NRC-076-R2
Submitted: 7/29/2015

June 8, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CROW BUTTE RESOURCES, INC.	)	Docket No. 40-8943-OLA
	)	
(License Renewal for the In Situ Leach Facility, Crawford, Nebraska)	)	ASLBP No. 08-867-02-OLA-BD01

NRC STAFF'S REBUTTAL TESTIMONY

INTRODUCTION

Q.1 Please state your name, position, and employer, and briefly describe your role in reviewing Crow Butte Resource's (CBR)'s application for renewal of the license associated with the Crow Butte project.

A.1a My name is David Back. I am a Hydrogeologist at Sanford Cohen and Associates Inc. (SC&A). Exhibit (Ex.) NRC-002 provides a statement of my professional qualifications. I provided technical support to the lead Environmental Project Manager, Mr. Nathan Goodman, for the NRC Staff's environmental review of the CBR License Renewal application. I prepared the sections of the final environmental assessment (EA) that address water resources, including affected environment, impacts, and cumulative impacts.

A.1b My name is Tianqing Cao. I am a Senior Seismologist in the U.S. Nuclear Regulatory Commission's (NRC's) Office of Nuclear Material Safety and Safeguards, Division of Spent Fuel Management, Long Term Spent Fuel Management Branch. Exhibit NRC-003 provides a statement of my professional qualifications. I was not involved in the safety or environmental reviews of the CBR License Renewal Application, but I

reviewed relevant sections of the EA and the safety evaluation report (SER) regarding seismology in conjunction with testimony development.

A.1c My name is Mark Fuhrmann. I am a Geochemist in the NRC's Office of Research. Exhibit NRC-077 provides a statement of my professional qualifications. I was not involved in the safety or environmental reviews of the CBR License Renewal Application, but I reviewed relevant sections of the Intervenors' testimony and exhibits in conjunction with testimony development.

A.1d My name is Nathan Goodman. I am an Environmental Project Manager in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Fuel Cycle Safety, Safeguards, and Environmental Review, Environmental Review Branch. Exhibit NRC-004 provides a statement of my professional qualifications. I am the lead Environmental Project Manager for the NRC Staff's environmental review of the CBR License Renewal application. In addition to developing the final EA, I provided expertise in Section 106, National Historic Preservation Act (NHPA) consultation, ecological resources, and environmental justice.

A.1e My name is Thomas R. Lancaster. I am a Hydrogeologist in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Fuel Cycle Safety, Safeguards, Uranium Review and Licensing Branch, Exhibit NRC-005 provides a statement of my professional qualifications. I serve as the alternate Safety Project Manager for the Crow Butte license renewal. As a technical reviewer, I provided support to the lead Safety Project Manager, Mr. Ron Burrows, in the NRC Staff's safety review of hydrology- and hydrogeology-related sections of the Crow Butte License Renewal application. In addition, I have provided technical support for several onsite inspections of the CBR facility.

A.1f My name is Paul Nickens. I am a Senior Cultural Resources Specialist for SC&A, under contract to the NRC for cultural resources technical for the EA. Exhibit NRC-

006 provides a statement of my professional qualifications. I provided technical support to the lead Environmental Project Manager, Mr. Goodman, for the NRC Staff's cultural resources assessment during the environmental review of the CBR License Renewal application. I prepared the following sections of the final EA: cultural resources affected environment, impacts, and cumulative impacts. I also provided support to NRC's Tribal consultation efforts per Section 106, NHPA.

A.1g My name is Dr. Elise Striz. I am a Hydrogeologist in the NRC's Office of Nuclear Material Safety and Safeguards, Division of Fuel Cycle Safety, Safeguards, Uranium Review and Licensing Branch. Exhibit NRC-008 provides a statement of my professional qualifications. I provided support to the lead Safety Project Manager, Mr. Ron Burrows, for the NRC Staff's safety review of hydrology- and hydrogeology-related sections of the Crow Butte License Renewal application. I also provided support to the lead Environmental Project Manager, Mr. Nathan Goodman, in preparing the EA for the NRC Staff's environmental review of the CBR License Renewal application.

Q.2 Are you familiar with the initial testimony and exhibits filed by the Oglala Sioux Tribe and Consolidated Intervenors in this proceeding?

A.2 (D. Back, T. Cao, M. Fuhrmann, N. Goodman, T. Lancaster, P. Nickens, E. Striz) Yes. We have reviewed the testimony of both the Oglala Sioux Tribe (OST) and Consolidated Intervenors (CI) that is relevant to the contentions on which we will be testifying. We have also reviewed any relevant supporting information cited by the OST or CI, including their exhibits.

Q.3 What are the contentions on which you will be testifying?

A.3a (D. Back) I will be testifying on Contentions A (Non Radiological Health Impacts to Aquifers), C (Impacts to Surface Water from Accidents), D (Communication Among

Aquifers/Environmental Justice), F (Failure to Include Recent Research), 6 (Water Quantity Impacts), and 9 (Ground water Mitigation).

A.3b (T. Cao) I will be testifying on Contention 14 (impacts of earthquakes).

A.3c (M. Fuhrmann) I will be testifying on Contentions D (Communication Among Aquifers/Environmental Justice) and 9 (Ground water Mitigation).

A.3d (N. Goodman) I will be testifying on Contentions 1 (Cultural Resources), D (Communication Among Aquifers/Environmental Justice), 12 (Air Emission and Liquid Waste), and 14 (Impacts of Earthquakes).

A.3e (T. Lancaster) I will be testifying on Contentions A (Non Radiological Health Impacts to Aquifers), C (Impacts to Surface Water from Accidents), D (Communication Among Aquifers/Environmental Justice), F (failure to Include Recent Research), 6 (Water Quantity Impacts), 9 (Ground Water Mitigation), and 14 (Impacts of Earthquakes).

A.3f (P.Nickens) I will be testifying on Contention 1 (Cultural Resources).

A.3g (E. Striz) I will be testifying on Contentions A (Non Radiological Health Impacts to Aquifers), C (Impacts to Surface Water from Accidents), D (Communication Among Aquifers/Environmental Justice), F (Failure to Include Recent Research), 6 (Water Quantity Impacts), 9 (Ground Water Mitigation), and 14 (Impacts of Earthquakes).

CONTENTION A

Q.A.1 **Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?**

A.A.1 (D. Back, T. Lancaster, E. Striz) Yes. As supporting testimony for Contention A, the Intervenors have filed opinions by Dr. Hannan LaGarry (Ex. INT-043), Mickel Wireman (Ex. INT-047), Dr. David Kreamer (Ex. INT-046), Dr. Linsey McLean (Ex. INT-048), and Charmaine White Face (Ex. OST-001). We have reviewed these opinions and are

familiar with the arguments that the Intervenors' witnesses make. We have also reviewed all of the relevant exhibits filed in support of Contention A by the Intervenors.

Q.A.2 In Section IV of Dr. Kreamer's testimony, excerpted on pages 87-88 of the Intervenors' Joint Position Statement, Dr. Kreamer raises concerns relating to monitoring wells used for excursion monitoring and for wellfield restoration. Can you briefly describe the significant differences between the types of monitoring wells used for these purposes?

A.A.2 (D. Back, T. Lancaster, E. Striz) Dr. Kreamer's testimony appears to conflate the different types of monitoring wells used for excursion and restoration monitoring. We believe that it would be useful to clarify the differences between these types of wells at the outset of our testimony on the ground water-related claims raised by the Intervenors.

Excursion monitoring wells are employed for the sole purpose of detecting the movement of process fluids away from the wellfield. At CBR, the excursion monitoring wells are installed in the overlying aquifer and in a perimeter ring. To optimize detection, these wells are screened across the entire interval of the aquifer in which they are installed. They are monitored biweekly for conservative excursion indicator parameters (i.e chloride, alkalinity, and conductivity) to provide an early warning of the movement of process fluids away from the wellfield. This early warning allows corrective actions to be taken to draw fluids back into the wellfields.

Excursion monitoring wells are not "point of compliance" wells. They are not designed or intended to be sampled to meet any regulatory standard for ground water quality compliance. Therefore, they are not designed to ". . . accurately reflect levels and spatial orientation of any potential pollutant release, synergistic effects of multiple contaminant . . ," as Dr. Kreamer suggests (Ex. INT-046 at 5). As they are intended to

act as detection wells only, they do however "provide early warning of contaminant migration" through the use of conservative excursion parameter indicators.

Restoration monitoring wells are "point of compliance" wells. They are located within the wellfield production aquifer and typically screened across the ore body interval. They are designed and sampled to demonstrate compliance with the ISR ground water quality restoration standards listed in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5). These wells are sampled for all constituents of concern to meet the ground water quality standards and to demonstrate stability of the constituents as required by CBR License Condition 10.6 (Ex. NRC-012 at 8). Restoration monitoring wells are not used to detect or quantify potential pollutant release. Therefore, they are not designed to ". . . accurately reflect levels and spatial orientation of any potential pollutant release, synergistic effects of multiple contaminants[.]" (Ex. INT-046 at 5).

Finally, we note that Dr. Kreamer's claims regarding restoration pertain to the issues raised by the Intervenors in Contention 9. We therefore address these claims, as relevant, in our testimony relating to Contention 9.

Q.A.3 On pages 86-87 of their Joint Position Statement, the Intervenors refer to testimony filed by Dr. LaGarry, Mr. Wireman, and Dr. Kreamer, in which they maintain that there is evidence of faults and fractures in the area of the Crow Butte facility that would enable hydraulic connectivity between aquifers and potentially to surface alluvium. Can you address this claim?

A.A.3 (D. Back, T. Lancaster, E. Striz) This claim was raised by Dr. LaGarry in his earlier Opinions filed in support of the Intervenors' petition to intervene and their submission of new contentions on the EA. We addressed claims relating to faults and fractures in A.C.2, A.C.7, A.D.3 through A.D.5, A.D.9 through A.D.11, A.D.17, and A.D.18 of our initial testimony. We further address these claims and the related arguments made by Dr. LaGarry, Mr. Wireman, and Dr. Kreamer in A.C.5, A.C.7, A.D.2 through A.D.9, and

A.D.17 through A.D.19 of our rebuttal testimony, as those claims pertain more directly to the matters raised by the Intervenors in Contentions C and D.

Q.A.4 **In Section II of his testimony, Mr. Wireman claims that the characterization of the local and regional hydrogeology and ground water flow at the Crow Butte facility is inadequate. Can you address this claim?**

A.A.4 (D. Back, T. Lancaster, E. Striz) As we explained in A.A.3 of our rebuttal testimony, above, this claim concerns the issues raised by the Intervenors in Contentions C and D. We therefore discuss these issues in A.C.3, A.C.6 through A.C.8, and A.D.13 through A.D.16 our rebuttal testimony for Contentions C and D.

Q.A.5 **In Section IV of his testimony, excerpted on page 87 of the Intervenors' Joint Position Statement, Mr. Wireman claims that the ground water monitoring program in place at Crow Butte is inadequate and poorly reported. He points to the 19 domestic water supply wells in CBR's ground water monitoring program and claims that trend data should be presented "for these and other monitoring wells." Can you respond to his claim?**

A.A.5 (D. Back, T. Lancaster, E. Striz) This claim concerns the issues raised by the Intervenors in Contention C. We therefore discuss these issues in A.C.10 of our rebuttal testimony for Contention C.

Q.A.6 **Mr. Wireman also states in Section IV of his testimony that "[th]ere should be a more complete analyte list that includes metals, [total dissolved solids (TDS)] and selected anions" for domestic water supply wells and other monitoring wells. Can you address this statement?**

A.A.6 (D. Back, T. Lancaster, E. Striz) This claim largely concerns the issues raised by the Intervenors in Contention C. We therefore discuss this issue in A.C.10 of our rebuttal testimony for Contention C.

To the extent that Mr. Wireman's claim is intended to apply to excursion monitoring wells, we note again that the purpose of CBR's ground water monitoring program is to detect excursions. In A.A.7 through A.A.9 of our initial testimony, we explained that the indicator parameters selected for sampling in the excursion monitoring wells are conservative, leading edge monitoring parameters that the NRC has determined will enable the licensee to identify an excursion most quickly. We also explained that the use of chloride, conductivity, and total alkalinity as the excursion indicators at Crow Butte is both consistent with NRC guidance and supported by operating experience at the Crow Butte facility.

Mr. Wireman does not explain how sampling for a "more complete analyte list," including unspecified metals and anions, will enhance the ability of CBR to detect excursions. Nor does he indicate that the suite of indicator parameters for which CBR is required to sample is inadequate to detect excursions. NUREG-1569 states that the ground water monitoring program is acceptable if it will allow the early detection and timely restoration of excursions (Ex. NRC-013 at 5-38). The Staff determined in its SER that CBR's operational ground water monitoring program satisfies the applicable regulatory requirements and the acceptance criteria of NUREG-1569 (Ex. NRC-009 at 130-31).

Q.A.7 In Section IV of his testimony, Dr. Kreamer alleges that "[s]ite monitoring has the potential to provide information that does not accurately reflect levels and spatial orientation of any potential pollutant release, synergistic effects of multiple contaminants, and does not provide early warning of contaminant migration." Can you respond to these claims?

A.A.7 (D. Back, T. Lancaster, E. Striz) As we stated in A.A.2 and A.A.6 of our rebuttal testimony, above, CBR's ground water excursion monitoring program is oriented at the detection of excursions; in other words, the purpose of the program is not to assess

the environmental effects of contaminants, synergistically or otherwise, but to detect the existence and source of an excursion. While Dr. Kreamer alleges that the monitoring program "has the potential" to provide inaccurate information and does not provide early warning of contaminant migration, he does not support his allegations with evidence that this is in fact the case.

In support of his claims, Dr. Kreamer first describes problems he believes exist with respect to ground water monitoring during restoration. These claims do not relate to CBR's operational excursion monitoring program, and so are not instructive in an assessment of the adequacy of that program. Dr. Kreamer next states that "[t]he monitoring program investigates a very limited number of potential pollutants and water quality parameters, atypical of most rigorous monitoring programs." (Ex. INT-046 at 5). He states that this "leaves no solid basis for assessing the potential migration and impacts of potential groundwater contaminants[.]" (Ex. INT-046 at 5).

While Dr. Kreamer implies that the requirement to sample for a "limited number" of water quality parameters results in an inadequate excursion monitoring program, he does not provide any information that supports that this is the case. Furthermore, while he states that use of a limited number of water quality parameters is atypical of "most rigorous monitoring programs," he does not provide any information about these monitoring programs to which he alludes, or their relevance to CBR's excursion monitoring program. By contrast, as the Staff explained in A.A.6 and A.A.8 of its initial testimony and in the EA, CBR's excursion monitoring program has identified excursions and enabled the Staff to find that there has been no measurable impact to ground water beyond the licensed area from Crow Butte operations (Ex. NRC-010 at 79). This is evidence in practice that the selection of chloride, conductivity and total alkalinity as indicator parameters for excursions has been, and will continue to be, effective at identifying excursions at the Crow Butte facility.

Finally, Dr. Kreamer states that "mining activities release potential 'tracers' that can be used to determine the potential influence of ISL on groundwater, often sequentially in advance of the arrival of any contaminants," and that "[u]se of these indicators . . . are potentially very beneficial and can act as an early warning system, but are largely ignored in stated future efforts at the site." We respond that CBR is required to sample for such tracers: chloride, conductivity and total alkalinity (Ex. NRC-009 at 124, Ex. NRC-010 at 78, Ex. NRC-012 at 11). These "tracers," or excursion indicators, are used because their properties enable them to serve as early indicators of migrating lixiviant. As the use of these excursion indicators is a requirement of CBR's license (LC 11.4) (Ex. NRC-012 at 11), it is not apparent how their use is "largely ignored," as Dr. Kreamer suggests.

Q.A.8 The Intervenors also offer the testimony of Dr. Linsey McLean and Charmaine White Face as support for their position on Contention A. Can you address Ms. McLean's and Ms. White Face's testimony?

A.A.8 (D. Back, T. Lancaster, E. Striz) Dr. McLean makes several claims regarding the impacts of selenium and other ground water constituents on human health and wildlife. Ms. White Face alleges that Crow Butte operations is polluting the drinking water of the Pine Ridge Reservation and causing high cancer rates. These claims do not relate to the claims that we understand to be admitted relative to this contention – namely, the EA's assessment of aspects of CBR's excursion monitoring program, specifically the frequency by which CBR is required to monitor for excursions and the suite of early excursion indicators for which CBR is required to sample. That said, neither Dr. McLean nor Ms. White Face establish that a pathway exists between ground water at the site of Crow Butte operations and the Pine Ridge Reservation. Therefore, we do not view their testimony as affecting our analyses or conclusions in the EA.

