UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)	Docket No. 40-8943-MLA-2 ASLBP No. 13-926-01-MLA-BD01

Hearing Exhibit

Exhibit Number: CBR033

Exhibit Title: Rebuttal Testimony on Contention 2

September 7, 2018

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 40-8943-MLA-2
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(Marsland Expansion Area)	)	

WRITTEN REBUTTAL TESTIMONY OF CROW BUTTE RESOURCES WITNESSES
ROBERT LEWIS, WALTER NELSON, DOUGLAS PAVLICK, AND JAMES STRIVER
ON CONTENTION 2

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WRITTEN REBUTTAL TESTIMONY OF CROW BUTTE RESOURCES WITNESSES ROBERT LEWIS, WALTER NELSON AND DOUGLAS PAVLICK

EXPERT WITNESSES

A. Robert Lewis

Q1. Please state your full name, your employer, and your position.

A1. Robert Lewis ("RL"). I am the owner and Principal Hydrogeologist of AquiferTek LLC, providing specialized hydrogeologic and environmental consulting services. My professional qualifications were provided in connection with direct testimony on Contention 2.

Q2. What is the purpose of your testimony?

A2. (RL) The purpose of my testimony is to respond to the issues raised by Oglala Sioux Tribe ("OST" or "Intervenors") in their direct testimony on Contention 2.

B. Walter Nelson

Q3. Please state your full name, your employer, and your position.

A3. Walter Nelson ("WN"). I am employed by Crow Butte Resources as the Safety, Health, Environment, and Quality ("SHEQ") Coordinator at the Crow Butte facility. My professional qualifications were provided in connection with direct testimony on Contention 2.

Q4. What is the purpose of your testimony?

A4. (WN) The purpose of my testimony is to respond to the issues raised by OST in their direct testimony on Contention 2.

C. Douglas Pavlick

Q5. Please state your full name, your employer, and your position.

A5. Douglas Pavlick ("DP"). I am employed by Crow Butte Resources as the General Manager for U.S. Operations. My professional qualifications were provided in connection with direct testimony on Contention 2.

Q6. What is the purpose of your testimony?

A6. (DP) The purpose of my testimony is to respond to the issues raised by OST in their direct testimony on Contention 2.

D. James Striver

Q7. Please state your full name, your employer, and your position.

A7. James Striver ("JS"). I am employed by Crow Butte Resources as the Senior Geologist at Smith Ranch-Highland facility in Douglas, Wyoming. My professional qualifications are attached to my affidavit provided in connection with rebuttal testimony on Contention 2.

Q8. What is the purpose of your testimony?

A8. (JS) The purpose of my testimony is to respond to the issues raised by OST in their direct testimony on Contention 2.

BACKGROUND

Q9. What is your understanding of Contention 2 as a whole?

A9. (RL, WN, DP, JS) OST Contention 2, as admitted by the Board in this proceeding and limited as described in its Memorandum and Order of March 16, 2018 (LBP-18-02), reads as follows:

> The application and draft environmental assessment fail to provide sufficient information regarding the geological setting of the area to meet the requirements of 10 C.F.R. Part 40, Appendix A, Criteria 4(e) and 5G(2); the National Environmental Policy Act; and NUREG-1569 section 2.6. The application and draft environmental assessment similarly fail to provide sufficient information to establish potential effects of the project on the adjacent surface and ground-water resources, as required by NUREG-1569 section 2.7, and the National Environmental Policy Act.

In LBP-18-02, the Board specified that the contention includes four Concerns, as migrated (restricting the scope of the second Concern to safety issues only), as follows:

Concern 1: [T]he adequacy of the descriptions of the affected environment for establishing the potential effects of the proposed MEA operation on the adjacent surface water and groundwater resources;

Concern 2: [E]xclusively as a safety concern [and not with regard to the EA], the absence in the applicant's technical report, in accord with NUREG-1569 section 2.7, of a description of the effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient of site hydrogeology, along with other information relative to the control and prevention of excursions;

Concern 3: [T]he failure to develop, in accord with NUREG-1569 section 2.7, an acceptable conceptual model of site hydrology that is adequately supported by site characterization data so as to demonstrate with scientific confidence that the area hydrogeology, including horizontal and vertical hydraulic conductivity, will result in the confinement of extraction fluids and expected operational and restoration performance; and

Concern 4: [W]hether the draft EA contains unsubstantiated assumptions as to the isolation of the aquifers in the ore-bearing zones.

RESPONSE TO KREAMER OPINION

Q10. What is Dr. Kreamer's Opinion 1?

A10. (RL, WN, DP) Dr. Kreamer claims that the site characterization is deficient and mischaracterizes the hydrogeologic environment at the MEA site. He alleges that "much of the collected pumping test data was selectively ignored, the solitary pumping test covered very little of the of the MEA site leaving the majority of the site hydrogeologically undefined, and the single pumping test that was analyzed was influenced by conditions outside the site boundary." Dr. Kreamer goes on to argue that the "failed" Marsland pumping test that went on for 19 hours had a long enough duration to be "possibly analyzed and perhaps could have be [sic] included as a second analysis." He also claims that, "[i]f this occurred at the end of the test, the information recorded is still valid."

