May 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 INITIAL 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 NRC's Office of Nuclear Material Safety and Safeguards, Division of Spent Fuel Management, Long Term Spent Fuel Management Branch. Ex. 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 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. Ex. 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.1d 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. Ex. 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.1e 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. Ex. 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 the NRC's Tribal consultation efforts per Section 106, NHPA.

A.1f 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. Ex. 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 admitted contentions in this proceeding?

A.2 (D. Back, T. Cao, N. Goodman, T. Lancaster, P. Nickens, E. Striz) Yes. We have reviewed the Oglala Sioux Tribe's (OST) and Consolidated Intervenors' (CI) admitted contentions challenging the EA issued by the NRC Staff for the CBR License Renewal Application (LRA). We have reviewed the declarations filed by the intervenors in this proceeding, including the Expert Opinion Regarding the Renewal of ISL Uranium Mining (Crow Butte Resources) Near Crawford, Nebraska by Dr. Hannan E. LaGarry (2008) (2008 LaGarry Opinion), the Supplemental Expert Opinion Regarding the Renewal of ISL Uranium Mining (Crow Butte Resources) Near Crawford, Nebraska by Dr. Hannan E. LaGarry (2015) (2015 LaGarry Opinion), Declaration of Dr. Richard Abitz (2008) (Abitz Opinion), Declaration of Paul G. Ivancie, PG and W. Austin Creswell, PE (2008), and Declaration of Dr. Louis A. Redmond (2013). In addition, we have reviewed documents cited by the intervenors and their experts that pertain to the contentions on which we will be testifying.

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 (Groundwater Mitigation).

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

A.3c (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.3d (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 (Groundwater Mitigation), and 14 (Impacts of Earthquakes).

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

A.3f (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 (Groundwater Mitigation), and 14 (Impacts of Earthquakes).

CONTENTION A

Q.A.1 **In Contention A, as limited by the Board and Commission, the Intervenors argue that CBR's spill contingency plan inadequately addresses non-radiological contaminants. Specifically, they claim that the monitoring frequency for contaminants is inadequate and that there is no valid reason to exclude uranium from the list of excursion monitoring parameters. In support of their arguments, the OST refers to expert opinions provided by Dr. Richard Abitz (Abitz Opinion) and Dr. Hannan LaGarry (2008 LaGarry Opinion) commenting on the adequacy of**

CBR's license renewal application. Are you familiar with the arguments raised by the OST in their petition and in these reports?

A.A.1 (D. Back, T. Lancaster, E. Striz) Yes, we have reviewed the OST's petition and the opinions provided by Drs. Abitz and LaGarry and are familiar with the specific arguments made in those documents.

Q.A.2 **Contention A challenges the adequacy of CBR's spill contingency plan identified in the license renewal application (LRA). What is the spill contingency plan to which the OST refers?**

A.A.2 (D. Back, T. Lancaster, E. Striz) The OST refers to Section 5.8.1.3 of CBR's LRA. CBR states that it has procedures and plans that address responses to surface leaks, transportation accidents, and subsurface releases (Ex. CBR-011 at 5-29–5-31). These operating procedures are part of CBR's Environmental, Health, and Safety Management System (EHSMS) Program, and are maintained at the facility (Ex. CBR-011 at 5-7–5-9). We note that the specific challenge raised by the OST based on this section of the LRA is to the discussion in the section of the LRA on subsurface releases, namely its statement that the monitoring well ring is located no further than 300 feet (License Condition (LC) 10.4) from the wellfield and are sampled on a biweekly basis (Ex. CBR-011 at 5-30). This information is described in more detail in Section 5.8.8.2 of the LRA, which the OST also cites in their petition. Section 5.8.8.2 of the LRA describes the licensee's ground water monitoring program to detect excursions of lixiviant into the ore zone aquifer and the overlying water bearing strata (Ex. CBR-011 at 5-103).

Q.A.3 **Did the Staff make a determination regarding the adequacy of these procedures as part of its review of the license renewal application?**

A.A.3 (D. Back, T. Lancaster, E. Striz) The Staff did not make a determination regarding the overall adequacy of these procedures in its review of the license renewal application.

This is because the 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).

In accordance with NRC guidance governing the Staff's review and acceptance of ISR license applications, the Staff did not need to reconsider the adequacy of CBR's spill contingency plans unless the inspection history of the site, or operational changes made to the site, warranted such consideration. As the Staff explains in its SER, that was not the case here (Ex. NRC-009 at 65). This approach is consistent with the guidance the Staff follows in its review of a license renewal application. Moreover, as the Staff notes in the SER, during annual NRC facility inspections in 2006 and 2011, NRC staff reviewed emergency preparedness procedures that addressed fires, spills, and accidents, and determined at that time that CBR's emergency procedures were adequate for emergencies that could involve the release of radioactive material (Ex. NRC-009 at 156, 159).

That said, while Contention A appears on its face to challenge the adequacy of these plans, as we explain in A.A.2 of our testimony, the specific claims they raise in the contention as admitted challenge the sampling frequency for excursions in monitoring wells and the use of uranium as an excursion indicator. As we explain in A.A.6 through A.A.9 of our testimony, below, both the sampling frequency and the suite of indicator parameters sampled as part of CBR's excursion monitoring program are sufficient to identify excursions at the Crow Butte site; moreover, they are consistent with existing NRC guidance.

Q.A.4 Contention A, as narrowed by the Board and Commission, raises specific challenges relating to the ability of CBR's ground water monitoring system to protect against potential contamination affecting the OST. These challenges were migrated by the Board from the LRA to the Staff's environmental

assessment (EA). Has the Staff addressed in its EA the foreseeable potential environmental impacts to ground water that may result from the renewal of the Crow Butte project?

A.A.4 (D. Back, T. Lancaster, E. Striz) The Staff describes the potential ground water impacts from the project in Section 4.6.2 of the EA (Ex. NRC-010). The sections most relevant to the OST's admitted claims in Contention A are the Staff's discussions of ground water impacts from spills and leaks during operations, which is contained in Section 4.6.2.2.2 of the EA (Ex. NRC-010 at 75-77), and ground water impacts from excursions during operations, which is contained in Section 4.6.2.2.4 of the EA (Ex. NRC-010 at 78-80). The EA also describes in Section 4.6.2.2.6 the potential environmental impacts that could occur to ground water outside of the Crow Butte facility as a result of excursions (Ex. NRC-010 at 81).