Q.A.9 Having reviewed the claims raised by the OST in their initial written testimony and the associated exhibits for Contention A, has the Staff found any reason to revisit its conclusions regarding the potential impacts to the environment that may result from renewal of the Crow Butte license?

A.A.9 (D. Back, T. Lancaster, E. Striz) For the reasons described in our initial testimony (Ex. NRC-001) and our rebuttal testimony, we have not identified any reason to revisit our analysis or conclusions in the EA regarding the potential environmental impacts of the Crow Butte project.

CONTENTION C

Q.C.1 Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?

A.C.1 (D. Back, T. Lancaster, E. Striz) Yes. As supporting testimony for Contention C, the Intervenors filed testimony by Dr. Hannan LaGarry (Ex. INT-043), Dr. David Kreamer (Ex. INT-046), and Mr. Michael Wireman (Ex. INT-047). We have reviewed this testimony and are familiar with the witnesses' arguments. We have also reviewed all of the relevant exhibits that the Intervenors have filed in support of Contention C.

Q.C.2 On page 3 of his testimony, Dr. Kreamer asserts that "the potential for horizontal translation of groundwater along ephemeral stream courses" is not "explicitly quantitated." He then asserts that surface spills or contaminants transmitted through faulted regions or from surface expressions of the Chamberlain Pass Formation would have the potential to reach and infiltrate the alluvium. Could you please address these statements?

A.C.2 (D. Back, T. Lancaster, E. Striz) With regard to "explicit quantification" of the "potential for horizontal translation of groundwater along ephemeral stream courses" (i.e., English and Squaw Creeks), Dr. Kreamer does not explain why it is necessary to do so at the CBR site. As discussed in the remainder of this response, evidence has

demonstrated why contamination is unlikely, and monitoring results have not revealed any contamination impacts from ground water discharges into ephemeral stream courses.

Dr. Kreamer asserts that surface spills or contaminants that are transmitted through faulted regions or from surface expressions of the Basal Chadron Sandstone (Chamberlain Pass Formation) would have the potential to reach and infiltrate the alluvium. Dr. Kreamer makes this claim without providing any supporting evidence. With respect to his posited pathways for faults to receive contaminants, we addressed those pathways in A.C.4 (surface spills), A.C.5 (transmission through the mined aquifer), and A.C.6 (transmission through faults) of our initial testimony. In A.C.4 of our initial testimony, we described the extensive procedures and controls in place at the CBR site to prevent spills and leaks and to minimize their impacts should they occur. In that response, we also described the surface water and sediment monitoring programs for streams within the License Area (LA) and explained that results of that monitoring has shown no trends indicating contamination. As described in A.C.5 of our initial testimony, evidence indicates the Basal Chadron Sandstone does not outcrop anywhere in the CBR LA or in the proposed North Trend Expansion Area (NTEA) site northwest of the LA. Therefore, there is no pathway through a “surface expression” of the Basal Chadron Sandstone to the White River alluvium within or near the LA.

For reasons discussed in A.D.5 and A.D.11 of our initial testimony, there is no evidence of faults beneath the LA and adjacent areas. In A.C.6 of our initial testimony, we explained that the evidence of vertical confinement at the CBR site precludes faults as a plausible pathway for contaminants to reach the overlying Brule aquifer or the White River alluvium. And, as discussed in A.D.9, A.D.10, A.D.17 and A.D.18 of our initial testimony, the White River structural feature, which is approximately 2 miles

north of the LA, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. Finally, as discussed in A.D.3 and A.D.4 of our initial testimony, historical evidence has demonstrated process fluids are contained within the Basal Chadron Sandstone aquifer at the project site. The evidence includes over 20 years of operational monitoring data showing no impacts from excursions, spills, or daily operations.

Q.C.3 On page 3 of his testimony, Mr. Wireman asserts that ground water in the Brule "is hydraulically connected to the White River and likely to Squaw and English Creeks," and that "it is important to identify the location of gaining and losing reaches of the White River and the temporal nature base flow and stream loss to the shallow aquifer." Can you please address these statements?

A.C.3 (D. Back, T. Lancaster, E. Striz) With regard to identifying gaining and losing reaches and the temporal nature base flow and stream loss to the shallow aquifer, Mr. Wireman does not explain why such identification is necessary at the CBR site. In A.C.4 (surface spills) and A.C.5 (transmission through the mined aquifer) of our initial testimony, we acknowledged a potential pathway for contamination from surface spills or leaks via migration through the Brule aquifer into surface waters, including the White River. In A.C.2 above, which summarizes our responses in A.C.4, A.C.5, and A.C.6 of our initial testimony, we discuss the reasons why contamination of the White River and White River alluvium is unlikely and indicate that monitoring results have not revealed any contamination impacts to surface waters.

As we discussed in A.C.4 of our initial testimony, CBR's monitoring program is designed to detect any leaks or spills that directly or indirectly impact the Brule aquifer, the alluvial aquifers, or surface water. In A.C.10 of our initial testimony, we summarized the basis for the Staff's conclusion that impacts to surface waters would be SMALL. That conclusion was based on the extensive operational controls,

procedures and monitoring in place at the CBR facility to prevent and detect spills, leaks, and excursions, and to address and minimize impacts should they occur, as well as over 20 years of monitoring data that shows no evidence of impacts to surface waters or the shallow (Brule) aquifer, or to the White River alluvium and the White River, from operation of the CBR facility. The comprehensive design of the monitoring program makes the determination of gaining and losing reaches of streams, including the White River, irrelevant.

Q.C.4 **On page 3 of his testimony, Dr. Kreamer states that although the EA and CBR note that Brule Formation is "significantly jointed" in several places, allowing appreciable ground water flow in those areas, the number, orientation, and aperture size of these "joints" is not mentioned in the EA. Could you please address this statement?**

A.C.4 (D. Back, T. Lancaster, E. Striz) Dr. Kreamer did not explain why detailed information pertaining to specific quantification of small fractures or joints that may be present within the Brule aquifer is necessary. As described in A.C.2 and A.C.3 above, the comprehensive ground water and surface water monitoring programs at the CBR facility are designed to detect contamination entering or leaving the Brule aquifer independent of any areas of Brule secondary permeability referred to by Dr. Kreamer. Our discussion in A.C.2 and A.C.3 above also explains why contamination is unlikely and states that over 20 years of monitoring has not revealed any contamination impacts.

Q.C.5 **On page 3 of his testimony, Dr. Kreamer states as follows: "The EA notes discontinuities in the Brule formation, and the lack of horizontal consistency, of this water bearing unit. Permeable regions of this formation are said to be of limited horizontal extent, although geophysical evidence to support this claim is not presented." He then cites varying thicknesses of the Basal Chadron**

Sandstone and variation in the depth to the mineralized zone, and states that "[t]his indicates significant heterogeneities that were not considered in the ground water modeling." Could you please address these statements?

A.C.5 (D. Back, T. Lancaster, E. Striz) The numerical ground water modeling and maximum likelihood analysis of the probable hydraulic behavior of the White River structural feature on the confinement of the Basal Chadron Sandstone aquifer is discussed in A.D.3, A.D.10, A.D.17, A.D.20, and A.D.21 of our initial testimony, as well as Section 2.4.3.3 of the SER (Ex. NRC-009 at 23-27) and Section 3.5.2.3.3 of the EA (Ex. NRC-010 at 38-39). The objective of the ground water modeling effort was to evaluate the probability of communication between the Basal Chadron Sandstone aquifer and overlying Brule aquifer with respect to the White River structural feature. To be conservative in the model, the Brule aquifer was defined as a permeable aquifer which could receive flow from the feature. An attempt to incorporate any heterogeneity of the Brule aquifer in the ground water model would have been a less conservative approach.

Q.C.6 **On page 3 of his testimony, Mr. Wireman asserts that there is uncertainty regarding direction of ground water flow in the Brule aquifer. Can you please address this statement?**

A.C.6 (D. Back, T. Lancaster, E. Striz) Based on reported water-level data, the SER and LRA both state that the Brule flows northwest direction south of the White River (i.e., at the CBR site) (Ex. NRC-009 at 22, Ex. CBR-011 at 2-171). This is not inconsistent with the information in the LRA citing Souders, which reports that regionally the flow direction is north, northeast, or northwest depending on location with respect to the White River (Ex. CBR-011 at 2-170). All of the reported information indicates that ground water flow in the Brule is towards the White River since the river acts as a regional drain for ground water.

The ground water flow directions in the Brule aquifer may change due to natural and anthropogenic causes. For example, precipitation events or pumping water from wells in the Brule aquifer for irrigation, livestock or domestic purposes could affect the ground water flow directions. As discussed in the SER (Ex. NRC-009 at 21-22) and in A.C.8 of this rebuttal testimony, the water levels in the southern and central portions of the LA have not changed significantly between 1982 and 2009. In the northern portion of the LA, however, differences between the 1982 and 2009 water level elevations and gradients are observed because the depictions are based on data sets with significant variations in the number and locations of the well measurements. Most importantly, CBR has developed and implemented a network of wells that will effectively monitor the Brule aquifer regardless of the ground water flow direction. In its safety review, the Staff found that CBR's ground water monitoring network is consistent with the guidance in Section 5.7.8.3 of NUREG-1569 (Ex. NRC-009 at 130-31).

Q.C.7 **On pages 3 and 4 of his testimony, Mr. Wireman asserts that results and data from CBR's four aquifer pumping tests were focused on characterizing properties of the Basal Chadron Sandstone aquifer and "are not adequate to assess hydraulic properties and groundwater flow in the Brule aquifer." He asserts that aquifer pumping tests should be conducted in the Brule in areas where well yield is high and where significant fracturing or faulting is present. Can you please address these statements?**

A.C.7 (D. Back, T. Lancaster, E. Striz) Mr. Wireman does not explain why additional characterization of the Brule aquifer is necessary. The results of more than 20 years of monitoring have demonstrated that the characterization of the Brule aquifer at the site is adequate. In A.C.4 of our initial testimony, we explained the reasons why contamination of the Brule aquifer from leaks, spills, and vertical excursions is unlikely

and indicated that monitoring results have not revealed any contamination impacts. Therefore, additional characterization of the Brule is not warranted.

Q.C.8 **On page 4 of his testimony, Mr. Wireman asserts that the explanation of the water level rise of 4.5 m and increase in gradient in the Brule aquifer in the northern part of the LA needs to be better explained, and that the NRC's explanation in the SER is not acceptable. Can you please address these statements?**

A.C.8 (D. Back, T. Lancaster, E. Striz) We disagree that the explanation in the SER is not acceptable. As shown in Figure 2.7-3a of the LRA (Ex. CBR-011 at 2-173), the 1983 potentiometric contours in the Brule aquifer in the northern portion of the LA were based on four data points (wells 29, 30, 40 and 66 in Figure 2.7-3a, for which water level elevations are indicated), all of which were located outside of the LA. In contrast, more than 50 water level elevation data points were available within the LA to create the 2009 Brule potentiometric surface map shown in Figure 2.7-3d of the LRA (Ex. CBR-011 at 2-179). Furthermore, Mr. Wireman does not explain the relevance of his assertion. As described in A.C.3, A.C.4 and A.C.6 above, the network of wells is designed to effectively monitor the Brule aquifer regardless of the ground water flow direction.

Q.C.9 **On page 6 of his testimony, Mr. Wireman asserts that hydraulic properties of the Brule formation (both the upper confining unit (UCU) and overlying aquifer) "should be estimated based on more appropriate, more empirical methods which use data from outcrops (fracture frequency, orientation, aperture width)." Do you agree with this claim?**

A.C.9 (D. Back, T. Lancaster, E. Striz) We disagree with Mr. Wireman's assertion that fracture characterization solely from outcrops would be an appropriate method to characterize hydraulic properties of the upper confinement and the Brule aquifer. On

the contrary, characterizing properties of potential fractures that control ground water flow and contaminant transport is difficult and the uncertainty of the results is high. For example, as part of a multidisciplinary study by the United States Geological Survey (USGS) to characterize ground water flow and solute transport in fractured rock, the USGS set up an experimental field site to develop better methods to characterize fractures and assess their influence on ground water flow and contaminant transport (Ex. NRC-078 at 1). The USGS report on this study describes in detail the differences between data collected from boreholes versus outcrops, and concludes that after all of the efforts to characterize fractures using "state of the science methods," ground water flow through the fractures could not be quantified (Ex. NRC-078 at 37).

We do not believe that such intensive and expensive characterization is necessary or justified. As we explained in A.C.4, A.C.5, and A.D.4 of our initial testimony, the surface water and ground water monitoring programs that are in place at the CBR facility are designed to detect contamination in the Brule aquifer independent of any secondary permeability that may be caused by potential fractures. And, as we further explained in those initial testimony responses, over 20 years of monitoring results have shown no evidence of impacts on surface or ground water from CBR operations.

Q.C.10 On page 8 of his testimony, Mr. Wireman claims that the ground water monitoring program to detect offsite migration of contaminants is "inadequate and poorly reported." Specifically, Mr. Wireman states that "[n]either the LRA nor the SER include any information on the location, depth and screened interval for these wells." Mr. Wireman also asserts that "trend data should be presented for these and other monitoring wells and there should be a more complete analyte list that includes metals, TDS, and selected anions." Can you please address these statements?

A.C.10 (D. Back, T. Lancaster, E. Striz) We disagree with Mr. Wireman that the ground water monitoring program to detect offsite migration of contaminants is "inadequate and poorly reported." CBR's excursion monitoring program, conducted in accordance with License Condition (LC) 11.5 (Ex. NRC-012 at 12), is described in detail in Section 5.7.9.3 of the SER (Ex. NRC-009 at 123-28). The description in the SER includes a table summarizing reported excursions (Ex. NRC-009 at 126-27), and LC 11.5 requires reporting of excursions to NRC. As part of CBR's effluent and environmental monitoring program, conducted in accordance with LC 11.13, private wells within one kilometer of the wellfield area are monitored quarterly for uranium and radium (Ex. NRC-009 at 129). This monitoring is primarily conducted for dose assessment in accordance with guidance in Regulatory Guide 4.14 (Ex. NRC-079), and is not intended for detection as with the excursion monitoring program. In accordance with LC 11.1, a summary of private well monitoring results are submitted to the NRC in semi-annual reports that summarize results of the operational effluent and environmental monitoring program (see, e.g., Ex. CBR-018 at Appendix A).

With regard to information about location, depth and screened intervals of wells, as discussed in Section 4.6.2.2.6 of the EA, all but one of the private wells that are monitored are completed in the Brule aquifer (Ex. NRC-010 at 81). The only private well that does not tap the Brule is Well #61, which is completed in the Basal Chadron Sandstone aquifer. The locations of the private wells are shown in Figures 2.7-3a, 2.7-4a, and 2.9-1 of the LRA (Ex. CBR-011 at 2-173, 2-183, 2-279). The depths of the private wells and the formations in which they are completed are provided in Table 2.9-3 of the LRA (Ex. CBR-011 at 2-283).

Finally, we disagree with Mr. Wireman's suggestion that the offsite wells should be tested for additional metals, TDS and selected anions. As described in A.C.4, A.C.5, and A.D.4 of our initial testimony, the ground water and surface water

monitoring programs are designed to detect contamination before it migrates offsite. Also, as we noted in A.C.4 and A.D.4 of our initial testimony, over 20 years of monitoring results have shown no evidence of excursions moving beyond the LA, and radionuclide concentrations in the offsite private wells have remained at preoperational levels.

Q.C.11 With regard to his assertion that there should be a more complete analyte list that includes metals, TDS, and selected anions for sampling of offsite and other monitoring wells, Mr. Wireman states on page 8 of his testimony that "NRC plans to add this sampling via a condition in the renewed license." Is there such a license condition in the renewed license?

A.C.11 (D. Back, T. Lancaster, E. Striz) It is not clear which license condition Mr. Wireman is referring to. The only license condition that requires sampling for the types of analytes he identifies is LC 11.3 (Ex. NRC-012 at 11). The purpose of LC 11.3 is to establish preoperational background water quality for new mine units before they can go into operation. LC 11.3 does not establish operational testing requirements. Other license conditions, such as LC 11.4, LC 11.5, LC 11.12, and LC 11.13, address sampling requirements during operations, but those license conditions do not require sampling of all the analytes Mr. Wireman references (Ex. NRC-012 at 11, 12, 14). In A.C.10 above, we addressed Mr. Wireman's claim that offsite wells should be sampled for additional analytes. For excursion monitoring wells, we address that issue in A.A.6 of our rebuttal testimony for Contention A.

Q.C.12 On page 5 of his testimony, Dr. Kreamer asserts that "increased monitoring contingencies and plans for any future, identified spills are not well addressed by CBR." Can you please address this statement?