Q11. Do you agree?

A11. (RL) No. Analysis of the failed pump test data would not have been useful or insightful. The well CPW-1 test was terminated after only 19 hours, a small fraction of the time necessary to measure significant drawdown in more distant wells, and far short of the 4.3 days needed to reach all drawdown targets and terminate the test. Failed test well CPW-1 was also shown to be very inefficient (abnormally high drawdown) that prevented more ideal higher pumping rates. Well CPW-1 was subsequently replaced by well CPW-1A for the final test. *See* Revised Pumping Test Plan (CBR023) at 1.

Q12. Dr. Kreamer claims that the report only analyzed selective portions of the data from pumping test and that the excluded data shows lack of confinement. Do you agree?

A12. (RL, WN, DP) No. We disagree with OST's characterization. Certain data collected from the test are considered more reliable than others for purposes of data analyses. For example, early-time data does not characterize the aquifer response as accurately as do mid- and late-time data. Early-time drawdown data are negatively influenced by a number of factors not related to the aquifer response to pumping and, therefore, are inappropriate for estimating aquifer behavior. First, theoretical equations rely on the assumption that the well discharge remains constant and that the release of water from the aquifer is immediate and directly proportional to the rate of decline of pressure. This leads to initial disagreement between theory and actual flow, though, as the time of pumping extends, these effects are minimized, and closer agreement may be attained. Second, wellbore storage can also affect the early-time data, especially large diameter, deep production wells with large water column height. Because the amount of water stored within the wellbore can be substantial, it must be removed before the aquifer can respond properly to the induced drawdown, which further reduces the value of early-time data. The pumping test report provides the detailed discussion and explanation for how data was used to characterize the aquifer response, including the basis for concluding that adequate confinement exists. For example, no drawdown was observed in overlying Brule Formation observation wells during the test period (CBR016 at 1). This observation supports the conclusion that adequate confinement exists between the overlying Brule Formation and the Basal Chadron production zone. In addition, drawdown data vs. time were plotted for each observation well. Based on the character of the curves, it was determined that confined aquifer analytical methods were appropriate for the analysis of water level data (CBR016 at 11). Based on the above, we disagree with OST's witness's conclusion that the data show evidence of lack of aquifer confinement.

In any event and as we discussed in our direct testimony, there are multiple lines of evidence supporting confinement, in addition to the pumping test results, including: (1) hydrologic characteristics of the upper and lower confining units; (2) aquifer pumping test results; (3) the potentiometric surface of the Basal Chadron Sandstone aquifer; (4) differences in potentiometric surfaces between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; (5) water quality differences between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; and (6) isotopic age differences between water in the Brule and Basal Chadron Sandstone. *See also* TR Appendix AA-3 (CBR012). Collectively, these lines of evidence provide a robust basis for the conclusion that there is adequate confinement.

Q13. Dr. Kreamer claims that, even though the report states that Cooper-Jacob semi-logarithmic evaluations were performed on the data, these analyses did not appear in the report and, further, can identify a recharge boundary that is consistent with lack of confinement of the aquifer. Do you agree?

A13. (RL, WN, DP) No. The Cooper-Jacob semi-logarithmic distance-drawdown analysis was performed as stated in the report. Results are shown in Figure 18 and discussed in Section 7.6.1 in the test report (CBR016 at 12-13, Figure 18).

Q14. Dr. Kreamer complains that the pumping test report did not include an analysis of pumping test data from water level changes at Monitoring Wells 2 or 8 in the analysis, although these wells were reported to be in the radius of influence of the pumping test and those water level changes were used to define an extended radius of pumping well influence. Can you explain?

A14. (RL, WN, DP) Yes. As described in the test report and revised test workplan (CBR016, Section 5, *Monitoring Well Locations, Installation and Completion*, at 12; CBR023 at 1), Monitor Wells 2 and 8 were not part of the formal monitoring well network. The radius of influence for the test did not include data from Monitor Wells 2 or 8 since they were not part of the formal monitoring network. In accordance with NDEQ requirements that were incorporated into the testing workplan, monitor wells that are part of the formal monitoring network should have greater than 0.5 feet of drawdown at the end of the test. Even though Monitor Wells 2 and 8 were not part of the formal monitoring network, water level data from these wells were collected and analyzed for completeness, as both wells showed measurable drawdown due to pumping of approximately 0.5 feet. Data from Monitor Wells 2 and 8 were analyzed as other monitoring wells, and results are presented in Table 8 of the testing report (CBR016 at Figures page 10).

Q15. Dr. Kreamer claims that performing a single pumping test covered only a relatively small portion of the site "is poor professional practice." Do you agree?