Q.A.5 Can you summarize the potential impacts to ground water that the Staff identified related to the admitted claims made in this contention?

A.A.5 (D. Back, T. Lancaster, E. Striz) The Staff concluded in the EA that the potential long-term environmental impacts to ground water from spills, leaks and excursions during facility operations would be SMALL.

With respect to the operational impacts from spills and leaks, the EA states that ground water quality may be impacted from spills or leaks of process liquids from wellfield piping and infrastructure (Ex. NRC-010 at 75). The EA describes the measures in place at the Crow Butte site to prevent these types of releases, including monitoring of wellfield and plant operations, and describes the operational history of Crow Butte with respect to spills and leaks. The EA also describes the NRC and Nebraska Department of Environmental Quality (NDEQ) requirements in place, particularly with respect to mechanical integrity testing (MIT) employed to detect injection well casing failures, which may lead to leaks. The EA notes that no long-term

impact to ground water quality has been detected from a spill or leak, and that one MIT failure resulted in measurable environmental impacts, which were subsequently mitigated by corrective actions that were deemed successful in rectifying the environmental impact. The Staff concluded that due to the requirement to detect and provide an immediate response to spills and leaks at ISR facilities, conduct MIT testing, and undertake corrective actions for spills and leaks, the ground water impacts from spills and leaks would be temporary, and the overall long-term impact on ground water would be SMALL (Ex. NRC-010 at 76).

With respect to the operational impacts from excursions, the EA states that ground water quality may be impacted by excursions of process fluids from the production zone into the surrounding aquifers (Ex. NRC-010 at 78). The EA explains that to prevent these impacts from occurring, CBR is required to perform excursion monitoring, including biweekly monitoring of wells in the perimeter ring and overlying aquifer for indicator parameters. Should CBR identify that an exceedance of the upper control limits (UCLs) established for a monitoring well has occurred, in accordance with License Condition 11.5 in its license, it must place the well on excursion status, notify the NRC, begin corrective action, and increase the sampling frequency for the indicator parameters at the excursion well to once every seven (7) days.to ensure that the excursion is expeditiously corrected (Ex. NRC-010 at 78).

In its review of CBR's LRA, the Staff reviewed the excursion history of the CBR facility and found that in the majority of cases, excursion events were either resolved within 90 days without corrective actions, or, where corrective actions were implemented, those actions proved adequate for the control of excursions in a timely manner. Because certain monitoring wells screened in the shallow aquifer in two mine units were experiencing repeated excursion events, the Staff imposed a new license condition requiring weekly sampling for natural uranium for wells in those mine units

placed on excursion status in order to identify the source of the excursions (Ex. NRC-010 at 79, Ex. NRC-012 at 14). Based upon its review of the ground water quality impacts from excursions during the prior licensing period and the continued requirements for excursion monitoring to detect and take corrective action to eliminate the excursion, the Staff concluded that the long-term impacts on ground water from excursions would be SMALL (Ex. NRC-010 at 79).

Finally, the EA summarizes the ground water quality impacts outside of the CBR facility (Ex. NRC-010 at 81). Based upon its review of the site's operational experience during the prior licensing period, the Staff found that there have been no measureable impacts to the ground water at private wells from operations. Citing this operational history and the requirements relating to excursion monitoring detection and corrective actions and monitoring of private wells to detect contamination, the Staff concluded in the EA that the potential impacts of operations on ground water outside the Crow Butte facility would also be SMALL (Ex. NRC-010 at 81).

Q.A.6 **On page 7 of their petition, the OST challenge the monitoring frequency for contaminants, stating that the stated biweekly frequency does not recognize that leaks could occur and go undetected if the scheduled testing does not coincide with a leak. Can you address this claim?**

A.A.6 (D. Back, T. Lancaster, E. Striz) As we noted in A.A.2 of our testimony, the OST refer for this argument to Sections 5.8.1.3 and 5.8.8.2 of the LRA, which describes the location, screening and sampling frequency of the monitoring well network at the Crow Butte site (Ex. CBR-011 at 5-103 to 5-135). The Staff describes this excursion monitoring program in Section 4.6.2.2.4 of the EA (Ex. NRC-010 at 78) and Section 5.7.9 of the SER (Ex. NRC-009 at 123-33).

We do not agree with the OST that the sampling frequency for excursions currently employed at the Crow Butte site is insufficient to ensure that contaminants

will not affect the OST. The closely spaced monitoring wells and biweekly monitoring provide adequate coverage to identify any excursions. The biweekly standard is codified as a requirement in License Condition 11.5, which requires CBR to sample and test all perimeter and aquifer monitoring wells no more than 14 days apart (Ex. NRC-012 at 12). This requirement has been in place since CBR's initial license was granted in 1989 and was described in the EA for that licensing action, as well as in the NRC's EA for CBR's 1998 license renewal (Ex. NRC-015 at 54-55, Ex. CBR-044 at 35-36). This biweekly standard is also consistent with NUREG-1569, which states that "an acceptable excursion monitoring program should indicate that all monitor wells will be sampled for excursion indicators at least every 2 weeks during *in situ* leach operations." (Ex. NRC-013 at 43.)

The adequacy of the biweekly sampling standard is borne out by historical experience at the site. Between 1995 and 2010, CBR's excursion monitoring program has enabled CBR to identify and place 13 perimeter monitoring wells on excursion status and identify 16 excursion events in 12 monitoring wells in the overlying aquifer (Ex. NRC-010 at 79-80, Ex. NRC-009 at 124-25). CBR's biweekly sampling has also identified excursions that may be attributable to spills or unintended releases of production fluids (Ex. NRC-009 at 79, Ex. NRC-009 at 126). Importantly, however, the Staff notes in the EA that there has been no measurable impact to ground water beyond the licensed area from Crow Butte operations (Ex. NRC-010 at 81).