A.C.12 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. Kreamer's assertion. As required by LC 11.5 (Ex. NRC-012 at 12), if the biweekly excursion monitoring

program for the overlying aquifer detects an excursion, sampling frequency is increased to weekly and corrective action is implemented as specified. In A.C.4 of our initial testimony, we describe the operational controls, procedures, and monitoring employed at the CBR facility to address spills and leaks. Section 4.6.1.2 of the EA discusses the Spill Prevention, Control and Countermeasure plan for the immediate detection, containment, and correction of spills (Ex. NRC-010 at 70). And, as we explained in A.A.3 of our initial testimony, NRC has previously concluded that Crow Butte's spill contingency plans were acceptable, and the Staff did not find anything during its current licensing review to invalidate the Staff's previous findings (Ex. NRC-009 at 65).

As described in A.C.4 of our initial testimony, spill prevention measures include routine inspections, preventive maintenance, and administrative and engineering controls which are in place to prevent future spills. Standard operating procedures for these controls and activities as well as the spill contingency program are maintained onsite in the Safety Health Environment and Quality Management System Program Manual and reviewed by Staff during annual facility inspections. Additionally, process buildings are constructed with secondary containment and wellfield areas are installed with dikes or berms to prevent spilled process solutions from entering surface water features.

Q.C.13 On pages 5-6 of his testimony, Dr. Kreamer asserts that "tracers" released during ISR activities can be used as an early warning system of the influence of operations on ground water, but that use of those indicators "is largely ignored in stated future efforts at the site." Could you please address this statement?

A.C.13 (D. Back, T. Lancaster, E. Striz) We agree with Dr. Kreamer that ISR activities release potential "tracers" that can be used as an early warning system. However, we disagree with his assertion that use of such indicators is "largely ignored in stated

future efforts" at the CBR site. As explained in A.C.4 of our initial testimony, CBR is required under LC 11.5 (Ex. NRC-012 at 12) to conduct biweekly excursion monitoring. As described in A.A.7 of our initial testimony, the excursion indicator parameters of chloride, conductivity and alkalinity, which are present in ISR process fluids, have been used and will continue to be used in the future as "early warning tracers" in CBR's excursion monitoring program. In A.A.8 of our initial testimony we explain why these three constituents are effective and reliable excursion indicators.

Q.C.14 On page 9 of his testimony, Mr. Wireman asserts that "CBR should review the offsite (non-excursion) groundwater and surface water monitoring programs and make modifications necessary to accommodate new understandings and new mining units and satellite ore bodies. This information should be included in license renewal documentation." Can you address this statement?

A.C.14 (D. Back, T. Lancaster, E. Striz) Mr. Wireman has provided no support or explanation for this general assertion. He does not identify any "new understandings" or explain why it would be necessary for CBR to modify their surface and ground water monitoring programs. Nor does he explain what he is referring to by "new mining units and satellite ore bodies." There are no additional mine units planned for the CBR facility. If he is referring to the proposed CBR expansion areas, those areas are subject to separate licensing actions and are not within the scope of this license renewal.

CONTENTION D

Q.D.1 Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?

A.D.1 (D. Back, N. Goodman, T. Lancaster, E. Striz) Yes. As supporting testimony for Contention D, the Intervenors filed testimony by Dr. Hannan LaGarry (Ex. INT-043), Dr. David Kreamer (Ex. INT-046), and Mr. Michael Wireman (Ex. INT-047). In support

of the environmental justice portion of Contention D, the Intervenors filed a statement from Ms. Debra White Plume (Ex. INT-021), and the OST filed a statement from Ms. Charmaine White Face (Ex. OST-001). We have reviewed the Intervenors' testimony and statements and are familiar with the witnesses' arguments. We have also reviewed all of the relevant exhibits that the Intervenors have filed in support of Contention D.

Communication Among Aquifers

Q.D.2 Dr. LaGarry states that a lineament is "any unexplained straight-line topographic feature in remotely sensed imagery." He acknowledges that lineaments "may or may not represent faults or joints" and that "extensive fieldwork would be required to check each lineament." Do you agree with those statements?

A.D.2 (D. Back, T. Lancaster, E. Striz) According to the American Geological Institute's *Dictionary of Geological Terms* (3rd Ed., 1984), a lineament is "a linear topographic feature of regional extent that is *believed* to reflect crustal structure." (Ex. NRC-091 (emphasis added).) Dr. LaGarry's statement that lineaments are unexplained topographic features identified in remote sensing imagery is consistent with that definition. However, as Dr. LaGarry acknowledges, a claim that a lineament or a topographic feature in satellite imagery represents a subsurface geologic fault, fracture, or joint is speculative until ground truthing is performed with extensive hard data obtained in the field (e.g., test drill holes). More importantly, subsurface exploration is essential to determine not only the existence of faults, fractures, and joints, but also their extent and possible impacts on confinement.

Q.D.3 Citing a 2011 Master's thesis by Jennifer Balmat (Ex. INT-056), Dr. LaGarry asserts on pages 2-3 of his testimony that, based on field work and statistical analysis, Balmat "concluded that in this part of northwestern Nebraska, lineaments visible from Earth's orbit do, in fact, represent faults and joints

identifiable on the ground." Dr. LaGarry later claims on page 4 of his testimony, again based on Balmat's work, that "there is a high degree of statistical probability" that lineaments in the vicinity of the CBR facility represent faults or joints that could allow migration of lixiviant. Do you agree with these statements?

A.D.3 (D. Back, T. Lancaster, E. Striz) We do not agree with these statements. In our view, Dr. LaGarry has overstated Balmat's conclusions, extrapolating beyond the limits of her study, and giving it more weight than is warranted.

In her work, Balmat identified lineaments from remote sensing images covering an area of over 160,000 km^2 (area calculated based on latitude and longitude ranges provided) (Ex. INT-056 at 27). The field verification portion of Balmat's work consisted of field study of outcrops in a 20 km^2 area (4 km x 5 km) just southeast of Chadron, Nebraska (Ex. INT-056 at 27). That 20 km^2 area, which is more than 20 miles northeast of the CBR facility, was the only place where Balmat attempted to correlate the lineaments observed in remote sensing images with possible faults.

In her thesis, Balmat did not provide a map of identified lineaments in the above-referenced 160,000 km^2 area, nor did she provide any other information indicating any of the lineaments she identified are on or near the CBR site. Additionally, Balmat's conclusion that lineaments represent faults was limited to lineaments within her 20 km^2 study site south of Chadron (Ex. INT-056 at 53). Therefore, Dr. LaGarry's assertions based on Balmat's work—that "in this part of northwestern Nebraska, lineaments visible from orbit . . . represent widespread faults and joints identifiable on the ground," and that there is a "high degree of statistical probability" that lineaments in the vicinity of the CBR represent faults or joints that could allow migration of lixiviant—are unsubstantiated. It is inappropriate to broadly conclude, as Dr. LaGarry does, that Balmat's findings can be extrapolated to areas outside her field study area. To do so

implies that all lineaments represent faults and joints, which contradicts Dr. LaGarry's earlier statements (see A.D.2 above) that lineaments are unexplained topographic features identified in remote sensing imagery, and that extensive fieldwork is required to ground truth their origin.

In summary, Dr. LaGarry's additional testimony provides information on regional structural features and conjecture concerning the presence of faults at the CBR site based largely on unsubstantiated lineament analysis. As in his earlier opinions (Ex. INT-003 and Ex. INT-013), Dr. LaGarry's additional testimony provides no hard, physical evidence that there are geologic structures (e.g., faults, fractures, or joints) capable of transmitting production fluids outside of the CBR LA. As discussed in A.D.3 of our initial testimony, CBR has provided multiple lines of hard evidence demonstrating confinement of production fluids within the LA. And, as discussed in A.D.9, A.D.10, A.D.17, and A.D.18 of our initial testimony, there is no evidence that the White River structural feature (the only field-documented structural feature in the vicinity of the CBR facility) is a conduit for ground water movement.

Q.D.4 On pages 3-4 of his testimony, Dr. LaGarry discusses a poster presentation by Maher and Schuster (2012), which used fieldwork to describe regional structural features in northwestern Nebraska and southwestern South Dakota. Does that poster presentation provide any evidence of structural features at or near the CBR facility?

A.D.4 (D. Back, T. Lancaster, E. Striz) No. Based on Dr. LaGarry's statements and the information in the poster presentation (Ex. INT-060), Maher and Schuster's study did not take place near the CBR facility. Specifically, Toadstool Park is approximately 29 km from the CBR facility; Whitney, Nebraska, is approximately 15 km from the from the CBR facility; and the Nebraska-South Dakota border is approximately 35 km from

the CBR facility. Other locations mentioned by Dr. LaGarry (e.g., Badlands National Park and Harding County, South Dakota) are even farther away from the CBR facility.

In Dr. LaGarry's testimony, he provides some observations of Maher and Schuster's suggestions regarding structural trends. In doing so, Dr. LaGarry provides his own interpretation that faults and joints are "ubiquitous and pervasive" at the locations described by Maher and Schuster, and states that his associates have observed "countless faults and joints" with the same orientation in northwestern Nebraska without specifically referring to the area where the CBR facility is located. Dr. LaGarry provides these observations without providing any evidence that the structures observed by his associates are documented at or near the CBR facility.

In summary, Dr. LaGarry simply does not provide any information to refute the multiple lines of site-specific, hard evidence demonstrating confinement at the CBR facility, which are discussed in A.D.3 of our initial testimony. As discussed in A.D.5 of our initial testimony, this site-specific evidence demonstrates that there are not any faults at the CBR site that could serve as pathways for transmission of fluids from the Basal Chadron Sandstone aquifer to the Brule aquifer or surface waters. In addition, as discussed in A.D.11 and A.C.6 of our initial testimony, there is no evidence of faults beneath the LA and adjacent areas. As discussed in responses A.D.10 and A.D.17 of our initial testimony, the White River structural feature, which is approximately 2 miles north of the CBR LA, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. Finally, as discussed in A.D.3 and A.D.4 of the initial testimony, historical evidence has demonstrated that process fluids have been contained within the Basal Chadron Sandstone aquifer at the CBR site.

Q.D.5 Referring to a 1982 water resources map that depicts the potential ore body at the CBR facility, Dr. LaGarry asserts on page 4 of his testimony that "the area marked as the potential ore body is a generally NW-SE trending lineament

similar to the trend noted by Diffendal (1994)." In Figure 2 on page 5 of his testimony, Dr. LaGarry has drawn two lines on the 1982 map which he asserts could be faults, and which he asserts were observed by Diffendal and portrayed on Diffendal's map (Figure 1 on page 3 of Dr. LaGarry's testimony). Can you please comment on Dr. LaGarry's interpretations?

A.D.5 (D. Back, T. Lancaster, E. Striz) Dr. LaGarry's assertions and interpretations are merely conjecture. His reliance on his own lineament analysis based on the 1982 map (Ex. INT-043 at 5) along with Diffendal's analysis does not refute the multiple lines of site-specific, hard evidence, discussed in A.D.3 and A.D.5 of our initial testimony, indicating that process fluids are confined within the LA and that faults capable of transmitting process fluids are not present.

Dr. LaGarry's assertion that the orientation of Crow Butte's ore body represents a lineament since it trends in the same direction as other regional lineaments identified by Diffendal is conjecture. As discussed in A.D.14 of our initial testimony, the orientation of the ore body is a function of its roll-front depositional history. With regard to the two purported "faults" that Dr. LaGarry has identified on the 1982 map, they appear to be lines drawn by Dr. LaGarry as possible explanation of the plan view shape of the ore body. Dr. LaGarry has provided no supporting evidence other than his own conjecture for concluding that these lines represent actual faults and that they correspond to lineaments identified by Diffendal.

With regard to lineaments identified by Diffendal, in A.D.7 of our initial testimony we noted that those lineaments had not been ground truthed, and that Diffendal had acknowledged that field work was needed to determine whether they were in fact structures. Similarly, as discussed in A.D.2 above, Dr. LaGarry has acknowledged the need for field verification of lineaments, but there is no indication that he has used available hard data provided by CBR (e.g., aquifer pumping test results, borehole

geophysical logs, and over 20 years of operational and monitoring data) to ground truth whether his lines on the 1982 map are potential faults.

In summary, Dr. LaGarry's speculative interpretations from the 1982 map cannot refute the multiple lines of site-specific, hard evidence of confinement we described in A.D.3 of our initial testimony. This evidence of confinement demonstrates that there are not any faults at the CBR site that could serve as pathways for transmission of fluids from the Basal Chadron Sandstone aquifer to the Brule aquifer or surface waters. Also, in A.D.9, A.D.10, A.D.17, and A.D.18 of our initial testimony, we explained why the only field-verified structural feature in the area, the White River structural feature, is not a conduit for ground water flow.

Q.D.6 On page 1 of his testimony, Dr. Kreamer asserts that "secondary permeability has not been sufficiently addressed." On page 2 of his testimony he states that "recent literature on the number and nature of the geologic faults, noted discontinuities, varying formation thicknesses, and the geologic history of the area does not rigorously support [the] conceptual model [of site hydrogeology]." He also states on page 2 of his testimony that "inadequate characterization of secondary permeability is presented on the faults and folds associated with the Black Hills uplift and the Chadron Arch." Can you please respond to these statements?

A.D.6 (D. Back, T. Lancaster, E. Striz) Dr. Kreamer does not identify the "recent literature" he refers to, so we cannot respond to that unsupported assertion. The Staff describes regional geology in Section 3.4.1 of the EA and regional hydrogeology in Section 3.5.2.1 (Ex. NRC-010 at 24-29, 34-35). Section 3.5.2.2 describes local hydrogeology, and Section 3.5.2.3 of the EA describes in detail the hydrogeological characteristics of the uranium bearing aquifer and confining layers (Ex. NRC-010 at 35-39). As discussed in A.F.5 of our initial testimony, the hydrogeological data provided by the

licensee (e.g., geophysical logs, aquifer pumping tests, water levels, core testing) supports the hydrostratigraphic conceptual model of the subsurface at the CBR site and its control of ground water flow behavior at the CBR site.

The hydrostratigraphic conceptual model at the site has been validated by over 20 years of operational and monitoring data and multiple lines of hard evidence presented in our initial testimony and described in the EA. For example, as discussed in A.D.3 and A.D.4 of our initial testimony, reproducible evidence has demonstrated process fluids are contained within the Basal Chadron Sandstone aquifer at the CBR site. As indicated in A.D.5, A.D.11, and A.C.6 of our initial testimony, there is no evidence of faults in the LA and adjacent areas. We explain in A.D.9, A.D.10, A.D.17, and A.D.18 of our initial testimony why the White River structural feature, which is located approximately 2 miles northwest of the LA, does not affect confinement within the CBR LA, and provide further information that supports the conclusion that the White River structural feature is not a transmissive fault. The remaining faults and folds associated with the Black Hills uplift and Chadron Arch are sufficiently distant from the CBR facility that they do not affect confinement at the site.

Q.D.7 On page 3 of his testimony, Dr. Kreamer asserts that "[a]vailable scientific evidence shows heterogeneous conditions and a geologic history of faulting that would allow vertical migration of . . . contaminants," and states that "CBR does not supply sufficient scientific evidence to support the claim of no vertical or horizontal hydraulic connection via faulted or jointed subsurface strata." Similarly, on page 2 of his testimony, Mr. Wireman has stated that "[g]iven the structural setting in which these formations and the uranium ore body occurs, there is a potential for unwanted fluid migration upward from the ore-bearing

Basal Chadron . . . thru the [Upper Confining Unit] into the upper Brule aquifer." Can you please address these statements?

A.D.7 (D. Back, T. Lancaster, E. Striz) Dr. Kreamer does not identify the "available scientific evidence" to which he is referring. With regard to his claim of heterogeneous conditions and faulting that would allow for vertical migration of production fluids in the Basal Chadron Sandstone aquifer, we explained in A.D.3 and A.D.4 of our initial testimony that there is no evidence of conditions that would allow for vertical migration of production fluids or that would compromise lateral hydraulic containment within the Basal Chadron Sandstone aquifer at the CBR site. On the contrary, multiple lines of evidence support our conclusions that confinement and containment have been demonstrated.

With regard to the claims concerning effects of faulting, as we explained in A.C.6, A.D.5 and A.D.11 of our initial testimony, there is no evidence of faults transmitting fluids from the Basal Chadron Sandstone aquifer to the overlying Brule aquifer at or near the CBR site. All of the "indications of extensive secondary porosity" Mr. Wireman refers to in his testimony (Ex. INT-047 at 2-3) are described on a regional level and do not provide evidence of faults at or near the CBR site. Section 3.5.2.3.3 of the EA discusses the White River feature, its interpretation, and the reasons it does not affect confinement at the CBR main facility (Ex. NRC-010 at 38-39). We also discuss those topics in A.D.9, A.D.10, A.D.17, and A.D.18 of our initial testimony.