A15. (RL, WN, DP) No. Cameco's approach is consistent with industry practice and with NRC guidance. NUREG-1569 (NRC010 at 2-24) states that "[a]ny of a number of commonly used aquifer pumping tests may be used including single-well drawdown and recovery tests, drawdown versus time in a single observation well, and drawdown versus distance pumping tests using multiple observation wells." Cameco's approach is also consistent with practice at other recent ISR license applications.

With respect to Marsland specifically, Pump Test #8 was designed to characterize the area of the MEA that would be the location of the first four mine units to be developed. Additional pumping tests would provide little incremental value with respect to those mining units given the quality and reliability of existing data and analyses. The expectation is that additional site-specific pumping tests are performed, as required, as additional mine units are added. License Condition 11.3.4 (NRC009 at 19) states that, as part of developing its wellfield packages for any new mine units at the MEA, the applicant shall perform an aquifer pumping test for each new mine unit. For mine units MU-D through MU-F, the licensee shall submit its plan for conducting the aquifer pumping test for NRC review and written verification at least 60 days prior to the planned date for performing the aquifer pumping test.

Finally, there were several lines of evidence supporting confinement across the site in addition to the pumping test results. *See, e.g.*, TR Appendix AA-3 (CBR012). There is therefore a strong basis for concluding that confinement exists even without the pumping test data and analysis.

Q16. OST argues that the pumping test was impacted by hydrogeologic influences off-site that were not part of the area to be evaluated, claiming that the cone of depression's radius of influence extended off-site. Does that impact the analysis' conclusions?

A16. (RL, WN, DP) No. The aquifer test results are representative of average aquifer conditions over the radius of influence of test, which includes all monitoring wells that were evaluated as part of the test. The fact that the radius of influence extends off-site to the east and west of the MEA boundary is irrelevant to the outcome of the testing results.

Q17. According to Dr. Kreamer, the report does not make clear if the actual aquifer thicknesses were used to calculate transmissivity or only the average aquifer thickness. Is that true?

A17. (RL, WN, DP) No. As stated throughout the pump testing report (*see, e.g.*, CBR016 at 5, 13, 14, and Table 8), an average net sand thickness of 40 feet was used to calculate transmissivity of the Basal Chadron Sandstone at Marsland. Ore-grade uranium deposits underlying the Marsland Expansion Area are located in the Basal Chadron Sandstone, which averages 50 feet in thickness (typically 40 feet net sand). While there is some variability, the assumption is "reasonably satisfied over the test area." CBR016 at 11.

Q18. Dr. Kreamer states that the thickness of the Basal Chadron Sandstone varies across the site and that the screened intervals of the monitoring wells may not reflect the entire thickness of that aquifer. Is that relevant?

A18. (RL, WN, DP) Monitoring wells installed as part of the pump test penetrated all or the majority of the Basal Chadron Sandstone thickness and are sufficient to characterize the full thickness of the aquifer. In any event, given the relatively large distances from the pumped well to monitoring wells, partial penetration effects in observation wells are negligible.

Q19. Dr. Kreamer claims in his Opinion 2 that Crow Butte "mischaracterizes results of previous testing of the Basal Chadron Sandstone" when it states that the Basal Chadron is relatively homogeneous and isotropic within the current Class III UIC area. Can you respond?

A19. (RL, WN, DP) The homogeneous and confined nature of the Basal Chadron aquifer generally has been previously discussed in detail as part of previous CBR hearings on the main mining area. *See* LBP-16-13, slip op. at 74-75. The same conclusions extend to the Marsland area. The Basal Chadron Sandstone at the MEA is also relatively homogeneous, isotropic, and confined for purposes of aquifer characterization. Crow Butte used appropriate analytical techniques for such aquifers, but nevertheless was prepared to use more complex analytical techniques had it been necessary. It was not.

Q20. Dr. Kreamer includes several hand-drawn plots in his testimony. Are these relevant to Marsland?

A20. (RL, WN, DP) No. Dr. Kreamer is repeating arguments he made in the Crow Butte license renewal proceeding. The drawings included in his testimony here are those that he used to try to reanalyze aquifer pumping test data for the main mining area to match early time data in the license renewal proceeding. Those drawing are specific to pumping tests performed at the main mining area, and not to the pumping test performed in connection with the Marsland application. They therefore are irrelevant to the application at hand. In any event, the Board in the license renewal proceeding rejected Dr. Kreamer's views on the pumping tests in the main license area. *See* LBP-16-13, slip op. at 74.

Q21. In his Opinion 3, Dr. Kreamer states that Crow Butte omitted its analysis of the pumping test using the Cooper-Jacob technique and Dr. Kreamer asserts that a change in the level of water from the Theis curve is consistent with a lack of confinement of the aquifer. Do you agree?