Q.A.7 **In Contention A, the OST also challenges the adequacy of the parameters used at the Crow Butte site to detect excursions. Can you briefly address the parameters used to detect excursions at the site?**

A.A.7 (D. Back, T. Lancaster, E. Striz) As described in Section 4.6.2.2.4 of the EA (Ex. NRC-010 at 78) and Section 5.7.9.3.2 of the SER (Ex. NRC-009 at 124), CBR's excursion monitoring program consists of monitoring three indicator parameters –

chloride, conductivity, and total alkalinity. CBR's license documents the requirement to use these three indicators as excursion parameters in License Condition 11.4 (Ex. NRC-012 at 11). The use of alkalinity, conductivity and chloride as the excursion parameters for the Crow Butte site has been a requirement of CBR's license since 2003 (Ex. NRC-010 at 78). As we explain in more detail in A.A.8 of our testimony, below, the suite of excursion indicator parameters used at the Crow Butte site is consistent with NRC guidance. Furthermore, as we explain in A.A.6 and A.A.8 of our testimony, the use of these three parameters has historically been sufficient to identify excursions at the Crow Butte site.

Q.A.8 **On pages 5 and 13 of his opinion, Dr. Abitz, on behalf of the OST, claims that there is no valid scientific reason to exclude uranium from the list of excursion monitoring parameters used to monitor lixiviant migration because uranium is highly mobile as a carbonate complex in lixiviant and is an excellent indicator of excursions. Do you agree with his claims?**

A.A.8 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. Abitz's characterization of uranium as an excellent excursion indicator. Although the presence of carbonate ions in the lixiviant enhances the mobility of uranium, uranium will remain mobile only as long as the geochemical conditions are favorable. Once the lixiviant moves away from the wellfield, the geochemistry of the ground water and mineralogy of the sandstone is different, potentially affecting the mobility of the uranium.

The degree of mobility and the extent of adsorption of uranium depends upon the carbonate and uranium concentrations and pH of the ground water (Ex. NRC-016 at 13, 79). As the levels of these variables change, particularly as the concentrations of carbonate decrease as an excursion moves away from the production area, the extent of uranium complexed with carbonate would decrease, and therefore the adsorption of uranium on iron hydroxides and clay minerals would increase. In addition, as uranium

is transported outside of the production area, which has not been impacted by lixiviant, the presence of organic carbon and reduced minerals will retard the mobility of uranium. As soon as adsorption or other mechanisms cause uranium retardation to occur, the movement of uranium will slow down relative to the speed of the ground water. Therefore, uranium does not display the conservative behavior which is preferred when selecting a parameter to act as a leading indicator of an excursion outside the production zone.

Notably, existing NRC guidance discourages the use of uranium as an early-time excursion parameter. NUREG/CR-6733 states that

> Criteria for selection of an indicator parameter are that the constituent is found in elevated concentrations in uranium ISL process water and is generally nonsorbing and nonreactive so that it will be an early indicator of migrating lixiviant. UCLs are then established to determine when an indicator is present in concentrations statistically greater than background levels.

(Ex. NRC-017 at 4-38.) With respect to the use of uranium, specifically, as an excursion indicator, NUREG/CR-3709 states that

> Many potential indicators (such as uranium and pH) are not conservative, and their values will change rapidly as the lixiviant interacts with the sediment. In general, dissolved species that interact with the sediment do not travel as rapidly as water and thus would not be useful as an early indicator of an excursion.

(Ex. NRC-018 at 5.) NUREG-1569 also states that uranium is a poor excursion indicator (Ex. NRC-013 at 5-41). Finally, a historical review of excursions at ISR sites (Staub et. al) documents that excursions were detected and corrected without the use of uranium as an excursion parameter (Ex. NRC-019). That review also concludes that chloride and total dissolved solids have no potential interfering chemical reactions; by contrast, trace elements, including uranium, are subject to chemical precipitation and adsorption on clay minerals.

The historical record of excursions at the Crow Butte site also demonstrates that chloride, conductivity, and total alkalinity are reliable as excursion indicators. As described in Section 4.6.2.2.4 (including Table 4-3) of the EA (Ex. NRC-010 at 79-80) and Section 5.7.9.3.2 of the SER (Ex. NRC-009 at 124-25), between 1995 and 2010, CBR reported 13 perimeter monitoring wells had been placed on excursion status, and CBR identified 16 excursion events in 12 monitoring wells in the overlying aquifer. Corrective action for the perimeter ring wells primarily consisted of adjusting extraction and injection rates near the excursion well to capture any outward flow. None of these excursions are known to have impacted the surrounding ground water quality (Ex. NRC-010 at 79). These findings demonstrate that the selection of chloride, conductivity and total alkalinity as indicator parameters for excursions was effective at identifying excursions in the past, and provide a sufficient basis for the expectation that the use of these three parameters will still be an effective practice in the future.

Q.A.9 **On page 6 of his opinion, Dr. Abitz claims that uranium is a key indicator of lixiviant excursion because its concentration in baseline wells is generally two or three orders of magnitude lower than the lixiviant. Referring to Tables 2.7-15 and 3.1-3 of CBR's LRA, Dr. Abitz states that because the uranium ratio is approximately 100 times greater than it is for other parameters listed in the tables, it will perform "about 100 times better" as an excursion indicator. Can you address this claim?**

A.A.9 (D. Back, T. Lancaster, E. Striz) The Staff agree with Dr. Abitz that the ratio of uranium concentrations in the lixiviant to the natural concentrations in the aquifer are much higher than for the indicator parameters (i.e. chloride, conductivity and total alkalinity). For the purposes of detecting an excursion, however, the concentration ratios are not as important as the mobility of the excursion parameter. The point is to select conservative, leading edge monitoring parameters to identify the excursion most

quickly. As we explain in A.A.8 of our testimony, indicator parameters need to be highly mobile in order to detect potential excursions as quickly as possible. Therefore, for the reasons explained in A.A.8 of our testimony – in short, because uranium is not as mobile as the parameters currently used to detect excursions at the Crow Butte site – its use as an excursion parameter is disfavored.

Q.A.10 You state in A.A.5 of your testimony that CBR is required to sample for natural uranium in the monitoring wells for two mine units at the Crow Butte site. Why, if uranium is disfavored as an excursion indicator, would the Staff require Crow Butte to sample for natural uranium in these mine units?