In A.D.5 of our initial testimony, we acknowledged that faults and joints exist in northwestern Nebraska, but we explained that there is no evidence of faults and joints at the CBR site that are capable of transmitting fluids from the Basal Chadron Sandstone aquifer through the upper confining layers to the overlying Brule aquifer. Neither Dr. Kreamer nor Mr. Wireman has pointed to a known feature within the LA that has been ground-truthed as a fault. As explained in A.D.3 of our initial testimony,

there are multiple lines of site-specific evidence supporting confinement, including thick confining layers with high clay content and low hydraulic conductivity, cross-sections based on geophysical logs that show no indication of faults, differences in potentiometric head and geochemistry between the Basal Chadron Sandstone and Brule aquifers, and aquifer pumping test results covering the entire LA. This site-specific evidence forms the basis for our conclusion that there are no faults capable of transmitting fluids from the Basal Chadron Sandstone aquifer to the overlying Brule aquifer, and, more generally, that there is adequate vertical confinement at the CBR site.

Q.D.8 On page 6 of his testimony, Mr. Wireman asserts that additional hydrogeologic mapping and hydraulic testing is necessary to determine magnitude and orientation of secondary permeability resulting from structural deformation of rocks in the Basal Chadron, Chadron and Brule formations. Can you please address this claim?

A.D.8 (D. Back, T. Lancaster, E. Striz) Mr. Wireman does not identify any hard data showing structural deformation, and thus, does not provide a justification or a basis for performing additional hydrogeologic mapping and hydraulic testing to determine magnitude and orientation of secondary permeability. As discussed in A.C.6, A.D.5 and A.D.11 of our initial testimony, there is no evidence of faults beneath the LA and adjacent areas. As discussed in A.D.9, A.D.10, A.D.17 and A.D.18 of our initial testimony, the White River structural feature, which is approximately 2 miles north of the LA, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. Finally, as discussed in A.D.3 and A.D.4 of our initial testimony, historical site-measured evidence has demonstrated process fluids are contained within the Basal Chadron Sandstone aquifer at the project site.

Q.D.9 On page 2 of his testimony, Dr. Kreamer asserts that effects of "large pulses of infiltrating precipitation from intense storm activity" are not adequately addressed. Could you please address this claim?

A.D.9 (D. Back, T. Lancaster, E. Striz) Dr. Kreamer provides no support or further explanation for this general assertion. With regard to effects of "large pulses of infiltrating precipitation from intense storm activity," it is not clear what effects or environmental impacts Dr. Kraemer intends to address. However, the CBR facility has been operating for over 20 years with the expected range of meteorological events, and we are unaware of any intense storm activity producing a specific environmental impact which was not addressed in the EA.

Q.D.10 On page 1 of his testimony, Dr. Kreamer asserts that simplifying assumptions in the site hydrologic conceptual model ignore reported field results and could provide misinterpretations of actual conditions and subsurface flows. He then asserts on page 2 of his testimony that CBR and the Staff assume that "the groundwater system can be treated as a series of relatively horizontal, isolated, hydrostratigraphic layers, with each layer having hydraulic conductivity which can be assumed to be homogeneous and isotropic." He also states that the models and data analysis methods "use assumptions of formation uniform thickness, homogeneity [and] isotropy," but the EA does not provide justification for those assumptions. Finally, Dr. Kreamer claims that "reported conditions of the subsurface geology indicate lack of uniformity, heterogeneities, and non isotropic subsurface conditions." Can you please address these claims?

A.D.10 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. Kreamer's assertion that the Staff assumed uniform thickness, homogeneity, and isotropy for all layers at the CBR site. As discussed in A.F.5 of our initial testimony, we used site-specific data to

describe the collective ground water behavior of subsurface layers. These data included geologic cross sections based on geophysical logs, potentiometric surfaces, and results of aquifer pumping tests that provide coverage of the project site. Over 20 years of performance data from wellfield injection and extraction operations and excursion monitoring provides validation of the Staff's interpretation of subsurface conditions and flows in the site hydrologic conceptual model for the CBR site.

In its ground water modeling of the White River structural feature, the Staff did not assume uniform thickness and isotropy. The Staff's model used six different layers of different thicknesses, whose top elevations were defined using interpolation of formation picks from 130 borehole geophysical logs. As explained in A.D.20 of our initial testimony, these logs were obtained in the vicinity of the White River feature from data provided with the license amendment application for the NTEA. Each layer had a hydraulic conductivity assigned within the ground water flow model to match site data. As explained in the SER, the model also incorporated regional anisotropy through the evaluation of the probable behavior of the White River structural feature using data from a 2006 aquifer pumping test conducted for the NTEA (Ex. NRC-009 at 26).

Q.D.11 On page 2 of his testimony, Dr. Kreamer asserts that the data analysis methods used for the aquifer tests (Theis, Jacob, Cooper Jacob, Hantush, Neuman and Witherspoon) were inappropriate for the stated field conditions, and use of these methods impacts interpretation of potential vertical flow and the extent of influence of well pumping and injection. Can you respond to these statements?

A.D.11 (D. Back, T. Lancaster, E. Striz) With regard to the various data analysis methods used in the aquifer pumping tests (e.g., Theis, Cooper/Jacob, Hantush), Dr. Kreamer does not explain why these methods are inappropriate for the stated field conditions. As we also explain in A.6.9 of our rebuttal testimony for Contention 6, these methods are widely used and accepted standard methods taught in hydrogeology and

hydrology courses today, and they have been incorporated into American Society of Testing and Materials (ASTM) standards related to aquifer testing (Ex. NRC-080). Dr. Kreamer suggests that these methods are only reliable for systems that are isotropic and homogeneous, but if that is the case, these methods would never be applicable since no hydrogeologic systems are truly homogeneous and isotropic.

Dr. Kreamer also asserts that using these methods adversely impacts the interpretation of potential vertical flow and the extent of the influence of the well pumping and injection. However, the predicted amount of vertical flow is determined from actual hydraulic head values in the Basal Chadron Sandstone aquifer and the overlying units in response to pumping, not from the analytical methods used to interpret the aquifer pumping tests. Regardless of the analytical method used, there is no evidence of vertical flow through the confining unit. Furthermore, as discussed in A.D.3 of our initial testimony, the conclusion that adequate confinement exists (and thus that vertical flow through the confining unit will be negligible) is supported by multiple lines of evidence, not just the aquifer pumping test results. With regard to Dr. Kreamer's assertion that the analysis methods impact interpretation of the extent of the influence of the well pumping and injection, this assertion appears to be based on a misunderstanding of how the licensee uses aquifer pumping test data. CBR used the analytical methods (e.g., Theis, Cooper/Jacob, Hantush) to evaluate the four original aquifer pumping tests that covered the entire LA. As each well field was constructed and put into operation, more information became available and well extraction and injection rates were adjusted accordingly. Once each well field became fully operational, the actual measured data (e.g., flow rates and drawdown) were used to verify and adjust as necessary the extent of the influence of well extraction and injection to maintain an inward gradient.

Finally, Dr. Kreamer generally asserts that "old data and research is presented when more current research is available," but he does not identify what he considers "old data and research," nor does he explain why its age makes it invalid. He also fails to identify more current research that should be used instead. If Dr. Kreamer is referring to the methods used to analyze aquifer pumping tests (e.g., Theis, Cooper/Jacob, Hantush), as we explained earlier in this response, those methods are taught in hydrogeology courses, are widely accepted and used in the field, and have been incorporated into standard test methods.

Q.D.12 On page 3 of his testimony, Dr. Kreamer asserts that CBR has conducted "limited groundwater modeling and data analysis to support claims of restricted natural vertical flow . . . ." He further states that "[t]ests for the possibility of vertical migration of contaminants between formations have been restricted to limited pressure testing/hydraulic response trials which emphasized quick response, as opposed to any other sort of testing for the possibility of long-term vertical communication of contaminated groundwater." Can you please respond to these statements?

A.D.12 (D. Back, T. Lancaster, E. Striz) We are aware that CBR has conducted its own ground water flow modeling to optimize their operations. However, because the Staff does not require applicants to conduct ground water modeling, we do not know the extent of CBR's modeling efforts. We do know that CBR has conducted four aquifer tests since 1982, as reported in the LRA (Ex. CBR-011 at 2-201 to 2-214). These four tests were long term, high pumping rate tests in which water was pumped from a well in the Basal Chadron Sandstone aquifer to stress the aquifer vertically and horizontally. During these tests, the water level responses in the Basal Chadron Sandstone aquifer and the overlying Brule aquifer were assessed using observation wells. These aquifer pumping tests are considered representative of the long term

behavior of the aquifer system. In a confined aquifer like the Basal Chadron Sandstone aquifer, leakage properties of the overlying confining unit can be ascertained during the pumping period of the aquifer pumping tests, which for the CBR tests ranged between 51 and 72 hours. As described in greater detail in A.6.9 of our rebuttal testimony for Contention 6, the aquifer pumping tests were designed, operated, and analyzed followed widely accepted practices that are incorporated into ASTM standards (Ex. NRC-080).

Finally, the continuous ISR operations over more than 20 years have essentially acted as a surrogate for a very long aquifer pumping test. As explained in A.D.3 of our initial testimony, during this 20-year period the potentiometric surface of the Basal Chadron Sandstone aquifer has decreased approximately 14 m (47 ft), but there has been very little change in the potentiometric surface in the overlying Brule aquifer. These are the results that were predicted by the aquifer pumping tests performed in 1982, 1987, 1996, and 2002.

Q.D.13 On page 4 of his testimony, Mr. Wireman asserts that only two aquifer tests included a monitoring well in the upper confining unit, and that given the size of the mined area and the spatial heterogeneity of the upper confining unit (UCU) lithologies, this was not adequate to characterize hydraulic properties of UCU rocks. Further, Mr. Wireman states that hydraulic properties of the UCU were based on consolidation tests of core samples (instead of aquifer test data) and this is not representative of field conditions and does not account for secondary permeability. Can you please address these statements?

A.D.13 (D. Back, T. Lancaster, E. Striz) We disagree with Mr. Wireman's assertions. CBR's 1987 aquifer pumping test (Test #2) employed one piezometer each in the overlying and underlying confining units (Ex. CBR-011 at 2- 207). The piezometer in the overlying confining unit showed no response during this test, confirming that the

overlying confinement behaved as an impermeable unit. In addition, all four aquifer pumping tests performed by CBR had observations wells in the overlying Brule aquifer, none of which showed a response (Ex. CBR-011 at 2-206 to 2-214). The aquifer pumping tests were long-term tests (51 to 72 hrs) with high pumping rates (23.8 -51.2 gpm) that significantly stressed the Basal Chadron Sandstone aquifer over large radii of influence (4,000-5,700 ft). These tests were designed to detect interaction with overlying and surrounding aquifers over a large area of interest. The complete lack of response in the overlying aquifer over these large regions for all tests confirmed that the upper confining units overlying the Basal Chadron Sandstone aquifer are impermeable.

The consolidation tests performed on the core samples taken from the overlying confining unit and lack of response in the overlying confining unit piezometer also demonstrated that the overlying confining layers are impermeable. The high stress aquifer pumping tests were sufficient to demonstrate the impermeable nature of the overlying confining units at the CBR LA and demonstrate that the “secondary permeability” proposed by Mr. Wireman is not present. Mr. Wireman’s criticisms of the failure to install monitoring in the overlying confining unit and the use of consolidation tests to provide local validation of the impermeable nature of the upper confinement are irrelevant, because the long term aquifer pumping tests provided site-wide assessment of confinement. Thus, there is no need to require CBR to install numerous monitoring wells in the overlying confining units to further confirm this behavior locally. Finally, as described in A.D. 3 of our initial testimony, there are multiple bases for concluding that confinement exists. Therefore, there is no evidence of continuous “secondary permeability” that could transmit fluids vertically at the CBR site.

Q.D.14 On page 5 of his testimony, Mr. Wireman notes that the LRA acknowledges minor leakage from the upper confining unit to the Basal Chadron Sandstone during aquifer pumping tests. He claims that this indicates that inter-formational flow can occur. Can you please address this statement?

A.D.14 (D. Back, T. Lancaster, E. Striz) There is some discussion in the LRA of the overlying and underlying confining units yielding a small amount of recharge (leakage) to the Basal Chadron Sandstone aquifer during the first two aquifer pumping tests (Ex. CBR-011 at 2-206 to 2-207, 2-210). However, as discussed in the LRA, test data (e.g., laboratory tests of core samples, confining unit piezometer responses, and drawdown analysis of the Basal Chadron Sandstone aquifer) indicated an extremely small recharge from the extensive stress applied to the confining unit during the aquifer pumping tests (Ex. CBR-011 at 2-207). This lack of substantial recharge is attributable to the extremely low vertical hydraulic conductivity of the confining layers as determined by laboratory testing of core samples.

More importantly, the LRA also indicated that all four aquifer pumping tests (Ex. CBR-011 at 2-201 to 2-214) showed that no leakage occurs through the 200 to 500 feet thick overlying confining unit and that no communication exists between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer. This line of evidence, combined with over 20 years of operational monitoring results as well as other lines of evidence discussed in A.D.3 of our initial testimony, supports our conclusion that CBR has demonstrated vertical confinement of the Basal Chadron Sandstone aquifer at the CBR site.

Q.D.15 On page 5 of his testimony, Mr. Wireman states that the analysis of vertical fluid migration through the UCU was based on properties of red clay that overlies the BCS, but there is no data indicating that this clay occurs over the entire extent of the mined aquifer. Mr. Wireman also asserts that "CBR did not adequately

assess the possibility for very anisotropic conditions due to secondary permeability." Can you please address these statements?

A.D.15 (D. Back, T. Lancaster, E. Striz) Mr. Wireman incorrectly states that the analysis of vertical fluid migration through the 60 to 150 m (200 to 500 ft) thick overlying confining unit throughout the well field areas was based on properties of a small red clay layer that overlies the Basal Chadron Sandstone aquifer. He also does not specify which red clay layer in the overlying confining unit pertains to his claim.

Contrary to Mr. Wireman's claim, the analysis of vertical fluid migration of the overlying confining unit was based on properties of the entire 60 to 150 m (200 to 500 ft) feet thick unit, not merely the properties of one layer. As explained in A.D.3 of our initial testimony and Section 3.4.1 of the EA (Ex. NRC-010 at 26), the Basal Chadron Sandstone aquifer is overlain by the upper and middle Chadron Formation, which is primarily composed of clays and fine-grained mudstones, and the lower portion of the Brule Formation, which consists of interbedded siltstone, mudstone, and claystone with occasional sandstone. As noted in Table 2.6-2 of the LRA, the overlying confining beds (the Chadron-Brule confining unit) contain significant percentages of montmorillonite clay, as well as other clays and/or calcite (Ex. CBR-011 at 2-127). Section 3.5.2.3.2 of the EA also explains that the overlying and underlying confining units have extremely low vertical hydraulic conductivities (Ex. NRC-010 at 38). Section 2.6 of the LRA provides cross-sections that illustrate the continuity of the three major confining units across the project area (Ex. CBR-011 at 2-111 to 2-125). Finally, as we explained in A.D.5 of our initial testimony, swelling of the saturated clays in the confining units above the Basal Chadron Sandstone aquifer would prevent any localized secondary porosity from fractures and joints from creating permanent continuous vertical permeable pathways that could hydraulically connect the Basal Chadron Sandstone aquifer to the overlying aquifers.

Q.D.16 On page 5 of his testimony, Mr. Wireman identifies a statement in the LRA reporting that during the 1987 aquifer pumping test the monitoring well in the UCU showed a response to barometric pressure. He asserts that this conclusion needs further support because, if this was a UCU well in the lower Brule/upper Chadron, the potentiometric surface should not be affected by barometric changes because the ground water in the UCU is isolated from surface pressures. He questions whether this was in fact a UCU well. Could you please address this claim?

A.D.16 (D. Back, T. Lancaster, E. Striz) Mr. Wireman's statements indicate a misunderstanding of how aquifer pumping tests are designed, performed and analyzed. The more confined an aquifer is, the more likely the pressures recorded at the monitoring well will be affected by barometric pressure (Ex. NRC-081 at 83). Water levels measured in wells penetrating confined aquifers at depth can incorrectly record the real potentiometric pressure in the aquifer adjacent to the well screen due to the difference in pressure being transmitted directly to the free surface of a well and the pressure being transmitted to ground water in the aquifer itself (Ex. NRC-081 at 84). For this reason, it is important to collect barometric data during the aquifer pumping tests and to make sure that the measured pressure data is corrected for barometric effects. The intent of placing piezometer UCP-1 in the confining unit during the 1987 aquifer pumping test was to determine whether vertical pressure gradients are established through the confining unit by the pumping within the Basal Chadron Sandstone Aquifer.