A21. (RL, WN, DP) No. As noted previously, the Cooper-Jacob semi-logarithmic distance-drawdown analysis was performed as stated in the report, and results are shown in Figure 18 and discussed in Section 7.6.1 in the test report (CBR016 at 12-13, Figure 18). Results of that analysis are consistent with Theis drawdown analyses also provided in the report. Given the great thickness, low permeability, and depth of the Basal Chadron Sandstone confining unit, there is no conceptual basis for additional aquifer test analyses. Significant local variations in aquifer thickness and hydraulic conductivity (transmissivity) described in the report are conceptually consistent with observed drawdown responses in a highly confined aquifer. There is no reason to perform hypothetical aquifer leakage analyses when no conceptual basis for such leakage exists. The Basal Chadron Sandstone at MEA has an even thicker confining unit than that observed at the main mining area, is more confined, has even stronger downward hydraulic gradients, and is therefore less susceptible to leakage.

With respect to the assumptions used, we recognize that, at some scale, all geologic systems are exhibit heterogeneity and anisotropy. But, at the relevant scale for licensing, we assume homogeneous, isotropic responses, and then look to the actual test results to show whether there were significant deviations from the assumed homogeneity and isotropy which, in turn, would establish the need for the use of more complex analysis methods. No such additional complexity was necessary here.

Finally, Dr. Kreamer did not provide an independent estimate for the rate of leakage based on some alternative interpretation of the Marsland pumping test data, nor did he suggest an alternative, superior method to those used by Crow Butte.

Q22. Dr. Kreamer argues that the assumption that the Basal Chadron is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping is inconsistent with data and evidence. Can you respond?

A22. (RL, WN, DP) As noted above, actual hydrogeological conditions always vary from ideal conditions in natural systems. The cited variability in aquifer transmissivity and storativity are not unusual, relatively small, and well within the expected range of variability of a sandstone aquifer. The observed variation in subsurface conditions at MEA does not preclude analysis of the data using analytical models with ideal boundary conditions. As noted in the pumping test report (CBR016 at 11), "[l]ocally, the Basal Chadron Sandstone is not homogenous and isotropic; however, over the scale of the pumping test, it can be treated as such for analytical purposes." (The relative homogeneity of the aquifer is further evidenced by relatively constant hydraulic gradient. CBR008-R at 113-116.)

Overall, the analyses performed as part of the MEA pump testing program are consistent with standard professional practice, were approved by NDEQ hydrogeologists as part of the pump test workplan, and provide reasonable estimates of aquifer properties for the intended purpose.

Q23. Dr. Kreamer also asserts that no "rigorous" analyses for anisotropy were undertaken. Please respond.

A23. (RL, WN, DP) The cone of depression observed during the pumping test did not show significant anisotropy as demonstrated by the relatively circular drawdown cone at the end of the pumping test, utilizing drawdown data from all monitoring wells. CBR016 at 14 and Figure 16. More detailed analyses of anisotropy are not necessary given lack of conceptual basis in the geometry of the drawdown cone.

<u>RESPONSE TO WIREMAN OPINION</u>

Q24. Mr. Wireman claims that the characterization of the local/regional hydrogeology and groundwater flow is inadequate for demonstrating the ability to contain unwanted fluid migration from excursions and to adequately conduct groundwater restoration. Do you agree?

A24. (RL, WN, DP, JS) No. The MEA technical report provides a detailed and robust characterization of the local and regional groundwater flow and hydrogeology.

Q25. Mr. Wireman argues that the there is no information on sources of recharge or the primary pathways that deliver recharge to the deep, confined aquifer. Is that correct?

A25. (RL, WN, DP, JS) No. A conceptual diagram showing areas of recharge and discharge from the Basal Chadron Sandstone was provided (CBR021). Recharge to the Basal Chadron Sandstone occurs as direct infiltration of precipitation where the formation is exposed at distant locations west and south of the main mining area and the MEA, and also as a small amount of downward flow from the overlying confining unit. Elevations of the potentiometric surface of the basal sandstone of the Chadron Formation indicate that the recharge zone must be located above a minimum elevation of 3,715 feet amsl. *See, e.g.*, TR at Section 2.7.2.3, *Hydrologic Conditions* (CBR006); *see also* EA Section 3.3.2.1 (NRC006 at 3-27 to 3-29). Discharge from the Basal Chadron Sandstone currently occurs primarily to wells at the main mining area and flowing wells located near the town of Chadron. Prior to ISR development and the installation of flowing wells, discharge from the Basal Chadron Sandstone occurred in drainages and by evapotranspiration in areas east and north of Chadron where the formation is exposed at and near the surface. The distance from the recharge and discharge areas from the MEA are such that they will not affect the behavior of the Basal Chadron Sandstone aquifer at the MEA.

Q26. Mr. Wireman claims there is significant uncertainty about groundwater flow in the Basal Chadron downgradient of the MEA. Do you agree?