A.A.10 (D. Back, T. Lancaster, E. Striz) The requirement to sample for natural uranium in Mine Units 6 and 8 was not imposed for the usual purpose of detecting excursions. License Condition 11.12, which documents this requirement, was imposed because excursions were detected at several wells in the overlying aquifer in these mine units (Ex. NRC-009 at 126). Because efforts to ascertain the source of these excursions had not been successful, the NRC decided to require CBR to test weekly all shallow overlying aquifer wells in Mine Unit 6 and Mine Unit 8 that are placed on excursion status for natural uranium, in addition to the required indicators of total alkalinity, conductivity, and chloride (Ex. NRC-009 at 126). As the language of the license condition indicates, the requirement to sample for natural uranium does not arise until an excursion is detected in accordance with the usual excursion monitoring protocol (Ex. NRC-012 at 14). In summary, the requirement to sample for natural uranium in these mine units is for the purpose of discovering the source of an already identified excursion, not for detecting the excursion itself.

Q.A.11 Would any of the claims raised by the OST in the admitted portion of Contention A cause the Staff to revisit their conclusions regarding the potential impacts to the environment from that may result from renewal of the Crow Butte license?

A.A.11 (D. Back, T. Lancaster, E. Striz) For the reasons described in our foregoing testimony, we have not identified any reason to revisit our conclusions in the EA regarding the potential environmental impacts of the Crow Butte project.

CONTENTION C

Q.C.1 **In Contention C, the OST asserts that the White River alluvium is a potential pathway for contamination from accidents at the CBR facility, and that potential impacts to the White River were not adequately addressed in the LRA or in the EA. Are you familiar with this contention and with the documents provided in support of it?**

A.C.1 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with the claims raised in this contention and with the 2008 opinions of Dr. Hannan LaGarry and JR Engineering (Paul Ivancie and W. Austin Cromwell) provided in support of the contention.

Q.C.2 **Where in the EA does the Staff describe surface water features in and near the CBR facility and impacts to those surface waters?**

A.C.2 (D. Back, T. Lancaster, E. Striz) Section 3.5.1 of the EA describes the surface water features present on and near the CBR facility (Ex. NRC-010 at 32). Section 3.5.1.2 summarizes trends and results from recent NDEQ water quality assessments for the White River, and describes the preoperational surface water quality monitoring that was performed prior to original licensing of the CBR facility (Ex. NRC-010 at 33-34). The impacts on surface waters from construction, operations, aquifer restoration, and decommissioning are discussed in Section 4.6.1 of the EA (Ex. NRC-010 at 69-73). Cumulative impacts on surface waters are discussed in Section 4.13.6.1 of the EA (Ex. NRC-010 at 112-115).

Q.C.3 **Please describe the surface water features at the CBR facility and downstream of the CBR facility.**

A.C.3 (D. Back, T. Lancaster, E. Striz) As described in Section 3.5.1 of the EA and shown in Figure 2.2-3 of the LRA, the White River flows northeast through Crawford and Dawes County into South Dakota (Ex. NRC-010 at 32, Ex. CBR-011 at 2-25). The CBR facility lies within the watersheds of White Clay Creek, Squaw Creek, and English Creek, which are small southern tributaries to the White River (Ex. NRC-010 at 32, Ex. CBR-011 at 2-25). As shown in Figure 2.2-3 of the LRA, Squaw Creek and English Creek flow from southeast to northwest within the CBR License Area (designated as the "permit boundary" in Figure 2.2-3 of the LRA), while White Clay Creek, on the west side of the CBR facility, is located primarily outside of the License Area (LA) (Ex. CBR-011 at 2-25). All three streams converge north of the LA and enter the White River approximately 3 miles north of the LA and 2 miles downstream from the city of Crawford (Ex. CBR-011 at 2-25).

There are also eight surface water impoundments in or near the LA, which are generally used for livestock watering (Ex. NRC-010 at 32, Ex. CBR-011 at 2-163). The four impoundments within the LA are on Squaw and English Creeks (Ex. CBR-011 at 2-159, 2-163).

Q.C.4 **On page 3 of his 2008 Opinion, Dr. LaGarry claims that the White River alluvium can receive contaminants from surface spills at the Crow Butte facility. Can you address this claim?**

A.C.4 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim that contamination from surface spills at the CBR facility can reach the White River alluvium. Our position is based on the extensive operational controls, procedures and monitoring in place at the CBR facility to prevent and detect spills and leaks and to address and minimize impacts should they occur, and historical 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.

There are two primary pathways for contaminants from spills or leaks to reach the White River alluvium from the LA. First, contaminants from a spill or leak could enter English Creek or Squaw Creek, the streams that flow through the LA, and be transported downstream to the White River. This would typically occur during a rain event, where contaminants would be transported by surface runoff into the stream. Second, contaminants from a spill or leak, or from a vertical excursion (i.e., unintended flow of process fluids from the production zone to the overlying Brule aquifer), could enter the shallow Brule aquifer and migrate underground to one of the onsite streams or to the White River alluvium. Migration through the Brule aquifer to the White River would require travel over a distance of approximately 2 miles, during which natural processes (e.g., dilution, sorption, precipitation) would reduce potential impacts.

Spills at the Crow Butte facility that could impact surface waters or shallow aquifers include leaks from exposed or buried piping, well casing failures, leaks or overflows from evaporation ponds, and vertical excursions. The EA addresses these in Sections 4.6.1.2, 4.6.2.2.2, 4.6.2.2.3, and 4.6.2.2.4 (Ex. NRC-010 at 69-72, 75-80). As described in Section 4.6.1.2 of the EA, CBR has implemented extensive controls and procedures for investigating and responding to spills and leaks, including a Spill Prevention, Control and Countermeasure (SPCC) plan, and has appropriately addressed spills that have occurred and mitigated their impacts satisfactorily (Ex. NRC-010 at 70). As explained in Section 4.6.1.2 of the EA, CBR has installed dikes and berms in wellfields and secondary containment in process buildings to prevent spills or leaks from entering surface waters (Ex. NRC-010 at 70). As discussed in Section 4.6.2.2.2 of the EA and Section 3.1.3.4 of the SER, CBR maintains continuous real-time monitoring and control of flow rates and trunk line pressures, and has alarms, sensors and other instrumentation in place to monitor the status of the injection system and alert operators to leaks or spills (Ex. NRC-010 at 75, Ex. NRC-009 at 38). To

reduce the likelihood of pipe breaks or ruptures, all pipelines are pressure tested at operating pressures prior to use. Also, as required by License Condition 10.14, flow rates and pressures are monitored daily, and injection pressures at well heads are limited (Ex. NRC-012 at 9).