Q.D.17 On page 95 of their Joint Position Statement, the Intervenors cite several portions of witness testimony as support for their assertion that the White River feature is a fault. These include portions of Dr. LaGarry's opinions and testimony (¶¶ 7-12, 16, 17, 24-32 at pages 8-9, 11, 13-14 of the Joint Position

Statement), Dr. Kreamer's testimony (¶ 12 at page 17 of the Joint Position Statement), and Mr. Wireman's testimony (¶ 4 at page 20 of the Joint Position Statement). They also cite two exhibits, the 1989 Petersen letter (Ex. INT-009) and the 1984 Elliot report (Ex. INT-066). Do you agree that those referenced statements and documents support the Intervenors' assertion?

A.D.17 (D. Back, T. Lancaster, E. Striz) No, we do not agree that any of those referenced statements or documents support an interpretation of the White River structural feature as a fault. The original interpretation of site historical information identified a vertical offset of strata which was interpreted as support for the existence of a potential fault from the sparse structural analysis data (historical regional data and surface field data). However, as discussed in A.D.9, A.D.10, A.D.17 and A.D.18 of our initial testimony, more recent evidence (e.g., drilling and geological modeling) near the White River structural feature supports the interpretation that this feature is a fold.

The cited portions of Dr. LaGarry's opinions and testimony only address regional faulting based on remote sensing imagery or surface field studies. Although he identifies the existence of the White River structural feature, he provides no evidence regarding its interpretation. The Petersen letter (Ex. INT-009), referenced in Dr. LaGarry's opinions and testimony, only offers Petersen's opinion that faults are probable without any supporting evidence, and he does not identify a particular fault at the CBR site. The Petersen letter does not refer to the White River feature at all. Likewise, the Elliot Report (Ex. INT-066) does not address or identify the White River feature specifically.

In the cited paragraph of Dr. Kreamer's testimony, he asserts that CBR does not supply sufficient evidence to support claim of no vertical or horizontal connection via faulted or jointed subsurface strata. Dr. Kreamer does not provide any further

discussion to support either of these statements, nor does he specifically mention the White River feature.

Finally, the cited portions of Mr. Wireman's testimony assert that "it is clear from the 2007 LRA and the 2014 SER that the nature of the White River fault/fold . . . is very uncertain" and that "the current CBR explanation that the feature is a fold in the post-Pierre Shale rocks is not rigorously supported by data." However, Mr. Wireman does not specify the basis for his assertions. As discussed in our initial testimony in A.D.9, A.D.10, A.D.17 and A.D.18, the White River structural feature, which is approximately 2 miles north of the LA, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. Also, as we explained in A.D.9 of our initial testimony, in its review of the aquifer exemption (AE) petition for North Trend, the Nebraska Department of Environmental Quality (NDEQ) reached a similar conclusion based on several lines of evidence. NDEQ also concluded, with input from independent experts, that CBR's interpretation of the White River structural feature was plausible.

Q.D.18 In their testimony, Dr. Kreamer and Mr. Wireman make several statements regarding inadequacies in modeling. In particular, on page 2 of his testimony, Dr. Kreamer states that "model validation, model numerical stability, uniqueness of solutions, grid intervals, and evaluation of more realistic scenarios beyond testing a single fault" are not reported. Dr. Kreamer also states on page 2 of his testimony that "modeling modifications by CBR and NRC . . . do not simulate multiple fractures beyond either a single fault, or isolated and non interconnected faults in the system," and that modeling does not consider heterogeneity at the site. Finally, on page 3 of his testimony, Mr. Wireman asserts that the NRC's modeling analysis of the White River structural feature "is a poor substitute for empirical data from drilling and has too much uncertainty." Could you please address those statements?

A.D.18 (D. Back, T. Lancaster, E. Striz) With regard to Dr. Kreamer's statements, he provides no further explanation for these remarks, so it is not clear whether he is addressing the site conceptual hydrological model, the Staff's modeling of the White River structural feature, or both. To the extent that he is addressing the White River structural feature modeling, we discussed the modeling effort in A.D.20 of our initial testimony as well as in Section 2.4.3.3 of the SER (Ex. NRC-009 at 23-27) and Section 3.5.2.3.3 of the EA (Ex. NRC-010 at 38-39). The model was used to support a stochastic evaluation of the likely behavior of the White River structural feature. Because the model was used stochastically, it was only necessary to capture the major features of the hydrogeological system. The model employed six different stratigraphic layers whose top elevations were defined using interpolation of formation picks from 130 borehole geophysical logs. Each layer had hydraulic parameters assigned to match site-measured data. The model was then used with different definitions of the White River structural feature (flow, no-flow, etc.) to assess its probable behavior (Ex. NRC-009 at 24-25). Specifically, the fit of each run of the model with a different structural feature assignment was evaluated using data from a NTEA aquifer pumping test and then assessed statistically to ascertain the most probable definition of the feature.

The Staff's ground water flow model of the White River structural feature was not used to match or predict the historical, present or future ground water flow behavior of the feature. To match or predict the historical, current or future behavior of the ground water flow system, a deterministic ground water flow model of the site must be used. This type of ground water flow model requires the modeler to define all hydraulic features based on site specific data at the outset and does not allow for major modification of features once developed. A deterministic ground water flow model also requires much more rigor in its development, calibration and verification including an

assessment of model numerical stability and sensitivity to parameter assignment, grid size and boundary conditions.

As we acknowledged in A.D.21 of our initial testimony, all models are non-unique and uncertain due to the inherent assumptions in their development and application using limited site data. The use of numerical models to simulate multiple fractures, as suggested by Dr. Kreamer, would be even more uncertain and non-unique because a multiple fracture system cannot be fully described by inherently limited field data.

We also explained in A.D.21 of our initial testimony that the ground water flow model described in the Staff's SER and EA is not an essential piece of evidence supporting confinement in the CBR LA, particularly because the White River structural feature is approximately 2 miles from the LA. As we explained in A.D.3 and A.D.21 of our initial testimony, we consider our ground water flow model to be one more line of evidence in addition to several other lines of evidence demonstrating confinement.

Finally, as we explained in A.D.17 of our initial testimony, CBR conducted additional close spaced drilling and developed a three-dimensional geological model of the White River structural feature to support its NDEQ underground injection control (UIC) permit application for the NTEA. This information addresses Dr. Wireman's comment that modeling is a poor substitute for empirical data based on drilling. We also explained in A.D.17 of our initial testimony that this additional drilling data, along with other evidence, supports our conclusion that the interpretation of the White River structural feature as a fold is reasonable. As discussed in A.D.9 of our initial testimony, NDEQ reached a similar conclusion.

Q.D.19 On page 3 of his testimony, Dr. Kreamer states that only a limited number of faults are reported in the LRA and no rigorous hydraulic testing has been made on those identified. Can you please address this statement?

A.D.19 (D. Back, T. Lancaster, E. Striz) Section 2.6.1.7 of the LRA describes regional structure and Section 2.6.2.5 of the LRA describes structural features (e.g., folding and faulting) in the LRA's area of review, which extends 2 miles beyond the License Area (Ex. CBR-011 at 2-105 to 2-106, 2-131). The only structural feature that CBR identified in the area of review is the White River structural feature (Ex. CBR-011 at 2-133).

As discussed in A.D.5, A.D.11, and A.C.6 of our initial testimony, there is no evidence of faults at the CBR site. As we explain in A.D.9, A.D.10, A.D.17, and A.D.18 of our initial testimony, the White River structural feature, which is approximately 2 miles north of the LA, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. Finally, as we discussed in A.D.3 and A.D.4 of our initial testimony, historical evidence has demonstrated process fluids are contained within the Basal Chadron Sandstone aquifer at the project site.

Environmental Justice

Q.D.20 In support of its claims concerning environmental justice (EJ), the OST has provided a statement by Ms. Charmaine White Face. On page 3 of her statement, Ms. White Face claims that CBR "pumps dissolving lixiviant into the Arikaree aquifer" at their ISR facility near Crawford, Nebraska. Can you please respond to this claim?

A.D.20 (D. Back, T. Lancaster, E. Striz) We disagree with Ms. White Face's claim. The mined aquifer at the CBR facility is the Basal Chadron sandstone aquifer. This is the only site aquifer into which CBR injects lixiviant. CBR does not inject lixiviant into the Arikaree aquifer. As we explained in A.D.3 of our initial testimony, there are multiple lines of evidence demonstrating confinement between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer at the CBR site. We also explained in A.D.4 of our initial testimony how it was not possible for water to migrate through the Basal

Chadron Sandstone aquifer to the Pine Ridge Reservation because the Basal Chadron Sandstone pinches out northeast of the LA and is not present at the Pine Ridge Reservation.

Q.D.21 On page 3 of her statement, Ms. White Face also claims, based on a USGS potentiometric map of the Arikaree aquifer, that "water flows to the north and east of Crawford . . . into the Pine Ridge Reservation." Can you please address this statement?

A.D.21 (D. Back, T. Lancaster, E. Striz) We disagree with Ms. White Face's assertion that the Arikaree aquifer flows north and east of Crawford, Nebraska into the Pine Ridge Reservation. As explained in A.F.4 of our initial testimony, the Arikaree Formation is present only in the far southeast corner of the site and forms the Pine Ridge Escarpment located south and southeast of the LA. As described in A.D.3 and A.D.4 of our initial testimony, vertical confinement exists at the CBR site, and process fluids are contained within the LA. Therefore, operations at the CBR site would not impact the Brule aquifer or the Arikaree aquifer, which overlies the Brule. Furthermore, according to the USGS formation map that Ms. White Face provided, the Arikaree aquifer is absent in northeastern Dawes County (Ex. OST-001 at 14). The absence of the Arikaree aquifer is also evident by comparing the USGS formation map (Ex. OST-001 at 14) with the potentiometric map that Ms. White Face provided (Ex. OST-001 at 15). Finally, a close examination of the potentiometric map (Ex. OST-001 at 15) indicates that the ground water flow direction in the Arikaree aquifer at its southwestern edges is primarily west and northwest, away from the Reservation. For the reasons stated above, water cannot flow via the Arikaree aquifer from Crawford through northeastern Dawes County to the Pine Ridge Reservation.

Q.D.22 On page 4 of her statement, Ms. White Face claims that the pumping action of the five deep wells in the Arikaree aquifer at the Pine Ridge Reservation "would

also add pressure to the Arikaree aquifer for the lixiviant with dissolved radionuclides to travel more rapidly under the Pine Ridge Reservation." Could you please address this statement?

A.D.22 (D. Back, T. Lancaster, E. Striz) First, as we have explained in A.D.20 above, CBR does not pump lixiviant into the Arikaree aquifer. As explained in A.F.4 of our initial testimony, the Arikaree Formation is present only in the far southeast corner of the site and forms the Pine Ridge Escarpment located south and southeast of the LA. CBR injects lixiviant into the Basal Chadron Sandstone aquifer, which is hydraulically isolated from the overlying Brule aquifer as demonstrated by numerous lines of evidence discussed in A.D.3 of our initial testimony. Also, as we explained in A.D.4 of our initial testimony, there is not a pathway for contaminants to migrate through underground aquifers to the Pine Ridge Reservation. Therefore, we disagree with Ms. White Face that lixiviant or other fluids from CBR operations can travel from the CBR site to Pine Ridge Reservation by any pathway.

With respect to the assertion that pumping action would cause fluids to travel more rapidly, any well pumping in the Arikaree aquifer will draw in water from a radius of influence confined to the Arikaree aquifer. As we explained above, there is no pathway for ground water to travel from the Basal Chadron Sandstone aquifer at the CBR site to the Arikaree aquifer at the Pine Ridge Reservation. Moreover, Ms. White Face has identified the locations of three of the five Arikaree wells as Oglala, South Dakota, Pine Ridge, South Dakota, and Kyle, South Dakota. The closest of these to the CBR facility is the well at Oglala, South Dakota, which is approximately 49 miles from the nearest CBR LA boundary. Although water flow within the Arikaree aquifer on the Pine Ridge Reservation could be locally influenced by pumping action, Ms. White Face has failed to explain how pumping at the identified wells in the Arikaree aquifer

would have any effect on the Basal Chadron Sandstone aquifer 49 miles (or more) away at the CBR site.

Q.D.23 In support of her assertion that CBR's operations are contaminating the Arikaree aquifer wells on the Pine Ridge Reservation, on page 5 of her statement Ms. White Face claims that "when naturally occurring uranium is disturbed, the ratio of U-238 to U-234 will change." She then cites results from three wells (in Kyle, SD; Pine Ridge, SD; and Oglala, SD) that show "there is always more U-234 than U-238" in the samples. Can you please address these statements?

A.D.23 (D. Back, M. Fuhrmann, T. Lancaster, E. Striz) First, we reiterate based on our preceding responses (A.D.20 through A.D.22), as well as A.D.3 and A.D.4 of our initial testimony, that there is no plausible pathway for contaminants to migrate from the Basal Chadron Sandstone aquifer (the mined aquifer at the CBR facility) to the Arikaree aquifer wells on the Pine Ridge Reservation. As noted in A.D.22 above, the wells Ms. White Face refers to are all at least 49 miles away from the CBR facility. In A.D.4 of our initial testimony, we explained that the Basal Chadron Sandstone pinches out and is not present at the Pine Ridge Reservation. Moreover, the Arikaree Formation is present only in the far southeast corner of the site and forms the Pine Ridge Escarpment located south and southeast of the LA and is an overlying formation above the White River Group at the Pine Ridge Reservation. Finally, as we explained in A.D.4 of our initial testimony, the White River Group is considered impermeable and not an aquifer on the Pine Ridge Reservation.

Ms. White Face's statement that disturbing natural uranium will change the ratio of U-234 to U-238 is unsupported. Ms. White Face appears to be claiming that the ISR process preferentially releases U-234. But the ISR process involves chemical reactions that change the oxidation state of uranium to make it more soluble, and these chemical reactions are isotope independent. The transformation from U-238 to

U-234 happens through radioactive decay, which is not influenced by the chemical reactions associated with the ISR process.

As evidence of her claim that contaminants from the CBR facility are reaching the Pine Ridge Reservation, Ms. White Face compares the activity ratios of U-234/U-238 observed in water taken from three wells on the Pine Ridge Reservation to the natural abundance ratio of those isotopes. Referring to Exhibits 6, 7, 8 and 10 of her statement, she cites a nearly 2 to 1 ratio of U-234/U-238 (e.g., in Exhibit 6, 8.0 pCi/L for U-234 versus 4.5 pCi/L for U-238) (Ex. OST-001 at 17-19, 23). There are two problems with this analysis. The first is the comparison of the U-234/U-238 ratio based on natural abundance (measured in percent by mass) to well test results, which are based on activity (pCi/L). This makes direct comparison inappropriate, because the specific activity of U-234 is over four orders of magnitude greater than that of U-238 (Ex. NRC-082 at PDF 2).

The second problem with the analysis is that the natural activity ratio of U-234/U-238 in ground water typically ranges between 1 and 3, with occasionally higher values (Ex. NRC-082 at PDF 2). The measured U-234/U-238 activity ratios from the three wells from which data are presented are 1.8, 1.9, and 2.1. These are within the range for natural ground water as reported by Rhodes et al (Ex. NRC-082 at PDF 2, 3). The activity ratios based on Ms. White Face's test data are also consistent with U-234/U-238 activity ratios based on data in Heakin's report (USGS Water Resources Investigations Report 99-4063) on water quality at the Pine Ridge Reservation (Ex. NRC-025). Heakin reported U-234 and U-238 activity measurements for five wells in the vicinity of Manderson, South Dakota and Porcupine, South Dakota (Ex. NRC-025 at 60-61, 11) that were tested in 1995. Ratios of U-234/U-238 calculated from these test results (Ex. NRC-025 at 60-61) indicate values near 2 in all cases.

Finally, Ms. White Face asserts that "naturally occurring Thorium has been unnaturally displaced so that it is in the drinking water at Oglala." Ms. White Face appears to be implying that Th-234 is traveling from the CBR site to the Pine Ridge Reservation, but she has not provided any evidence that Th-234 is produced by CBR operations, nor has she identified a plausible pathway for any contaminants to travel between the CBR site and the Arikaree wells at Pine Ridge Reservation. As we explained earlier in this response, there is no such pathway. And given the short half-life of Th-234 (24 days), it is highly unlikely that measurable amounts of Th-234 could travel in ground water approximately 50 miles from the CBR facility to the wells at the Pine Ridge Reservation, even if a pathway existed.

For the reasons stated above, Ms. White Face has provided no evidence that CBR's operations have had any impact on ground water quality at the Pine Ridge Reservation. Rather, naturally-occurring uranium on and near the Pine Ridge Reservation is the most likely explanation for the water quality test results (Ex. NRC-025 at 2, 38-39).