A26. (RL, WN, DP) No. The potentiometric surface elevation at the MEA has shown consistent flow toward the north-northwest, consistent with pre-development and current regional flow direction near the main mining area (*see, e.g.*, CBR021). These observations indicate no influence (flow divide) exists due to the Pine Ridge escarpment in the Basal Chadron Aquifer, which is consistent with the conceptual model of groundwater flow indicating no significant recharge to the Basal Chadron Sandstone along the Pine Ridge Escarpment. This is not unexpected given the significant depth of the Basal Chadron Aquifer below the escarpment, and the significant thickness of the confining unit that separates the Basal Chadron Sandstone from the Brule and Arikaree aquifers.

In contrast, groundwater flow in the overlying Brule and Arikaree aquifers is northwest near the main mining area, and southeast near MEA. This observation clearly indicates a flow divide exists between the main mining area and MEA in the shallow aquifers, due to significant recharge to the shallow formations exposed along the Pine Ridge Escarpment.

Hydraulic gradient data, at both regional and local levels, is presented in potentiometric maps provided as TR Figures 2.9-4a through 2.9-4d, 2.9-5a through 2.9-5d, and 2.9-6a through 2.9-6d (CBR008).

Q27. Mr. Wireman claims that Crow Butte has not installed any Basal Chadron monitoring wells upgradient or downgradient of the license area. Is this true?

A27. (RL, WN, DP) No. Monitoring wells will be installed inside the proposed license area upgradient, downgradient, and to the sides of ISR production and injection wells as part of the monitor well ring for the mine units. These monitoring wells will be used to ensure hydraulic containment and provide the necessary monitoring of groundwater quality downgradient (and in all directions) from active mining areas. There is no need to install such wells prior to operations. No monitor wells will be installed outside the license area, and no active existing wells are completed in the Chadron Formation within the area of review.

Q28. Mr. Wireman claims that Crow Butte omitted discussion of ephemeral streams (*e.g.*, Dooley spring) located within the MEA and that baseline sampling should include the streams. Can you respond?

A28. (RL, WN, DP) Yes. Dooley Spring is not located within the MEA. It is located approximately 1.5 miles west of the MEA boundary. As discussed in the MEA TR, section 2.7 (CBR006), site investigations found no surface water impoundments within the MEA. The lack of water flow in ephemeral drainages in the MEA has prevented collection of surface water samples (section 2.9.4). The TR also notes that rainfall runoff occasionally creates temporary small pools in a few places on the MEA site, but there is no evidence of persistent stream flow in recent times.

Q29. Mr. Wireman asserts that more meteorological data should be collected because 2011 (the year the data was collected) was an abnormal year. Can you respond?

A29. (RL, WN, DP) Yes. Normal annual rainfall for the MEA is expected to be around 15 inches per year, as described in TR Section 2.5-25. To demonstrate that the one-year baseline meteorological data is representative of the longer term conditions, CBR performed regression analysis on historical wind data from the Chadron (NE of MEA) and Scottsbluff (SW of MEA). The analysis showed strong correlation. *See* CBR038 (Appendix S – Justification for use of 15 Years of Scottsbluff's Meteorological Data, MEA TR). As a result, additional data collection is not warranted or necessary.

Q30. Mr. Wireman argues that the TR provides no information on baseline restoration wells that will be used to establish the baseline. Can you address his comment?

A30. (RL, WN, DP) Yes. As an initial matter, this concern is outside the scope of Contention 2, which questions the adequacy of the description of site geology and hydrogeology, including confinement and ability to contain mining fluids. Baseline restoration wells are not relevant to the demonstration of confinement or ability to control mining fluids.

Regardless, these wells will be established as part of developing the mine units at Marsland. License Condition 11.1.3 (NRC009) specifically addresses the sampling necessary to establish background ground water quality data for the ore zone and overlying aquifers. This background water quality will be used to define the background ground water protection standards required to be met in 10 CFR Part 40, Appendix A, Criterion 5B(5), for the ore zone aquifer and surrounding aquifers.

Q31. Mr. Wireman argues (OST004 at 3) that characterization of structural geology at a regional level is insufficient to develop an acceptable conceptual model of site hydrology, in particular with respect to the effects of the Pine Ridge escarpment on groundwater flow in the Basal Chadron aquifer. Can you respond?

A31. (RL, JS, DP) Yes. Mr. Wireman does not discuss how the structural geology that he implies may exist between the main mining and the MEA can be reconciled with the hydrologic data at those sites. There is no hydrogeological conceptual model that can reconcile consistent northwestward groundwater flow between

MEA and main mining area in the Basal Chadron Aquifer if there is a significant discontinuity along the Pine Ridge Escarpment. *See, e.g.*, CBR021.