As discussed in Section 4.6.2.2.2 of the EA, to minimize potential spills from well failures, CBR is required under License Condition 10.5 to conduct mechanical integrity testing (MIT) of wells initially and every 5 years (Ex. NRC-010 at 75, Ex. NRC-012 at 8). In addition, any time a leak is suspected, a well will be tested for mechanical integrity. MIT ensures that all wells are constructed properly and are capable of maintaining pressure without leakage. If a leak is detected during MIT, the well is repaired and a new mechanical integrity test is performed. If the well cannot be repaired or fails MIT after repair, it is plugged and abandoned. Well integrity is also subject to oversight under CBR's NDEQ Class III injection well permit (Ex. NRC-010 at 75).

To minimize potential leaks and spills from evaporation ponds, the ponds were designed to meet criteria in NRC Regulatory Guide 3.11 (Ex. NRC-010 at 72, Ex. NRC-020). The commercial evaporation ponds have primary and secondary impermeable liners with leak detection systems installed between the liners (Ex. NRC-010 at 9, 77). The ponds are also subject to regular inspections, including daily pond liner and berm inspections, and monitoring wells are installed around the ponds to assess impacts in the event of leaks (Ex. NRC-010 at 77). Leaks that have occurred to date have had no impacts on shallow ground water (Ex. NRC-010 at 77). To prevent overflow, ponds are required by License Condition 10.16 to have sufficient freeboard to prevent overflow resulting from rain events (Ex. NRC-012 at 9). Pond levels are monitored daily, and dikes and berms have been installed to divert runoff away from ponds (Ex. NRC-010 at 78).

Despite the fact that spills and leaks, as well as vertical excursions, have occurred at the CBR facility, there is no evidence that those events have resulted in transport of contaminants outside of the LA. This is demonstrated by operational monitoring data covering over 20 years of operation. As part of its environmental monitoring program, CBR conducts quarterly surface water sampling for natural uranium and radium at upstream and downstream locations on English Creek and Squaw Creek, and at surface impoundments on them (Ex. NRC-010 at 70, Ex. CBR-011 at 5-78). The data show that, from 1990 to 2010, radionuclide concentrations for these water bodies remained at or below preoperational levels (Ex. NRC-010 at 70).

Section 4.6.1.2 of the EA also discusses annual sediment sampling in English and Squaw Creeks upstream and downstream of the CBR facility (Ex. NRC-010 at 69-70). The sediment samples are analyzed annually for natural uranium, radium, and lead-210. Data provided in Figures 4-1 and 4-2 of the EA and Tables 5.8-14 and 5.8-15 of the LRA show no clear trends at the downstream sample locations (E-5 and S-5) since the last license renewal that could indicate contamination from surface spills or leaks (Ex. NRC-010 at 71-72, Ex. CBR-011 at 5-129 to 5-130).

As noted above, vertical excursions into the overlying Brule aquifer are another possible pathway for contaminants to reach the White River. Such events are unlikely because CBR has plugged and abandoned all exploratory drill holes at the CBR facility, and because wells are subject to MIT as discussed above (Ex. CBR-011 at 5-30). In addition, the confining layer between the Basal Chadron Sandstone aquifer and the Brule aquifer is composed of a thick competent sequence of low permeability clays, mudstones and siltstones which prevent vertical excursions (Ex. NRC-010 at 38).

As explained in Section 4.6.2.2.4 of the EA, and as required by License Condition 11.5, excursion monitoring wells have been installed in the overlying Brule

aquifer and are sampled biweekly for indicators to detect vertical excursions (Ex. NRC-010 at 78, Ex. NRC-012 at 12). If an excursion is detected, corrective actions must be implemented and sampling frequency is increased to weekly (Ex. NRC-012 at 12, Ex. CBR-011 at 5-124). From 1995 to 2010, there were 16 vertical excursion detections reported in overlying aquifer monitoring wells in the Brule aquifer (Ex. NRC-010 at 79). All of these excursions were corrected and no long term impacts were determined to have occurred. In addition, as described in the EA in Section 4.6.2.2.6, a review of ground water monitoring data from private wells shows water quality has remained consistent with radiological background levels (Ex. NRC-010 at 81). Because all but one of those wells are screened in the Brule aquifer (Ex. NRC-009 at 129), the data indicate that vertical excursions, spills, leaks and CBR facility operations in general, have not had an impact on the Brule aquifer.

Q.C.5 **On page 3 of his 2008 Opinion, Dr. LaGarry claims that the White River alluvium can receive contaminants from "waters transmitted through the Chamberlain Pass Formation where it is exposed at the land surface." Can you address this claim?**

A.C.5 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim. In order for contaminants to be transported by the pathway Dr. LaGarry suggests, contaminated water would have to travel from the LA through the Basal Chadron Sandstone (referred to by Dr. LaGarry as the Chamberlain Pass Formation) to where this formation outcrops into the White River alluvium. As demonstrated in the cross sections provided in Figures 2.6-4 through 2.6-11 of the LRA, the Basal Chadron Sandstone does not outcrop anywhere in the LA or in the proposed NTEA site northwest of the LA. The cross sections indicate the Basal Chadron Sandstone is located 60 to 200 m (200 to 700 ft) below the ground surface throughout all of the cross sections. We are only aware of two reported field observations of outcrop of the

Basal Chadron Sandstone, both of which are located in Whitehead Creek (Section 36, Township 34N, Range 54W) in northern Sioux County (Ex. NRC-021 at 7-8). These outcrops are located approximately 12 miles northwest of the City of Crawford, far north of the location of the White River alluvium. Therefore, there is no pathway through an outcrop of the Basal Chadron Sandstone within in or near the LA to the White River alluvium.

In addition to the lack of evidence of any outcrop of the Basal Chadron Sandstone in or near the LA, the ISR operations in this aquifer are conducted under an inward gradient, which CBR is required by License Condition 10.7 to maintain in the wellfields to contain process fluids and prevent horizontal excursions (Ex. NRC-010 at 75, Ex. NRC-009 at 40, Ex. NRC-012 at 8). This inward gradient creates a cone of depression which has reversed the direction of ground water flow (originally northwest) towards the interior of the CBR LA, preventing any fluid movement offsite.

