper, confined BC/CPF.⁶⁴ In the vicinity of the MEA, water has been observed in the Arikaree Group, Brule Formation, and

⁵⁸ SER at 45; see also Tech. Rep. Figs. at figs. 2.7-2 to -3.

⁵⁹ SER at 21.

⁶⁰ EA at 3-21.

⁶¹ Id.

⁶² Id.

⁶³ Tech. Rep. at 2-79 to -81. Aquifers are geological formations “with sufficient permeability and porosity to significantly transmit and store groundwater,” and confining units are “strata with insufficient permeability (e.g., shale units) that hydraulically separate aquifers.” SER at 48.

⁶⁴ SER at 48.

sandstone of BC/CPF.⁶⁵ Alluvial deposits are discontinuous at the MEA and have not been shown to contain usable amounts of water.⁶⁶

Separating the BC/CPF sandstone aquifer from the surficial unconfined aquifers in the Upper Brule Formation and the Arikaree Group are the remaining members of the Chadron and Brule Formations, which collectively are identified as the UCU to BC/CPF sandstone aquifer.⁶⁷ The LCU beneath the BC/CPF sandstone aquifer is the Pierre Shale.⁶⁸

II. REACHING PARTY AGREEMENT ON STIPULATION

In a joint filing to be provided to the Board by Friday, September 28, 2018, the parties should indicate whether they disagree with any portion of the above factual background statement and, in the event of such a disagreement, they should consult and submit proposed alternative wording.

It is so ORDERED.

FOR THE ATOMIC SAFETY
AND LICENSING BOARD

/RA/

G. Paul Bollwerk, III, Chairman
ADMINISTRATIVE JUDGE

Rockville, Maryland

September 18, 2018

⁶⁵ Tech. Rep. at 2-79.

⁶⁶ Id.

⁶⁷ Id. at 2-79, 2-84 to -85.

⁶⁸ Id. at 2-52, 2-79, 2-84 to -86.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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In-Situ Leach Uranium Recovery Facility,) ASLBP No. 13-926-01-MLA-BD01
Crawford, Nebraska)
)
(License Amendment –)
Marsland Expansion Area))

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **MEMORANDUM AND ORDER (Request to Stipulate to Factual Background)** have been served upon the following persons by Electronic Information Exchange.

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[Original signed by Brian Newell]
Office of the Secretary of the Commission

Dated at Rockville, Maryland
this 18th day of September, 2018