Q.D.24 After reviewing the testimony and associated exhibits provided by the Intervenors in support of their EJ claim, has the Staff found any reason to revisit its EJ analysis or the conclusions of that analysis?

A.D.24 (N. Goodman) No. In A.D.27 and A.D.28 of our initial testimony, we explained that the Staff saw no basis to deviate from a 4-mile radius for the EJ review area, and we also explained why further EJ analysis was unnecessary based on our conclusion that impacts to surface and ground water quality would be SMALL. For the reasons explained in A.D.20 to A.D.23 above, Ms. White Face's statement (Ex. OST-001) does not provide any information that would cause the Staff to revise its choice of a 4-mile radius for the EJ review area or its conclusion that impacts of the CBR license renewal

on ground water quality will be SMALL. Therefore, we have not identified a reason to revisit the EJ analysis or its conclusions.

Q.D.25 Having reviewed the claims raised by the Intervenors in their initial written testimony and the associated exhibits for Contention D, do you have any additional testimony to offer regarding whether the Staff's consideration of cumulative effects in the context of EJ should be expanded to consider potential impacts on the drinking water aquifer at the Pine Ridge Reservation?

A.D.25 (N. Goodman) No. The Intervenors have offered no arguments, testimony or exhibits related to the issue of whether the Staff's analysis of cumulative impacts in the context of EJ should be expanded to include potential impacts on the drinking water aquifer at the Pine Ridge Reservation. Therefore, the Staff has no rebuttal testimony to offer on this subject.

CONTENTION F

Q.F.1 Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?

A.F.1 (D. Back, T. Lancaster, E. Striz) Yes. As supporting testimony for Contention F, the Intervenors filed testimony by Dr. Hannan LaGarry (Ex. INT-043), Dr. David Kreamer (Ex. INT-046), and Mr. Michael Wireman (Ex. INT-047). We have reviewed the Intervenors' testimony and are familiar with the witnesses' arguments.

Q.F.2 On page 1 of his testimony, Dr. Kreamer asserts that simplifying assumptions in the site hydrologic conceptual model ignore reported field results and could provide misinterpretations of actual conditions and subsurface flows. He then asserts on page 2 of his testimony that CBR and the Staff assume that "the groundwater system can be treated as a series of relatively horizontal, isolated, hydrostratigraphic layers, with each layer having hydraulic conductivity which

can be assumed to be homogeneous and isotropic." Could you please address these statements?

A.F.2 (D. Back, T. Lancaster, E. Striz) Because this statement also relates to the issue of adequate confinement, we also address this question in A.D.10 of our rebuttal testimony for Contention D. As stated in A.D.10 of our rebuttal testimony, we disagree with Dr. Kreamer's assertion that the Staff assumed uniform thickness, homogeneity, and isotropy for all layers at the CBR site. As discussed in A.F.5 of our initial testimony, we used site-specific data to describe the collective ground water behavior of subsurface layers. These data included geologic cross sections based on geophysical logs, potentiometric surfaces, and results of aquifer pumping tests that provide coverage of the project site. Over 20 years of performance data from wellfield injection and extraction operations and excursion monitoring provides validation of the Staff's interpretation of subsurface conditions and flows in the site hydrologic conceptual model for the CBR site.

CONTENTION 1

Q.1.1 On page 78 of their Joint Position Statement, the Intervenors argue that the consultation process was inappropriately "delegated" to the SRI Foundation, CBR's contractor. How does the Staff respond?

A.1.1 (N. Goodman, P. Nickens) Pertaining to government-to-government consultation between the NRC and the Tribes, SRI Foundation was responsible for none of the consultation activities. They had no role in the Staff's decision and were not hired or employed as a contractor for the NRC. SRI Foundation was hired by the applicant as their third-party contractor, and its role was to assist the applicant in data collection, license application preparation, and advisement to the applicant as a consulting party in Section 106. The Staff worked with SRI Foundation as it would with any applicant or

third-party contractor representing an applicant, who have a right to be a consulting party under the National Historic Preservation Act.

SRI Foundation did not have a decision-making role in determining whether the TCP survey would be conducted. SRI was a participant on phone calls pertaining to the planning of the TCP survey, as were any Tribes that wished to be. SRI Foundation also participated in the face-to-face meetings. However, SRI Foundation was there exclusively as the applicant's consultant, and did not hold any special influence over any decision the Staff made pertaining to consultation. The Staff did not consult directly with SRI Foundation regarding its decisions pertaining to section 106 consultation. SRI did not have any role in conducting the TCP survey itself.

Q.1.2 On page 73 of their Joint Position Statement, the Intervenors, citing Dr. Redmond's 2013 letter to David Frankel (Ex. INT-054), argue that "the lack of subsurface testing when large scale ground disturbances are being contemplated is a violation of TCP survey standards and protocols." What "standards and protocols" govern TCP surveys?

A.1.2 (N. Goodman, P. Nickens) The Intervenors both mischaracterize and misinterpret the focus and scope of Dr. Redmond's 2013 letter to Mr. Frankel. In his letter of 2013, Dr. Redmond refers specifically to the class III archaeological and historical resources inventories completed for the Marsland Expansion Area (MEA), which is a proposed project area and will have future ground disturbing activities associated with development of mine units. Dr. Redmond does not refer to a TCP survey or to the current CBR license project area in his 2013 letter, nor does he suggest that subsurface testing would be a useful investigative tool for conducting a TCP survey.

The License Renewal EA covers the current CBR ISR uranium milling facility and appurtenant facilities in which the renewal of License SUA-1534 would continue the proposed operating schedule, primarily the near-term completion of mining activities,

followed by ground water restoration, surface reclamation, and decommissioning activities. Consequently, renewal of the current license would lead to *much smaller scale* ground disturbances than would be anticipated for development of a new expansion area such as the MEA.

There are currently no "standards and protocols" that govern TCP Surveys. Some broadly defined guidelines for identifying, recording, and determining eligibility of potential places of traditional religious or cultural significance for the National Register of Historic Places are found in National Register Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties*, currently under revision (Ex. NRC-083).

Q.1.3 On page 2 of his 2015 letter to David Frankel, Dr. Redmond states that the Crow Butte license renewal is "in direct opposition" to the "Nebraska State Historic State Historic Preservation Plan" [*sic*]. What is the function of the Nebraska Historic Preservation Plan?

A.1.3 (N. Goodman, P. Nickens) Section 101(b)(3)(C) of the NHPA instructs individual State Historic Preservation Officers (SHPOs) to "prepare and implement a comprehensive statewide historic preservation plan" (HPP). National Park Service (NPS) guidelines list the general requirements of such a plan: (1) meets the circumstances of each State; (2) achieves broad-based public and professional involvement throughout the State; (3) takes into consideration issues affecting the broad spectrum of historic and cultural resources within the State; (4) is based on the analyses of resource data and user needs; (5) encourages the consideration of historic preservation within broader planning environments at the federal, state, and local levels; and (6) is implemented by SHPO operation (Ex. NRC-084), as implemented by 36 C.F.R. Part 61 – *Procedures for State, Tribal, and Local Government Historic Preservation Programs*.

Within this framework, the Nebraska HPP essentially serves two purposes. First, it guides the work of the SHPO, which authors the plan and plays the lead role in its implementation – a role mandated under the NHPA. Second, and equally important, the plan provides a framework for the ongoing work of historic preservation by all of the State's preservation partners – citizens, organizations, government agencies, elected officials, preservation professionals, and the State's federally recognized Indian tribes. The Nebraska HPP does not include standards or requirements for conduct of environmental reviews of cultural resources within the State.

Q.1.4 Is the function of the Nebraska HPP applicable here?

A.1.4 (N. Goodman, P. Nickens) The current Nebraska HPP is the report, *Building on the Historic and Cultural Foundations of Nebraska: The State Historic Preservation Plan for Nebraska—2012-2016* (Ex. NRC-085). The Nebraska HPP incorporates the following topics: (1) Trends Affecting Historic Preservation; (2) Knowledge of Nebraska Historical Periods; (3) Preservation in Nebraska; (4) Public Participation Process; (5) A Five-Year Vision for Historic Preservation in Nebraska; and (6) A Call to Action – How You Can Help. The Nebraska HPP does not include any "standards" for historic preservation within the State, but it does contain four goals (under the five-year vision), including: (1) Rural and Community Development; (2) Identification and Assessment of Significant Historic and Cultural Places; (3) Funding, Incentives & Legislation; and (4) Outreach and Education.

As specified by the NHPA and delineated in the implementing regulation, the Nebraska HPP has little or no applicability for the NRC Staff's environmental analyses for the CBR License Renewal EA. Instead, the Staff's analyses and evaluation of the potential environmental consequences from a renewal of CBR's license to continue its operations at the Crow Butte ISR facility are directly guided by requirements of NEPA

and its implementing regulations at 40 C.F.R. Parts 1500-1508, 10 C.F.R. Part 51, and NRC staff guidance in NUREG-1748 (Ex. NRC-014).

While the Nebraska HPP itself is not applicable to the cultural resources analysis for the LR EA, the document, *Nebraska State Historic Preservation Office, National Historic Preservation Act, Archaeological Properties, Section 106 Guidelines* (Ex. NRC-049), is relevant. This document offers guidance for personal qualifications for those conducting archaeological field inventories, as well as standards for field coverage, resource identification, recording, and evaluation for National Register significance. Previous Class III archaeological and historic resources inventories for the CBR license renewal project area conform in all respects to the guidelines outlined in this document.

Q.1.5 On page 1 of his 2015 letter to David Frankel (Ex. INT-022), Dr. Redmond states that "very specific qualifications must be met for field surveyors, supervisors and principal investigators of Class III archeological surveys and Traditional Cultural Property investigation." He cites the *Secretary of Interior's Standards and Guidelines*, which he states "are the defining standards nationally." Are these the defining standards for Class III surveys?

A.1.5 (N. Goodman, P. Nickens) Yes, these are the professional qualifications commonly referred to as being the minimum education and experience required to perform identification, evaluation, registration, and treatment activities of archaeological and historic resources. This same set of standards and guidelines is referenced in the *NE SHPO, NHPA, Archaeological Properties, Section 106 Guidelines* as follows:

> Archeological resource surveys will be conducted by or under the supervision of qualified professional personnel. The Principal Investigator responsible for archeological resource assessments will meet the minimum professional qualifications in the Department of the Interior's, National Park Service, Archeology and Historic Preservation, Secretary of the Interior's Standards and Guidelines (Federal Register, vol. 48, no. 190, p. 44739). The Principal Investigator takes responsibility for all work,

> findings, and recommendations in the cultural resource report. If the Principal Investigator does not already have on file at the NeSHPO office a documenting vita, it will be made part of the resource report at the time of review.

(Ex. NRC-049 at 6.)

Q.1.6 Does the principal investigator for the 1982 and 1987 Class III surveys meet these requirements?

A.1.6 (N. Goodman, P. Nickens) The Class III field inventories for the CBR facility project area (the current license area were conducted in two phases, with the combined results from both inventories discussed in the 1987 report, "A Cultural Resources Study of the Crow Butte Uranium Prospect, Dawes County, Nebraska" (Ex. CBR-027; Ex. CBR-028). The first inventory was conducted in 1982, under the direction of Robert E. Pepperl, University of Nebraska-Lincoln. The second field effort, completed in 1987, was under the direction of John R. Bozell, Nebraska State Historical Society. The final cultural resources report was co-authored by the two principal investigators.

Professional resumes for the two principal investigators who directed the separate field inventories at the CBR project area are not included in the final report. That the final report findings, including the identification, recording, and evaluation of archaeological and historic resources documented by the two field inventories, were accepted and the National Register evaluations concurred with by the NE SHPO indicates that the principal investigators met the minimum "Professional Qualifications Standards," as established by the Secretary of the Interior, which became effective on September 29, 1983. Moreover, both principal investigators were, at the time of the field efforts, employed by the State of Nebraska, and each has an established record of cultural resources investigations in Nebraska over a period of several years. Mr. Bozell is employed today as the Nebraska Highway Archeology Program Manager, an

office established through a cooperative agreement between the Department of Roads and the Nebraska State Historical Society.

Q.1.7 Are the *Secretary of Interior's Standards and Guidelines* the defining standards for traditional cultural property (TCP) surveys, as Dr. Redmond's 2015 letter states?

A.1.7 (N. Goodman, P. Nickens) *The Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* include "Professional Qualifications Standards" for the following professional fields: History, Archaeology, Architectural History, Architecture, and Historic Architecture. The *Secretary of Interior's Standards and Guidelines* do not include qualifications that define minimum education and experience required to perform TCP surveys, documentation, evaluation, or registration of TCP properties. Similar standards for professional qualifications in conducting TCP surveys also do not currently exist elsewhere.

Appendix II to National Register Bulletin 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties,* offers guidance for "Professional Qualifications: Ethnography." (Ex. NRC-083 at 26.) These guidelines, however, refer to specialists in ethnographic fieldwork, usually cultural anthropologists or related disciplines, such as folklore/folklife, who have training and experience in working with Tribes or other communities who may assign traditional cultural significance to such places.

Q.1.8 Were any known or potential cultural resources given special emphasis during the cultural background research and analysis efforts for the CBR license renewal EA?

A.1.8 (N. Goodman, P. Nickens) For the LR EA cultural resources analysis, all known or potential cultural resources were given equal consideration during the evaluation process. Initially, the Class III field inventories completed for the original license

application were reviewed for completeness, including extent of coverage, site file and literature searches, resource identification, and evaluation. Six prehistoric and historic archaeological properties were recommended by the original investigators as being potentially eligible for listing on the National Register. One of these was later dropped from the list when additional field testing and subsequent evaluation indicated that it was "not eligible." Given the time that had elapsed since the original identification and evaluation, the Staff conducted an assessment of the current status of these resource sites through a field visit to the sites to evaluate their physical condition and to conduct discussions with CBR personnel regarding their ongoing management practices to avoid the potentially eligible sites during ISR mining and other activities (Exs. NRC-051A through NRC-051C).

Recognizing that the original license application and environmental review did not adequately address known or potential places of religious or cultural significance for Tribes, the Staff completed several steps to mitigate this deficiency. First, literature reviews were completed to: (1) identify historic-period Tribes that traditionally occupied or used the Nebraska Panhandle region, and (2) identify potential places or resources of religious or cultural significance that could occur within the LR EA area of potential effect (APE) or in close proximity. Next, since the Lakota ancestors of the modern-day Tribes of the Rosebud, Standing Rock, Pine Ridge (Oglala), Crow Creek, Lower Brule, Cheyenne River, and Fort Peck Sioux Reservations appear to have been the traditional occupants of the area, special emphasis was given to potential Lakota places of significance, especially for the nearby Oglala Sioux Tribe. To identify potential Lakota places or resources of religious or cultural significance, additional literature searches were conducted, along with interviews with local experts in the history and ethnohistory of the area (Ex. NRC-051A at 3; Ex. NRC-051C at 6-8), including information gained from Oglala Sioux experts during a 2011 field visit to the

project area (Ex. NRC-050). This analysis revealed the presence of several potential places of tribal importance in the vicinity of the project area, but none within the specified APE.

Q.1.9 On pages 6-7 of his testimony (Ex. INT-031 ¶ 25), Mr. CatchesEnemy points to the historical mid-19th century Fort Robinson treaty-making era when the various Lakota bands were forced to occupy encampments in the vicinity of the fort, and implies that there could have been such a camp within the CBR license renewal project area that was "missed" by the 1982 and 1987 Class III surveys. How do you respond?

A.1.9 (N. Goodman, P. Nickens) Mr. CatchesEnemy is correct that a potential exists for the occurrence of mid-19th century Lakota and other Tribal encampments associated with the Fort Robinson era and the treaty-making activities in the general vicinity. To assess this possibility, the Staff reviewed historical literature and maps dealing with the historical activities associated with that era. Some of this effort also involved similar evaluation for the proposed CBR NTEA, which is located north of the town of Crawford and closer to Fort Robinson. The inquiry indicated that the Lakota camps associated with the Fort Robinson treaty-making era were distributed from just south of the fort, eastward along the White River, but in proximity to the Red Cloud Agency situated in the eastern part of the military reservation. While the literature review did not indicate the presence of mid-19th century Lakota encampments within or close to the current CBR license area, the previous Class III survey data were evaluated for a possible presence of a sizable historic period Native American camp. None was evident in the archaeological data.