Finally, as required by License Condition 11.5, each wellfield is surrounded by a ring of perimeter monitoring wells screened in the Basal Chadron Sandstone aquifer that are sampled biweekly to detect excursions (Ex. NRC-010 at 78, Ex. NRC-012 at 7, 12). If an excursion is detected, the licensee adjusts the wellfield extraction and injection rates to draw fluids back into the wellfield, and sampling frequency of the well on excursion is increased to weekly. The historical record of excursions demonstrates that adjustments in pumping and injection rates have successfully corrected excursions within the LA.

Q.C.6 On page 3 of his 2008 Opinion, Dr. LaGarry claims that the White River alluvium can receive contaminants from the CBR facility through faults. Dr. LaGarry states that faults and fractures "could potentially connect the uranium-bearing Chamberlain Pass Formation to modern river alluvium" and to "the overlying secondary porosity of the Brule Formation." Can you address this claim?

A.C.6 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim that contaminants could be transmitted through the Basal Chadron Sandstone aquifer (referred to by Dr. LaGarry as the Chamberlain Pass Formation) through faults and fractures to the overlying aquifer, ground surface, and river alluvium. The Staff has found no evidence of faults or fractures at the CBR site which could act as permeable pathways between the Basal Chadron Sandstone aquifer and the White River Alluvium or the overlying Brule aquifer. CBR has demonstrated vertical hydrological confinement of the Basal Chadron Sandstone aquifer in the LA through several lines of evidence. These include the results of four separate aquifer pumping tests in the LA, discussed in Section 3.5.2.3.1 of the EA, which show no hydrological connection between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer; the presence of thick clay and mudstone layers of the upper Chadron and lower Brule formations that isolate the Basal Chadron Sandstone aquifer from the overlying Brule aquifer, discussed in Section 3.5.2.3.2 of the EA; the substantial and continued difference in potentiometric head between the Basal Chadron Sandstone aquifer and overlying Brule aquifer and continued artesian pressure in the Basal Chadron Sandstone aquifer before and during operations as discussed in Section 4.6.2.2.1 of the EA; and the substantial and continued difference in water quality between wells screened in the Brule and wells screened in the Basal Chadron Sandstone aquifer (Ex. NRC-010 at 37, 38, 75, 81). Our testimony in Contention D (A.D.3) provides a detailed discussion of these lines of evidence that support the conclusion that the Basal Chadron Sandstone aquifer has and continues to be hydraulically isolated from the overlying Brule aquifer.

Finally, the operational ground water and surface water monitoring record of the CBR site during more than 20 years of operation has not and does not to date show any evidence of contamination of the surrounding or overlying aquifers from the mining

operations that would be expected if fault or fracture pathways existed. As discussed in Section 3.5.2.3.2 of the EA, none of the vertical excursions which have been detected to date have been attributed to a lack of integrity of the confining layer (Ex. NRC-010 at 38). In addition, as discussed in A.C.4, monitoring results from private Brule wells within one kilometer of a wellfield have shown no discernible trends and remain at preoperational levels (Ex. NRC-010 at 81).

Q.C.7 **On page 3 of his 2008 Opinion, Dr. LaGarry asserts that contaminants that reach the White River alluvium will be pushed downstream with every rain event, eventually reaching the Pine Ridge Reservation. Can you address this claim?**

A.C.7 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's assertion. In A.C.4, A.C.5, and A.C.6, we explain why contaminants have not reached the White River alluvium or the White River through the various mechanisms Dr. LaGarry has proposed, and are unlikely to do so in the future. Furthermore, water quality testing by the South Dakota Department of Environmental and Natural Resources (SD DENR) at a monitoring station (#460842) on the White River near Oglala, South Dakota (within the Pine Ridge Reservation) has shown no impacts from the ISR operations occurring upstream at the CBR facility (Ex. NRC-022 at 143, 187, 193). SD DENR stated that it chose this monitoring location "due to in-situ uranium mining upstream in Nebraska and the naturally occurring uranium in the highly erodible soils in the White River basin." (Ex. NRC-022 at 143.) Results of surface water monitoring at this station, which includes sampling for uranium "and other parameters associated with uranium mining," indicate that CBR's ISR operations are not impacting the White River in this area (Ex. NRC-022 at 143). Considering that the CBR facility has been operating for 24 years, these results further negate Dr. LaGarry's speculation that contaminants are reaching the White River alluvium and being pushed downstream with every rain event, eventually reaching the Pine Ridge Reservation.

Q.C.8 On page 4 of his 2008 Opinion, Dr. LaGarry claims that artesian flow could transmit mineral-laden waters onto the land surface and into the White River alluvium. Can you address this claim?

A.C.8 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim. For contamination to reach land surface by artesian pressure there must be a pathway from the Basal Chadron Sandstone aquifer to the surface. To date, we are unaware of any such pathway in the CBR LA, and over 20 years of water quality monitoring have not detected any contamination from artesian flow at the surface. As discussed in A.C.4 and A.C.6 above, several lines of evidence have demonstrated vertical hydraulic isolation of the Basal Chadron Sandstone aquifer from the Brule aquifer and the ground surface above the Brule aquifer within the CBR license area. Monitoring programs, as well as controls and procedures discussed in A.C.4 and A.C.5, are and have been in place to prevent and detect the movement of mining fluids from the Basal Chadron Sandstone aquifer to surrounding aquifers and surface waters in the LA. Any flow of fluids at the surface from artesian flow from the Basal Chadron Sandstone aquifer would also be detected by spill and leak monitoring at the surface within the license area.

Q.C.9 On page 18 of their petition, the OST expresses concerns about contamination outside the boundaries of the CBR facility and asserts, in particular, that water sampling along the White River is needed. Dr. LaGarry suggests such sampling on page 4 of his 2008 Opinion, as did JR Engineering on page 2 of their 2008 opinion. Do you agree that such sampling is needed?