Regardless, Regional Cross Sections in TR Figures 2.6-22 to -24 (CBR008-R) extend from South of the Niobrara River (south of the MEA) northward through the Marsland Expansion Area, across the Crow Butte License Area and the North Trend License Area. Each cross section crosses the Niobrara River Fault, Cochran Arch, Pine Ridge Fault, and White River Fault. See also EA at 3-6 to 3-7 (NRC006). In particular, Regional Cross Section R1-R1' (Figure 2.6-23) crosses the Cochran Arch/Pine Ridge Escarpment with an average distance between boreholes of 1,400 feet through this 2-mile area, and indicates no significant discontinuity of the Basal Chadron aquifer. Appendix Z in the TR (CBR039 at Figures 2 and 3) contains an additional five cross sections associated with the Three Crow Expansion Area. None of the cross sections substantiate a large north side down vertical displacement across the Pine Ridge Fault. In two of the cross sections, the top of the Pierre Shale surface elevations decreases southward, which is contradictory to a north side down vertical displacement. While we cannot rule out the possibility of a short/small offset, the data demonstrates that there is not a large offset fault that could act as a boundary for groundwater flow and movement that could impact production operations at the MEA. Overall, nothing in Mr. Wireman's general and speculative assertions indicates any errors in the discussion of structural geology.

Q32. Like Dr. Kreamer, Mr. Wireman asserts that the aquifer testing at MEA was inadequate and that data indicate that hydraulic conductivity and transmissivity of the Basal Chadron near the pumping well is an order of magnitude lower than at the outlying monitoring wells. Do you agree?

A32. (RL, WN, DP) No. We have previously addressed the basis for concluding that the aquifer pumping test is sufficient to characterize the portions of the site that would be affected by development of the first four mining units at Marsland. Beyond that, we disagree with Mr. Wireman's characterization that transmissivity and hydraulic conductivity near the pumped well is an order of magnitude lower than outlying monitor wells. Transmissivity and hydraulic conductivity of monitor wells are within a factor of 2 to 4, suggesting relative homogeneity, with the exception of Monitor 3, which is 2 to 9 times lower than other monitor well locations. There is no evidence of the hypothetical structural heterogeneities cited by Mr. Wireman.

Q33. Mr. Wireman claims that there is "too much" uncertainty regarding applicable groundwater restoration standards, citing references to NDEQ restoration standards. Do you agree?

A33. (RL, WN, DP) No. This concern is outside the scope of Contention 2 as admitted. Restoration standards are not relevant to any of the concerns in Contention 2.

Regardless, as the EA (NRC006 at 37) and TR (CBR006 at 297) recognize, the primary goal of the groundwater restoration program is to return groundwater affected by uranium recovery operations to pre-injection baseline values on a mine-unit average, as determined by the baseline water quality sampling program. Licensees and applicants must commit to achieve the ground water quality standards in 10 C.F.R. Part 40, Appendix A Criterion 5B(5) for all restored aquifers, which conforms to the standards promulgated by the U.S. EPA in 40 C.F.R. Part 192 Subpart D 192.32(2). These standards state the concentration of a hazardous constituent (Criterion 13) must not exceed: (a) the Commission approved background concentration of that constituent in ground water; (b) the respective value in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed or; (c) an alternative concentration limit established by the Commission. If an ACL is necessary, an application to use ACLs will include consideration of factors listed under Criterion 5B(6) of 10 CFR Part 40, Appendix A and approval by NRC pursuant to Criterion 5B(5)(c). NDEQ restoration standards exist separate and apart from NRC requirements.

Q34. Mr. Wireman asks, without providing any response, what criteria will be applied to determine whether best available technology has been used if an application for an ACL is necessary. He also wonders how NRC and NDEQ stabilization monitoring can be harmonized. Can you address his questions?

A34. (RL, WN, DP) Yes. Again, this aspect of Mr. Wireman's testimony is outside the scope of Contention 2. Regardless, NRC assesses applicability of best available technology applied as part of the review process to determine that a mine unit is restored or in consideration of an ACL. The outcome of that review will obviously depend on the efforts undertaken to restore the aquifer once mining ends, and may not be necessary depending on the status of restoration efforts

CBR will conduct stability sampling to meet both NDEQ and NRC regulations regarding stabilization phase monitoring. Long term monitoring is determined by NRC as a part of issuing an ACL, if one is required.

Q35. Mr. Wireman alleges that there is inadequate information regarding wastewater disposal. Can you respond?

A35. (RL, WN, DP) Yes. First, this issue is outside the scope of admitted Contention 2 as we understand it. Nevertheless, we provide the following information on deep disposal wells (DDWs) for completeness. Crow Butte currently operates two non-hazardous Class I injection wells in the main license area for disposal of wastewater (DDW-1 and DDW-2). The wells are permitted under NDEQ regulations in Title 122 (NDEQ 2010b) and operated under a Class I UIC Permit. Crow Butte has operated the initial DDW-1 at the current license area for more than 15 years with excellent results. Crow Butte has prepared a permit application for a DDW at Marsland in accordance with regulatory requirements in the NDEQ Assessment Section, Title 122 Rules and Regulations for Underground Injection and Mineral Production Wells (Effective April 02, 2002). The formation receiving the injected waste fluids (Injection Zone) is restricted to the Lower Dakota, Morrison, and Sundance Formations, which have been demonstrated to be located below the lowermost underground source of drinking water. In addition, the Lower Dakota, Morrison, and Sundance Formations exhibit water quality that is not considered under state and federal regulations to be underground sources of drinking water due to measured concentrations of their total dissolved solids.