During the 2011 field visit to the project area by Tribal representatives, Oglala Sioux representatives noted the presence of nearby buttes, outside the LR EA APE, as earlier vision quest places (Ex. NRC-010 at 56-57), and they observed that some

medicinal plants of importance to the Oglala Sioux could grow within the APE (Ex. NRC-050). The potential for impacts from renewal of the CBR license for the latter was addressed in the LR EA, Section 4.8 (Ex. NRC-010 at 86-88). At the time of the 2011 field visit, the Oglala Sioux representatives did not specify a potential for mid-19th century Lakota encampments to be located within the CBR ISR project area boundaries.

Q.1.10 On page 4 of his testimony (Ex. INT-031 ¶ 15), Mr. CatchesEnemy describes Crow Butte as a sacred peak. Did the Staff consider Crow Butte itself as a potential TCP?

A.1.10 (N. Goodman, P. Nickens) Because of its prominence and close proximity to the CBR license renewal project area, the Staff did consider the Crow Butte as a potential TCP. To date, the feature has not been recorded or evaluated as a place of Tribal significance, or nominated for listing on the National Register as a TCP. The Crow Butte (also shown on early maps and known to the Lakota and Cheyenne as "Dancer's Hill") was the site of a legendary 1849 battle between members of the Brule Lakota and the Crow Tribes. Although exact details of the event differ in accounts over time, it is well remembered through Native American memory and by non-Indians as well. Oglala Sioux cultural resources experts also identified it as a place for vision quests, especially noting a long ridge adjacent to Crow Butte that was used in earlier years as a place that young Lakota men went to for vision quests. Although the Crow Butte is close to and highly visible from the CBR ISR facility, renewal of the CBR license to operate the facility would not have potential for future adverse effects for the landform. Cessation of ongoing activities in current mine units and subsequent surface reclamation of the land in the project area would improve a cultural viewscape from the butte in the long term.

CONTENTION 6

Q.6.1 What is meant by the term "consumptive use" of ground water at an ISR facility?

A.6.1 (D. Back, T. Lancaster, E. Striz) Consumptive use of ground water at an ISR facility is the actual amount of ground water that is permanently removed from the production zone aquifer during operations and restoration. CBR is permitted by its NRC license to have a maximum production flow rate of 9000 gallons per minute (gpm). This is the maximum amount of ground water which may be pumped from all extraction wells in the CBR mine units. CBR, however, returns almost all of this flow back to the Basal Chadron Sandstone aquifer through injection wells, removing only a small portion (1-2%) as bleed. This 1-2% bleed represents the total consumptive use of ground water from the Basal Chadron Sandstone aquifer. For a permitted production flow of 9000 gpm, the total consumptive use of ground water from the Basal Chadron Sandstone aquifer for assuming a 2% overall bleed would be 180 gpm.

As described in A.6.8 of the Staff's initial testimony, the Staff assumes that all liquid routed to the evaporation ponds and deep disposal wells is consumptive use of the water (Ex. NRC-001 at 87). This approach provides a conservatively high estimate of the consumptive use rates because it includes not only water from consumptive use, but all liquid wastes.

Q.6.2 The Intervenors, citing Exhibit INT-050, state that 36.47 pore volumes were required for the restoration of Mine Unit 1. However, CBR states in the LRA that 9 pore volumes were used (Ex. CBR-011 at 6-22). Can the Staff explain the discrepancy?

A.6.2 (D. Back, T. Lancaster, E. Striz) The Intervenors state that 36.47 pore volumes were used to restore CBR MU1 based on CBR's August 24, 2001 response to a Request for Additional Information (RAI) from the Staff. In that RAI response, CBR included a "Table 1: Restoration Summary," listing "restoration steps" and associated pore

volumes (Ex. INT-050 at 7). One of the "restoration steps" listed is Ion Exchange (IX), in which 26.62 pore volumes were processed. During the IX phase, the licensee is recovering uranium from the ion exchange resin. Because an activity that recovers uranium is a production activity, not a restoration activity, the Staff does not consider the pore volumes used for IX (uranium recovery) as part of the total pore volumes used for the accepted restoration phases at MU1 (e.g., Reverse Osmosis). In its LRA (Ex. CBR-011 at 565), CBR conforms to this restoration pore volume definition and states that the restoration of MU1 required approximately nine pore volumes.

Q.6.3 How did the Staff conclude that CBR may need to extract more than 11 pore volumes to restore the remaining mine units?

A.6.3 (D. Back, T. Lancaster, E. Striz) The Staff evaluated the statements in the LRA based on CBR's restoration experience, the results at MU1, and information from another CBR report on restoration at MU2 and MU3 to arrive at the 11 pore volume estimate. In the LRA, CBR states that the remaining MUs 2-11 will require 11 pore volumes (Ex. CBR-011 at 565). The restoration at MU1 was reported to require approximately nine pore volumes (Ex. CBR-011 at 565). In 2013, CBR provided NRC with two letters reporting the number of pore volumes used at MU2 and MU3, as well as a third party pore volume restoration analysis to improve the efficiency of restoration at the CBR Facility (Ex. NRC-086). The letters indicated that the restoration at MU2 had used 41.38 pore volumes (excluding IX) by March 2013 (Ex. NRC-086 at PDF 5) and the restoration at MU3 had used 28.74 pore volumes (excluding IX) by March 2013 (Ex. NRC-086 at PDF 9). The Pore Volume Restoration Analysis concluded based on site measured data that the application of a model based restoration plan (MBRP) enabled restoration to be conducted in an efficient manner at CBR using far fewer pore volumes (i.e., 3.6-6.0) to achieve the restoration standards (Ex. NRC-086 at PDF 16-17). Based on this information, the Staff took a conservative approach, accepting the

applicant's estimate that restoration of future mine units at CBR may take approximately 11 pore volumes based on past restoration performance, tempered by the likely efficiencies to be gained by the proposed MBRP.

Q.6.4 Regardless of which pore volume estimate is used, is the total number of pore volumes the important factor in estimating drawdown?

A.6.4 (D. Back, T. Lancaster, E. Striz) No, as shown in Figure 1 of Exhibit NRC-023 (p. 3) the Basal Chadron Sandstone aquifer extends for many miles beyond the CBR license boundary. Because the aquifer is so large, it represents a very large volume of water storage underground. The drawdown in this aquifer is a function of the consumptive use rate (gpm). The pore volumes represent the total water withdrawn at a given rate for the time of extraction. If the consumptive use rate is low, the drawdown realized in the aquifer will be less than if the rate is high for the same number of pore volumes.

Q.6.5 Are there factors limiting the consumptive use rate during restoration at CBR?

A.6.5 (D. Back, T. Lancaster, E. Striz) Yes. As indicated in A.6.6 of the Staff's initial testimony, CBR may operate no more than five mine units, restore no more than five mine units, and develop no more than three mine units at any given time (Ex. NRC-001 at 86). This restriction limits the total consumptive use of ground water from restoration activities at any given time.

Q.6.6 Regionally, what effect will drawdown due to CBR's restoration efforts have on the resource?

A.6.6 (D. Back, T. Lancaster, E. Striz) Regionally, the Staff concludes that the consumptive use and associated drawdown will have essentially no impact on the regional availability of the ground water resource, which is large as described above in A.6.4 and Exhibit NRC-023 (p. 3). The maximum rate of consumptive ground water use for the CBR ISR facility is estimated by Staff to be 210 gpm. The current rate of water consumption of about 105 gpm has created a localized drawdown which is of limited

extent as shown in Exhibit NRC-087. This drawdown represents a small amount of extraction from the large regional aquifer resource, which is the Basal Chadron Sandstone aquifer as shown in Figure 1 of Exhibit NRC-023 (p. 3). The Staff therefore concludes that the consumptive use rates will not destabilize the resource.

Q.6.7 On page 6 of his testimony, Mr. Wireman testifies that there should be a Basal Chadron Sandstone aquifer monitoring well near Chadron. Does the Staff agree?

A.6.7 (D. Back, T. Lancaster, E. Striz) The Staff disagrees with this position. The city of Chadron is separated from the LA by a distance of almost 20 miles. As discussed in A.D.4 of our initial testimony for Contention D, the Basal Chadron Sandstone pinches out and is not present beyond about 5 miles north and east of Crawford, between the CBR LA and the city of Chadron (Ex. NRC-023). Therefore, it is not possible or necessary to place a monitoring well in this aquifer near the city of Chadron.

Q.6.8 On page 6 of his testimony, Mr. Wireman further testifies that the EA should discuss recharge and discharge to the Basal Chadron Aquifer. Did the Staff assume recharge to the Basal Chadron aquifer in making drawdown predictions?

A.6.8 (D. Back, T. Lancaster, E. Striz) No. To be conservative, the Staff estimated drawdown and recovery rates in the Basal Chadron Sandstone aquifer assuming no recharge (Ex. NRC-001 at 92). Recharge to the Basal Chadron Sandstone aquifer would only reduce the estimates of drawdown and accelerate recovery rates. Discharge areas would not affect the results of the drawdown or recovery analysis performed by the Staff.

Q.6.9 On page 6 of his testimony, Dr. Kreamer indicates that the basic equations used to describe the impacts and drawdown of water tables and piezometric surfaces in the mining area are inappropriate for the indicated heterogeneous, anisotropic

conditions, which leads to unreasonable projections of restoration and decommissioning impacts. How does the Staff respond?

A.6.9 (D. Back, T. Lancaster, E. Striz) The Staff disagrees with his assertion. The "basic equations" to which Dr. Kreamer refers are ubiquitously accepted equations for the evaluation of the hydraulic characteristics of almost all ground water aquifers using aquifer pumping tests. These aquifer pumping test "basic equations" have been used in numerous ASTM standards (Ex. NRC-080), to determine aquifer hydraulic properties including application to heterogeneous anisotropic aquifers. These "basic equations" are taught in introductory classes in hydrogeology. It is likely that most practicing field hydrogeologists have used these "basic equations" to estimate aquifer hydraulic properties. Furthermore, at some scale all geologic systems are heterogeneous and anisotropic, and application of these "basic equations" to these systems is done with an understanding of the assumptions inherent to their use.

The potential drawdown within the Basal Chadron Sandstone aquifer will be impacted by the local heterogeneity/anisotropy of the formations. However, the aquifer pumping tests used by CBR were multiple day high rate tests which had large radii of influence (approximately 1 mile). These large long term aquifer tests provide results which average the hydraulic behavior over the region of influence, which minimizes the impact of small scale anisotropy and heterogeneity. For the CBR ISR operations, these aquifer pumping tests were used to establish the hydraulic properties of conductivity and storage for the Basal Chadron Sandstone aquifer. However, the most important information obtained from these aquifer pumping tests was the assessment of the behavior of the units overlying the Basal Chadron Sandstone aquifer to determine the degree of confinement created by the overlying low permeability layers.

In any event, the best means to assess the reliability of the predictions is to compare them against actual measured data. The basis for NRC's predictions of the

drawdowns created by consumptive use of ground water is detailed in A.6.8, A.6.9 and A.6.10 of our initial testimony (Ex. NRC-001 at 86-89). As described in A.6.10 of our initial testimony, CBR applied equations commonly used in hydrogeology to estimate the amount of drawdown that would occur in the Basal Chadron Sandstone aquifer at the expected consumptive use rate of approximately 105 gpm. The results of these estimates are shown in Table 7.12-2 of the LRA (Ex. CBR-011 at 7-47). In a 2009 RAI, CBR was asked to use current operational data to assess drawdown estimates. Since actual consumptive use rates were approximately double the pre-mining estimates, the predicted drawdowns under steady-state conditions would also be doubled and are shown in Exhibit NRC-087. As part of their response to the 2009 RAI, CBR also provided actual drawdown data collected from Basal Chadron Sandstone aquifer wells, which are also depicted in Exhibit NRC-087. As shown in the Exhibit, in every instance the "basic equations" overestimate the drawdown outside of the LA. Therefore, although the predictive equations assume a simplified representation of the hydrogeology, they provide a means to conservatively estimate drawdowns at any consumptive use rate.

CONTENTION 9

Q.9.1 On page 7 of his testimony, Mr. Wireman testifies for the Intervenors that "CBR failed to achieve the restoration standards for seven parameters at [mine unit] MU1," and that he assumes that CBR requested Alternative Concentration Limits (ACLs) for those parameters. Did CBR fail to meet restoration standards in MU1?

A.9.1 (D. Back, T. Lancaster, E. Striz) The restoration of CBR MU1 was approved by NRC as presented in a Staff technical evaluation report (TER) dated February 12, 2003 (Ex. NRC-088). In the TER, the Staff stated: "The submitted data show that ground-water quality has been restored to the baseline concentrations or the secondary restoration

standards established by license condition 10.3C, SUA-1534" (Ex. NRC-088 at PDF 4).

At the time of the restoration approval of CBR MU1, the NRC applied "class of use," a state water quality designation under the Safe Drinking Water Act, as a secondary restoration goal to approve ISR restoration of wellfield ground water. The "class of use" standard for restored ground water quality was based on restoration standards provided in NUREG-1569. The NRC has since determined that the primary and secondary restoration standards in NUREG-1569 are inconsistent with the restoration standards in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5). The NRC notified licensees and applicants in Regulatory Information Summary 2009-05, dated April 29, 2009 (Ex. NRC-061), that the restoration standards listed in NUREG-1569, Section 6.1.3(4) (Ex. NRC-013 at 6-12) are not consistent with those listed in 10 C.F.R. Part 40, Appendix A, and licensees and applicants and licensees must commit to achieve the restoration standards in Criterion 5B(5). Under License Condition 10.6 (Ex. NRC-012 at 8), CBR is required to meet the ground water protection standards in Criterion 5B(5) for remaining mine units.

Q.9.2 On page 7 of his testimony, Mr. Wireman further testifies that uranium concentrations at MUs 2-5 were "well above the restoration standard" in May 2011. Are MUs 2-5 well above restoration standards?

A.9.2 (D. Back, T. Lancaster, E. Striz) The restoration of CBR MUs 2-5 is currently ongoing. The NRC does not have a specific requirement for CBR to report on the ground water quality in the production zone aquifer during restoration. However, CBR provided this information to the NRC in two letters on MU2 and MU3 in 2013. The first letter provided the ground water quality in MU 2 in a table titled Mine Unit 2 Restoration Results (Ex. NRC-086 at PDF 7). The second letter provided the ground water quality in MU 3 in a table titled Mine Unit 3 Restoration Results (Ex. NRC-086 at PDF 11).

The ground water quality in these tables showed that the average MU2 and MU3 ground water quality was near or below the background ground water quality for the majority of constituents. Ground water restoration continued in MUs 2-3 through July 2014 when these mine units were entered into stability monitoring.

Q.9.3 On page 8 of his testimony, Mr. Wireman further testifies that "[v]ery little information is presented in the LRA or SER as to the details of restoration efforts at mine units 2-5." How does the Staff respond?

A.9.3 (D. Back, T. Lancaster, E. Striz) The NRC does not consider the progress or status of a mine unit restoration to be a significant safety issue as long as all ISR mine unit restoration and monitoring are conducted according to the license conditions and license application commitments. NRC only conducts a safety review of the restoration of a mine unit when the licensee provides the NRC with a final mine unit restoration report which demonstrates the ground water protection standards and stability requirements have been met. In the past license period, CBR has honored its license and license application commitments with respect to restoration. Therefore, in the license renewal it was sufficient for CBR to report on the status of individual mine unit restorations and provide a schedule estimating when restoration would be completed for the individual mine units. The NRC did add LC 11.1 B to the renewal license (Ex. NRC-012 at 10), which requires CBR to provide a discussion of "progress of wellfields in restoration'' in a semi-annual report to enable the NRC to more closely track mine unit restoration progress.

Q.9.4 On page 8 of his testimony, Mr. Wireman further testifies that "the potential conflict between State of Nebraska [class of use standards] and NRC restoration standards will provide CBR with support for establishment of [ACLs]." How does the Staff respond?

A.9.4 (D. Back, T. Lancaster, E. Striz) Under License Condition 10.6 (Ex. NRC-012 at 8), CBR is required to meet the ground water protection standards in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5), which states that the concentration of a hazardous constituent 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. As described in 10 C.F.R. Part 40, Appendix A, Criterion 5B(6), it is possible that the options of background and drinking water limits in Table 5C may not be practically achievable at a specific site. Therefore, ACLs that present no significant hazard may be proposed by the licensees for Commission consideration. The Commission may establish a site-specific ACL for a hazardous constituent as provided in Criterion 5B(6) if it finds that the proposed limit is as low as reasonably achievable, after considering practicable corrective actions and determining that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded.