A.C.9 (D. Back, T. Lancaster, E. Striz) No, we do not agree that sampling along the White River is needed. As required by License Condition 11.13 (effluent and environmental monitoring program), quarterly operational sampling of surface water and annual sampling of stream sediment is conducted on Squaw and English Creeks, which

traverse the LA and flow to the White River approximately 3 miles downstream of the LA (Ex. NRC-012 at 14). As stated in Section 4.6.1.2 of the EA, the samples on these creeks are taken from points S-1, S-2 and S-5 on Squaw Creek and from E-1 and E-5 on English Creek, which are located upstream and downstream of the license area (Ex. NRC-010 at 70). Results of the quarterly sampling provide water quality information that is representative of the surface water that runs through the license area and eventually drains into the White River. As discussed in A.C.5 and A.C.6, over 20 years of monitoring results have shown no evidence of any contamination being transported to surface waters outside of the LA. In A.C.4 and A.C.5, we discussed operational controls and procedures that are in place to prevent contaminants from reaching the White River alluvium. Also, as discussed in A.C.7 above, SD DENR monitors the White River downstream of the CBR facility at Oglala, SD, and has found no evidence of impacts to water quality from ISR operations at the CBR facility (Ex. NRC-022 at 143). For these reasons, we do not believe that additional monitoring of the White River is needed.

Q.C.10 **In Section 4.6.1.2 of the EA, the Staff concluded that impacts on surface waters from CBR operations would be small. Please explain the reasons for the Staff's conclusion.**

A.C.10 (D. Back, T. Lancaster, E. Striz) As explained in Section 4.6.1.2 of the EA, the Staff identified spills and leaks as the main potential sources of impacts to surface waters and described the controls in place to prevent them (Ex. NRC-010 at 69-70). As discussed in section 4.6.1.2 of the EA, quarterly surface water monitoring of surface streams and impoundments over 20 years (1990-2010) showed results that have remained at or below preoperational levels (Ex. NRC-010 at 70). Similarly, annual sediment testing results for English and Squaw Creek did not show significant trends (Ex. NRC-010 at 70). The Staff also reviewed historical spills and leaks at the facility

and the effectiveness of CBR's response to them (Ex. NRC-010 at 70). Finally, the Staff considered the SPCC Plan and other measures taken to protect surface water, such as dikes and berms in wellfields, secondary containment in process buildings, and regular inspections and preventive maintenance (Ex. NRC-010 at 70).

CONTENTION D

Communication Among Aquifers

Q.D.1 **In Contention D, the OST asserts that there is communication among aquifers, in particular between the Basal Chadron aquifer and the aquifer that supplies drinking water to the Pine Ridge Indian Reservation, and that this communication may result in contamination of potable water. Are you familiar with this contention and the documents provided in support of it?**

A.D.1 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with the contention and the documents provided in support of it, specifically, the opinions of Dr. Hannan LaGarry from 2008 and 2015, and the letter dated April 8, 2007, from NDEQ. We are also familiar with the 1989 letter from Mr. John Peterson to the NRC that is referred to in Dr. LaGarry's 2008 opinion.

Q.D.2 **Where in the EA does the Staff discuss aquifer confinement and potential impacts of CBR operations on ground water?**

A.D.2 (D. Back, T. Lancaster, E. Striz) Sections 3.4.1 of the EA describes regional geology, including descriptions of the upper and lower confining units at the CBR facility. Section 3.4.2 describes regional structure. Section 3.5.2 of the EA discusses ground water resources. In Sections 3.5.2.1 and 3.5.2.2, the Staff discusses the hydrogeological setting at the regional and local scales, respectively. Section 3.5.2.3 discusses the characteristics of the uranium bearing aquifer (the Basal Chadron Sandstone), including its hydrogeological characteristics (Section 3.5.2.3.1) and its confinement (Section 3.5.2.3.2). In Section 3.5.2.3.3, the Staff discusses computer

modeling to assess the probable hydrogeologic behavior of the White River structural feature, which is located approximately 2 miles northwest of the northern edge of the CBR LA boundary (Ex. NRC-010 at 38).

The Staff discusses potential operational impacts to ground water in Section 4.6.2.2 of the EA. Discussions include the impacts of spills or leaks, including leaks from evaporation ponds (Sections 4.6.2.2.2 and 4.6.2.2.3), vertical or horizontal excursions (Section 4.6.2.2.4), and impacts to ground water outside the CBR facility (Section 4.6.2.2.6) (Ex. NRC-010 at 74-81). Finally, cumulative impacts to ground water quality are discussed in Section 4.13.6.2 (Ex. NRC-010 at 115-120).

Q.D.3 **How do you respond to the allegation that there is lack of confinement of the Basal Chadron Sandstone aquifer or unsubstantiated assumptions as to the isolation of Basal Chadron Sandstone aquifer at the project site?**

A.D.3 (D. Back, T. Lancaster, E. Striz) We disagree with those statements. In Sections 3.5.2.3.1 and 3.5.2.3.2 of the EA and Section 2.4.3.2.2 of the SER, the Staff describes several bases for the conclusion that vertical confinement of the Basal Chadron Sandstone aquifer has been and continues to be demonstrated at the CBR facility (Ex. NRC-010 at 37-38, Ex. NRC-009 at 21). Based on our environmental and safety reviews, which considered information in the LRA, operational monitoring reports, relevant portions of documents associated with CBR's North Trend Expansion Area (NTEA) license amendment application (including the NTEA application and CBR's applications for an aquifer exemption and an Underground Injection Control (UIC) permit), and geological literature, we maintain that hydraulic isolation between the Basal Chadron Sandstone aquifer and the Brule aquifer is established by multiple lines of evidence based on measurable and reproducible data from the CBR site. These lines of evidence include the following: (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; (5) over 20 years of monitoring data from excursion monitoring wells and nearby private wells. We discuss each of these in enumerated sections below.

In addition, as discussed in Section 3.5.2.3.3 of the EA, the Staff performed computer modeling to assess the probable hydraulic behavior of the White River structural feature, which is located at the southeast boundary of the NTEA, approximately 2 miles northwest of the northern CBR license boundary (Ex. NRC-010 at 38). The Staff conducted this modeling to evaluate the probable behavior of this feature but does not consider the modeling essential to demonstrate confinement of the Basal Chadron Sandstone aquifer at the CBR facility, given the site-specific and reproducible nature of the five lines of physical evidence discussed below.