<u>RESPONSE TO LAGARRY OPINION</u>

Q36. Dr. LaGarry asserts that mining in the Marsland area would contribute to contamination that would migrate laterally into the White and Niobrara rivers. Can you respond?

A36. (RL, WN, DP, JS) Yes. This comment is hypothetical, speculative, and unsupported by data or evidence. Contaminant transport pathways to the White River and Niobrara Rivers from the Marsland site are implausible given the site conditions and operational practice at an ISR facility. Dr. LaGarry's claims are not based on any reasonable transport calculations or historical evidence.

Q37. Dr. LaGarry claims that surface leaks and spills at Marsland could be transmitted to the High Plains aquifer "within a few years." Do you agree?

A37. (RL, WN, DP, JS) No. Dr. LaGarry's statement is speculation and not supported by any evidence or transport analysis. Boring and well logs of surficial soils and shallow subsurface sediments at MEA indicate the site is underlain by 30 to more than 100 feet of unsaturated sediments between the ground surface and underlying water table, including a significant thickness of low permeability materials (*i.e.*, siltstones and claystones of the Brule Formation and/or formations of the Arikaree Group) across much of the site. Further, many of the potential water-bearing units in the Arikaree Group have limited lateral extent and are interbedded with low-permeability mudstone units. The significant thickness of the unsaturated zone and the presence of a significant amount of low permeability materials would significantly reduce the likelihood of downward migration of any spilled mining solutions into the underlying water-table. In the unlikely scenario of a surface spill migrating through unsaturated sediments into Arikaree Group water-bearing sands, the leak would be extremely limited in extent, both laterally and vertically.

More broadly, Crow Butte has considered migration of fluids to overlying aquifers and has put in place multiple controls to prevent such an occurrence. For example, Crow Butte will plug all exploration holes to prevent commingling of the Brule and Chadron Aquifers and to isolate the mineralized zone. In addition, mechanical integrity will be tested prior to placing a well into service. This requirement of the NDEQ UIC Program ensures that all wells are constructed properly and are capable of maintaining pressure without leakage. Finally, monitor wells completed in the overlying aquifer will be sampled every two weeks for the presence of leach solution. These controls have been shown to be effective at the Crow Butte site for over 27 years of operation.

Q38. Dr. LaGarry further claims that underground leaks and spills could contaminate overlying aquifers. How does Crow Butte address this claim?

A38. (RL, WN, DP) This concern is also hypothetical and ignores operational practices, well-construction requirements, and site-specific conditions that would tend to prevent upward contamination. Crow Butte will take the necessary steps to minimize the potential for leaks and spills. First, Crow Butte will have a comprehensive monitoring program (including a monitoring well ring and corrective actions) in place to detect and correct any such leaks or spills should they occur. Second, the possibility of a pipe failure and related release of injection of recovery solutions is minimal, as the wells are installed using standard techniques and all piping will be leak-checked before initial placement into service. Piping from the wellfield will be buried, minimizing the possibility of an accident. Third, the flows through the wellfield, piping and manifold pressure gauges in the wellhouses are monitored 24 hours per day, 7 days per week by control room operators using visual and audible alarms. Flow monitoring systems will alarm in the event of a significant piping failure, which will allow flow to be stopped, preventing any significant migration of process fluids. Wellfield buildings will also be equipped with wet alarms for early detection of leaks. Lastly, the strongly downward hydraulic gradient at Marsland

and the large thickness of confining units at the Marsland would prevent upward movement of mining solutions into overlying aquifers. *See, e.g.*, TR Appendix AA-3 (CBR012).

Q39. Dr. LaGarry claims that there are several potential faults in the Marsland area and potentially hundreds of smaller faults. Can you respond?

A39. (RL, WN, DP, JS) Yes. While faults may exist at a regional level, there is no evidence of any faulting within the MEA that affects confinement or could transmit mining liquids based on the large number of boreholes and wells drilled on the site to date, or any other surficial or subsurface geological data. Any hypothetical or potential features cited by LaGarry outside of the MEA boundary provide no pathway for transport of mining solutions from within the MEA. Moreover, if any minor fractures were to appear, they would close up quickly (*i.e.*, be essentially self-sealing) as a result of overburden pressure from the weight of overlying strata. Moreover, based on the undisputed evidence of confinement of the Basal Chadron aquifer, it is highly unlikely that the MEA contains a fault or a connected pathway of faults in the upper confining unit that is capable of transmitting contaminants. Finally, given strongly downward hydraulic gradients between shallow aquifer and the Basal Chadron Sandstone, migration of fluids along any fault or fracture in the system would likely be downward, precluding any impacts to surficial aquifers. *See, e.g.*, Appendix AA-3 (CBR012). There is simply no evidence of a fault or fracture in the MEA that could serve as a potential contaminant pathway.