The term “class of use” describes a state water quality designation under the Safe Drinking Water Act. A licensee may in the future use the State “class of use” as a basis of a request for an ACL for a specific hazardous constituent as provided in Criterion 5B(6). However, the State “class of use” standard will not receive special consideration by NRC. The licensee will still be required to demonstrate that the State “class of use “ standard for that constituent meets all the requirements of Criterion 5B(6), including that the “constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded.” In making the present and potential hazard finding, the NRC requires the licensee to address nine factors with respect to ground water (i.e.,

Criterion 5B(6)(a)(i-ix)) and ten factors (i.e., Criterion 5B(6)(b)(i-x)) with respect to surface water. These factors will ensure that the evaluation of the application of any "class of use" State water quality standard to justify an ACL for a constituent will meet all the requirements to demonstrate that the proposed ACL is protective of human health and the environment.

Q.9.5 Dr. Kreamer testifies for the Intervenors that the gains made through restoration may be reversed over time and constituent levels may rise over time. Does the Staff agree?

A.9.5 (D. Back, M. Fuhrmann, T. Lancaster, E. Striz) No, the Staff does not agree with this assertion. The NRC conducts a safety review of the restoration of a mine unit when the licensee provides the NRC with a final mine unit restoration report. To be approved, the mine unit restoration report must demonstrate that all constituents meet the Criterion 5B(5) ground water protection standards and show stability with no statistically significant increasing trends for all constituents for four consecutive quarters, as required in LC 10.6 (Ex. NRC-012 at 8). NRC has a strong record of enforcing the stability requirement. As described in the TER for the CBR MU1 restoration, the licensee failed to show stability of several constituents in its stability monitoring (Ex. NRC-088 at PDF 4). CBR was therefore required by NRC to conduct additional stability confirmatory monitoring to demonstrate the stability requirements have been met before the restoration was approved for these constituents (Ex. NRC-088 at PDF 4-5). In addition, NRC recently performed a safety evaluation of restoration reports submitted for the approval of Christensen Ranch Mine Units 2-6 at the Willow Creek ISR facility. In that TER, NRC rejected the restoration of Christensen Ranch MUs 2-6 in part based on the failure to show stability in individual wells for specific constituents at the mine units (Ex. NRC-089 at 47-48).

The Staff does agree that some redox sensitive constituents (e.g., selenium) can be remobilized if oxidizing conditions are reintroduced into an aquifer that was restored using either biological or chemical reductant treatments. However, oxidation is only probable in aquifers that can receive oxidizing fluids. This is only likely to occur in aquifers that are water table aquifers, with their ground water surface exposed to the atmosphere, or other shallow aquifers that receive recharge. The Basal Chadron Sandstone aquifer at CBR represents neither of these conditions. It is a deep confined aquifer, separated from the surface by hundreds of feet of confining layers. These conditions provide no pathway for the Basal Chadron Sandstone aquifer to receive dissolved oxygen that can remobilize constituents that have been reduced by the chemical reductants used for restoration in CBR mine units. Therefore, it is unlikely that remobilization of redox sensitive constituents will occur.

Q.9.6 On page 4 of his testimony, Dr. Kreamer further testifies that the calculation of mine unit baseline values "were not exclusively sampled and measured in a pre-mining, pre-drilling, and unperturbed environment." Does Staff believe that determining background water quality sequentially from mine field to mine field impacts the background values?

A.9.6 (D. Back, T. Lancaster, E. Striz) The Staff has found no evidence that determining background water quality in adjacent mine units after ISR recovery has begun in one mine unit affects the background of the new mine unit. Since it was licensed, CBR has committed to maintain an inward gradient in all mine units. This inward gradient prevents the movement of fluids into adjacent new mine units which would impact their background water quality. Therefore, the Staff finds no basis for this claim.

Q.9.7 On page 4 of his testimony, Dr. Kreamer further testifies that primary restoration goals are calculated by averaging baseline water quality concentrations at all

mine units at the facility, and that this practice has several weaknesses. How does the Staff respond?

A.9.7 (D. Back, T. Lancaster, E. Striz) The Staff disagrees with Dr. Kreamer's claim. The Staff requires that the background water quality be established within the Basal Chadron Sandstone production zone aquifer within each mine unit where the ground water quality will be altered by the ISR operation. For the Crow Butte facility, the NRC also requires that the background water quality in the overlying aquifers and the aquifer surrounding the production zone be measured in the overlying and perimeter ring excursion monitoring wells before operations. The requirements that CBR must meet for the establishment of background water quality are clearly set forth in LC 11.3 (Ex. NRC-012 at 11). The licensee is also required in license condition 11.3 D (Ex. NRC-012 at 11) to establish a representative background concentration for each required constituent using an NRC-approved statistically valid analysis. The Staff recently provided a presentation at the National Mining Association Uranium Recovery Workshop in 2013, entitled "ISR Wellfield Background and Restoration Ground Water Quality Data: Collection, Statistical Analysis and Public Access," to inform the industry and other stakeholders of the Staff's expectations for the establishment of background water quality using approved statistical methods (Ex. NRC-090).

Q.9.8 On page 8 of his testimony, Mr. Wireman further testifies that the LRA and SER do not provide any information on the location, depth or screened intervals for the 19 domestic water supply wells in the ground water monitoring program and that additional analytes should be added and trend data should be generated. Does the Staff agree with these assertions?

A.9.8 (D. Back, T. Lancaster, E. Striz) As explained in A.C.10 of our rebuttal testimony for Contention C, the EA and the LRA provide information about the locations and depths of private wells (Ex. NRC-010 at 81, Ex. CBR-011 at 2-173, 2-183, 2-279, 2-283).

With regard to Mr. Wireman's suggestion that additional analytes should be added and trend data should be generated for the offsite wells, we explain in A.C.10 of our rebuttal testimony that the private wells within one kilometer of the wellfield area are monitored quarterly for uranium and radium as part of CBR's effluent and environmental monitoring program, which is conducted in accordance with License Condition 11.13 (Ex. NRC-009 at 129). This monitoring is primarily conducted for dose assessment in accordance with guidance in Regulatory Guide 4.14 (Ex. NRC-079), and is not intended for detection as with the excursion monitoring program. In accordance with LC 11.1, a summary of private well monitoring results are submitted to the NRC in semi-annual reports that summarize results of the operational effluent and environmental monitoring program (see, e.g., Ex. CBR-018 at Appendix A).

Q.9.9 On page 5 of his testimony, Dr. Kreamer testifies that mining activities release potential "tracers" that can be used as an early warning system but are largely ignored in stated future efforts at the site. How does the Staff respond?

A.9.9 (D. Back, T. Lancaster, E. Striz) As discussed in A.C.13 of our rebuttal testimony for Contention C, we agree with Dr. Kreamer that ISR recovery activities release potential "tracers" that can be used as an early warning system, but we disagree with his assertion that use of such indicators is "largely ignored in stated future efforts" at the CBR site. We explain in A.C.13 of our rebuttal testimony (citing A.C.4 and A.A.7 of our initial testimony) that CBR is required under LC 11.5 (Ex. NRC-012 at 12) to conduct biweekly excursion monitoring, and in that monitoring program, the excursion indicator parameters of chloride, conductivity and alkalinity, which are present in ISR process fluids, are used as "early warning tracers." In A.A.8 of our initial testimony we explain why these three constituents are effective and reliable excursion indicators.

Q.9.10 On page 3 of his testimony, Mr. Wireman testifies that significant uncertainties regarding hydraulic properties in the upper confining unit constrain the ability to assess unwanted fluid migration. Does the Staff agree with this assertion?

A.9.10 (D. Back, T. Lancaster, E. Striz) No. As discussed in A.D.3 of our initial testimony, the confining properties of the upper confining unit are well established through multiple lines of evidence, including: (1) hydrological characteristics of the confining units; (2) aquifer pumping tests; (3) historic and current potentiometric surfaces of the Basal Chadron and Brule aquifers; (4) water quality of the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; and (5) over 20 years of monitoring data from excursion monitoring wells and nearby private wells.

CONTENTION 12

Q.12.1 Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?

A.12.1 (N. Goodman) Yes. I have reviewed the Opinion (Ex. INT-048) and PowerPoint presentation (Ex. INT-049) submitted by Dr. Linsey McLean in support of Contention 12 and I am familiar with her claims. In preparation for my initial testimony, I also reviewed the letter from the U.S. Fish and Wildlife Service (FWS) (Ex. INT-018) and the FWS report (Ex. INT-019) submitted as exhibits in this proceeding. These constitute all of the relevant exhibits filed in support of Contention 12 by the Intervenors.

Impacts Related to Tornadoes

Q.12.2 Having reviewed the claims raised by the Intervenors in their initial written testimony and the associated exhibits for Contention 12, do you have any additional testimony to offer regarding impacts related to tornadoes?

A.12.2 (N. Goodman) No. The Intervenors have offered no arguments, testimony or exhibits related to their claim that the EA is deficient because it does not describe potential

environmental impacts related specifically to tornados. Therefore, the Staff has no rebuttal testimony to offer on this subject.

Impacts Related to Land Application of Treated Process Wastewater

Q.12.3 The Intervenors submit the testimony of Dr. Linsey McLean as support for their position on Contention 12. Can you address Ms. McLean's testimony?

A.12.3 (N. Goodman) Dr. McLean makes several claims regarding the impacts of selenium and other heavy metals on human health and wildlife. She states at times that these health impacts result from "low levels" of selenium and other heavy metals in the organism (Ex. INT-048 at 9, 15, 18, 19, 22), and at other times from "high levels" of these metals (Ex. INT-048 at 8, 9, 12, 14, 15, 19-20, 24), where levels are discussed at all. However, she does not address with any specificity the concentration of selenium that must be present in the land-applied treated process wastewater at the Crow Butte site to be expected to cause the impacts she describes.

Dr. McLean identifies other pathways by which the heavy metals she discusses have been known to cause impacts to the environment, including impacts from uranium acting in concert with calcium ions generated by ISR mining generally "as well as in runoff waters of the Rocky Mountains over old uranium open pit mines" (Ex. INT-048 at 10) and "legal dumping" of arsenic "into commercial fertilizers from mining and ore smelting waste since 1976" (Ex. INT-048 at 14).

Q.12.4 On page 19 of her Opinion, Dr. McLean states that "[t]he impacts of selenium on humans and wildlife if Crow Butte uses land application of mining wastes are material, adverse and potentially fatal to humans and wildlife exposed to selenium." Can you respond to this claim?

A.12.4 (N. Goodman) None of the information Dr. McLean provides in her testimony directly support the claim that land application of treated process wastewater at the Crow Butte site – an activity subject to strict NRC and NDEQ regulatory requirements – could be

potentially *fatal* to humans and wildlife as a result of exposure to selenium in that water. To the contrary, as the Staff discussed in A.12.7 and A.12.8 of its initial testimony, any treated process wastewater applied to the land at Crow Butte may only contain levels of selenium equivalent to or lower than the levels of selenium that the EPA allows in drinking water (Ex. NRC-063 at 4-2, Ex. NRC-064 at PDF 3). This level, in turn, is equivalent to the EPA's health goal for concentrations of selenium in drinking water (Ex. NRC-065 at 1).

Furthermore, in her discussion of the basis for this claim, Dr. McLean relies upon unsupported assertions regarding the adverse impacts of land application on the environment. For example, she states without supporting authority that "land application for wastewater is destined for environmental contamination that will never be able to be remediated" (Ex. INT-048 at 20), and further, that "[t]he subsequent plants grown, if they are able to grow at all from the toxicity, would be far too contaminated to be used for any feeding (Ex. INT-048 at 23). Dr. McLean also states that "a water concentration of 10 ug/L . . . can increase to over 5,000 times that amount in fish tissues," but does not provide a source for this information (Ex. INT-048 at 22). These unsupported claims are not useful for the Staff's assessment of the potential environmental impacts of land application of treated process wastewater at the Crow Butte site. To the extent that Dr. McLean relies upon the FWS report to support these claims, the Staff explained in A.12.9 of its initial testimony why the information in that report does not support a finding that the conditions or environmental impacts at the site examined in the report would be comparable to those at the Crow Butte site.

Finally, Dr. McLean makes several arguments in support of her claim regarding the adverse impacts of land application of treated process wastewater that are completely unrelated to land application. Specifically, she raises claims regarding the

history excursions at ISR facilities generally and the experience of ISR facilities regarding restoration of the mined aquifer to baseline ground water quality (Ex. INT-048 at 21). She appears to argue that the Crow Butte site is comparable to, or destined for the same fate as, "the over 10,000 other old uranium mines that should be [Superfund sites] and are not, due to lack of funding for remediation/burial." (Ex. INT-048 at 21.) She also argues extensively against the safety of leach ponds, for a variety of reasons (Ex. INT-048 at 23-24). This information is not relevant to the Staff's assessment of the potential environmental impacts of selenium from the land application of treated process wastewater at the Crow Butte site.

Q.12.5 Does the Staff have anything further to add with regard to Dr. McLean's initial written testimony and the associated exhibits for Contention 12?

A.12.5 (N. Goodman) The Staff has nothing further to add. The Staff addressed the information contained in the Intervenors' Exhibits INT-018 and INT-019 in A.12.9 of its initial testimony.

Q.12.6 Having reviewed the claims raised by the Intervenors in their initial written testimony and the associated exhibits for Contention 12, has the Staff found any reason to revisit its conclusions regarding the potential impacts to the environment that may result from renewal of the Crow Butte license?

A.12.6 (N. Goodman) For the reasons described in the Staff's initial testimony (Ex. NRC-001) and rebuttal testimony, the Staff has not identified any reason to revisit the analysis or conclusions in the EA regarding the potential environmental impacts of the Crow Butte project. The testimony and exhibits offered by the Intervenors in support of Contention 12 do not provide sufficient information to indicate that the Staff's analysis in the EA is deficient, or to overturn the Staff's conclusion that the potential environmental impacts would be SMALL.

CONTENTION 14

Q.14.1 Have you reviewed the declarations, opinions and testimony filed as exhibits by the Intervenors on this contention?

A.14.1 (T. Cao, N. Goodman, T. Lancaster, E. Striz) Yes. As supporting testimony for Contention 14, the Intervenors filed testimony by Dr. Hannan LaGarry (Ex. INT-043), Dr. David Kreamer (Ex. INT-046), and Mr. Michael Wireman (Ex. INT-047). We have reviewed the Intervenors' testimony and are familiar with the witnesses' arguments.

Q.14.2 On page 2 of his testimony, Dr. Kreamer asserts that the effects of future or past earthquakes and tectonic activity are not adequately addressed. Could you please address this claim?

A.14.2 (D. Back, T. Cao, T. Lancaster, E. Striz) Dr. Kreamer provides no support or further explanation for this general assertion. In A.14.6, A.14.7, A.14.9 and A.14.10 of our initial testimony on Contention 14, we discussed the reasons why earthquakes do not pose a risk of creating permanent secondary porosity in the Basal Chadron Sandstone aquifer or layers above it. In A.14.8 of our initial testimony, we explained that biweekly excursion monitoring and several aquifer pumping tests conducted since the CBR facility began operating have shown no effects on confinement as a result of earthquakes. In that response we also indicated that we are unaware of any evidence that earthquakes occurring in the region since the CBR facility began operations have affected confinement. Therefore, as stated in A.14.11 of our initial testimony, no significant impacts from small earthquakes would be expected.

June 5, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach	)	
Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF DAVID BACK

I, David Back, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-002 (Statement of Professional Qualifications of David Back) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

_____

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Executed in Falls Church, VA
this 5th day of June, 2015

June 5, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach	)	
Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF TIANQING CAO

I, Tianqing Cao, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-003 (Statement of Professional Qualifications of Tianqing Cao) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

_____

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Executed in Elk Grove, California
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June 5, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach	)	
Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF MARK FUHRMANN

I, Mark Fuhrmann, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-077 (Statement of Professional Qualifications of Mark Fuhrmann) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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Executed in Rockville, Maryland
this 5th day of June, 2015

July 29, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF NATHAN GOODMAN

I, Nathan Goodman, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-004 (Statement of Professional Qualifications of Nathan Goodman) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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June 5, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF THOMAS LANCASTER

I, Thomas Lancaster, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-005 (Statement of Professional Qualifications of Thomas Lancaster) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

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July 29, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
	)	ASLBP No. 08-867-02-OLA-BD01
(License Renewal for the In-Situ Leach	)	
Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF PAUL NICKENS

I, Paul Nickens, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-006 (Statement of Professional Qualifications of Paul Nickens) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

_____

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Executed in Tucson, AZ
this 29th day of July, 2015

June 5, 2015

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 40-8943-OLA
CROW BUTTE RESOURCES, INC.	)	
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(License Renewal for the In-Situ Leach Facility, Crawford, Nebraska)	)	

AFFIDAVIT OF ELISE STRIZ

I, Elise Striz, do hereby declare under penalty of perjury that my statements in the foregoing testimony and in prefiled Exhibit NRC-008 (Statement of Professional Qualifications of Elise Striz) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR 2.304(d)

_____

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Executed in Rockville, MD
this 5th day of June, 2015