Q40. Dr. LaGarry also speculates that contaminated water could be drawn into agricultural wells or released into rivers. Can you respond?

A40. (RL, WN, DP) Yes. Dr. LaGarry's comment is unfounded conjecture. He assumes a series of highly unlikely hypothetical events and relies on erroneous technical conclusions. There is no evidentiary or data-driven basis for such inflammatory speculation. The comment that if the High Plains aquifer was impacted it could contaminate supply wells within a few hours is not supported by any available data. Groundwater in the shallow aquifer does not migrate eastward toward the White River, it migrates primarily southward toward the Niobrara River. Statements suggesting migration of contaminates more than 15 miles to the White River are completely without technical basis and wholly implausible. Statements suggesting rapid contamination of the Niobrara River are also without technical basis and implausible given the distances involved and the nature of uranium transport (*i.e.*, the physical processes at work that would retard any transmission and reduce the concentration of radioactive contaminants, including dispersion, attenuation, and chemical dilution).

With respect to the existence of irrigation wells near the MEA, Crow Butte used its calibrated groundwater flow model to calculate the 30-year capture zone of a nearby irrigation well (well 732). Particle-tracking techniques were used to illustrate the 30-year capture zone of irrigation well 732 to assess whether a hypothetical shallow casing leak from the MEA wellfields could potentially impact the irrigation well. A conservative (worst-case) scenario was assumed in which irrigation well 732 pumps the maximum allowable amount of groundwater (251 acre-ft/year, 373 gpm for 5 months) and a hypothetical shallow casing leak occurs at some time along the downgradient portion of the adjacent wellfields at the MEA. The revised 30-year capture zone of irrigation well 732 is illustrated in Appendix AA-2 (CBR011). Based on the results of this analysis, MEA wellfields are not located within the capture zone of irrigation well 732. A shallow casing leak within the MEA wellfields will not impact irrigation well 732 at any time in the future given expected operating conditions. CBR006 at 2-118.

CONCLUSIONS

Q41. What are your overall conclusions regarding Contention 2?

A41. (RL, WN, DP, JS). Contention 2 is almost entirely concerned with whether the information provided by CBR meets regulatory and statutory requirements. Neither Dr. Kreamer, Mr. Wireman, nor Dr. LaGarry have presented any new evidence or analysis of the site-specific Marsland data. They stated only that the existing data was insufficient, inadequate, or too uncertain. Their objections lack specificity and rely on overbroad and unsupported generalizations. In contrast, Crow Butte provided a detailed description of information necessary to demonstrate compliance with the regulatory and statutory requirements cited in the migrated contention. Moreover, the NRC Staff has reviewed all the required information, requested additional information from Crow Butte, and ultimately made independent technical and environmental conclusions regarding the adequacy and sufficiency of the information presented.

Q42. What are your overall conclusions regarding the adequacy of the descriptions of the affected environment for establishing the potential effects of the proposed MEA operation on the adjacent surface water and groundwater resources (Concern 1)?

A42. (RL, WN, DP, JS) CBR has provided in-depth and extensive discussion of the environment at the MEA, including groundwater resources. The ER and TR describe the data collected, the analyses performed, and the conclusions reached. The level of detail and breadth of the information provided is more than sufficient to meet regulatory requirements.

Q43. What are your overall conclusions regarding the adequacy of the TR and the SER and its discussion of effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient, along with other information relative to the control and prevention of excursions (Concern 2)?

A43. (RL, WN, DP, JS) The TR includes extensive discussion of the data and methods used to determine effective porosity, hydraulic porosity, hydraulic conductivity, and hydraulic gradient. Based on this information, the NRC Staff correctly concluded that "the information provided by the applicant, as supplemented by the requirements of the erosion concern and drawdown license conditions . . . meets the applicable acceptance criteria of Section 2.7.3 of NUREG-1569." (SER Section 2.4.4, NRC008)

Q44. What are your overall conclusions regarding the adequacy of the conceptual model of site hydrology provided and its utility in determining the probable confinement of extraction fluids and expected operational and restoration performance (Concern 3)?

A44. (RL, WN, DP, JS) The site conceptual model, and the bases for that model, are presented in extensive detail in the TR and provide an acceptable basis for assessing operational and restoration performance. CBR's conclusions are further buttressed by its experience at the Central Processing Facility.

Q45. What are your overall conclusions regarding the information in, and assumptions of, the EA and SER as to the isolation of the aquifers in the ore-bearing zones (Concern 4)?

A45. (RL,WN, DP, JS). There is extensive data and analysis supporting multiple lines of evidence, all of which support the conclusion that the ore-bearing zones are hydrologically isolated. The NRC Staff reviewed that data, performed its own assessment of the data, and reached the same conclusions. Overall, the information in the ER and TR, as well as the EA and SER, demonstrate the isolation of the aquifer in the ore-bearing zones.