(1) Hydrological Characteristics of Confining Units

Sections 3.4.1 and 3.5.2.3.2 of the EA describe the physical characteristics of the upper and lower confining units for the Basal Chadron Sandstone aquifer. As described in the EA, 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 (Ex. NRC-010 at 26). The upper confining unit ranges in thickness from about 60 to 150 m (200 to 500 ft) within the CBR wellfield area (Ex. CBR-011 at 2-136 and 2-137). The lower confining unit for the Basal Chadron Sandstone aquifer is the Pierre Shale, a marine shale that is approximately 300 m (1000 ft) thick at the CBR facility (Ex. NRC-010 at 26, 38). As noted in Table 2.6-2 of the LRA, both the overlying and underlying confining beds (the Chadron-Brule confining unit and the Pierre Shale) 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 both 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 based on exploratory drill hole geophysical log data that illustrate the continuity of the three major confining units across the project area (Ex. CBR-011 at 2-111 to 2-125). Figure 2.6-3 in the LRA shows that cross sections A-A' and NW-SE transect the NTEA and the LA, beginning near the northern boundary of the NTEA and ending outside the southeastern LA boundary (Ex. CBR-011 at 2-109). These cross sections, together with other east-west oriented cross sections in the LRA, further illustrate the continuity of the overlying Brule-Chadron confining unit across the CBR site (Ex. CBR-011 at 2-111 to 2-125).

(2) Aquifer Pumping Tests

As explained in Section 3.5.2.3.1 of the EA, CBR conducted four aquifer pumping tests in the LA between November 1982 and August 2002 to demonstrate the integrity of the confining layers over the Basal Chadron Sandstone aquifer. As stated in the EA and shown in Figure 2.7-8 of the LRA, these tests covered the entire LA (Ex. NRC-010 at 37, Ex. CBR-011 at 2-203). The aquifer pumping tests involved pumping a well screened within the Basal Chadron Sandstone aquifer and observing the responses in water levels within the Basal Chadron Sandstone aquifer and wells screened in the Brule aquifer. The four pumping tests were designed to significantly stress the Basal Chadron Sandstone aquifer with constant pumping rates ranging from 23.8 -51.2 gallons per minute applied for time periods of 51-72 hours (Ex. CBR-011 at 2-213). During all of the tests there was no response in the overlying Brule aquifer (i.e., no significant water level changes were observed in the wells screened in the Brule aquifer), indicating that the Basal Chadron Sandstone aquifer is hydraulically isolated from the Brule aquifer (Ex. NRC-010 at 38, Ex. NRC-009 at 22-23).

(3) Potentiometric Surfaces

A comparison of the historical potentiometric surfaces provides another indication that the Basal Chadron Sandstone and Brule aquifers are not hydraulically connected. Potentiometric surfaces for the Brule aquifer in 1982-83 and 2009 are presented in Figures 2.7-3a and 2.7-3d of the LRA respectively (Ex. CBR-011 at 2-173 and 2-179). As shown in the figures, there has been very little change in the potentiometric surface elevations in the Brule Formation aquifer since the initiation of ISR activities. In contrast, the potentiometric surface of the Basal Chadron Sandstone aquifer has decreased approximately 14 m (47 ft) over the same time period (Ex. NRC-009 at 43). If the aquifers were connected, the potentiometric surface of the

Brule Formation aquifer would have experienced declines in concert with those observed in the Basal Chadron Sandstone aquifer.

(4) Aquifer Water Quality

As noted in Section 4.13.6.2 of the EA and Section 2.4.3.2.2 of the SER, CBR identified geochemical differences as support for the conclusion that the Brule and Basal Chadron Sandstone aquifers are not hydraulically connected (Ex. NRC-010 at 115, Ex. NRC-009 at 23). Water quality data in Table 2.2-9 of the LRA shows distinct differences in geochemistry between the Brule and Basal Chadron Sandstone aquifers that indicate hydraulic isolation (Ex. CBR-011 at 2-28). In addition, as described in the EA in Section 4.6.2.2.6, a review of ground water monitoring data from private wells in the Brule and Basal Chadron Sandstone aquifers shows water quality has remained consistent with radiological background levels for each aquifer (Ex. NRC-010 at 81).

(5) Operational and Monitoring Data

Over 20 years of data obtained during facility operations and from operational ground water monitoring demonstrate the continued isolation of the Basal Chadron Sandstone aquifer over the period of CBR facility operation. As discussed in Section 3.5.2.3.2 and Section 5.7.9.3.2 of the SER, vertical excursions detected in the overlying Brule aquifer have resulted from issues with well completion, testing, or abandonment, and not integrity of the confining layers (Ex. NRC-010 at 38, Ex. NRC-009 at 124-25).

Q.D.4 In Contention D, The OST claims that the aquifer that provides drinking water to the Pine Ridge Reservation communicates with the Basal Chadron aquifer where CBR's operations occur. Do you agree with this statement? Please elaborate.

A.D.4 (D. Back, T. Lancaster, E. Striz) No, we do not agree with Dr. LaGarry's claim that the aquifer providing drinking water to the Pine Ridge Reservation communicates with the Basal Chadron Sandstone aquifer where CBR's operations occur. The closest

boundary of the Pine Ridge Reservation is at least 30 miles from the northeastern boundary of the LA. For contamination to move within the Basal Chadron Sandstone aquifer from the LA to the Pine Ridge Reservation, the Basal Chadron Sandstone would have to be continuous between these locations.

As described in Section 3.5.2.3.1 of the EA, the thickness of the Basal Chadron Sandstone decreases to zero northeast of the CBR facility. Figure 2.6-12 of the LRA, which is based on CBR exploratory drill hole data, shows the Basal Chadron Sandstone pinching out to the east-northeast (Ex. CBR-011 at 2-111). As described by Dickinson ". . . [the Basal Chadron Sandstone] was deposited primarily in a major fluvial belt, about 10 to 20 miles wide that extends eastward in Nebraska from the Wyoming-Nebraska line through north-central Sioux County and southeastward through southwest Dawes and Box Butte Counties." (Ex. NRC-023 at 3.) The thickness and extent of the Basal Chadron Sandstone is shown in Plate 1 of Ex. NRC-023, and as demonstrated by the zero contour line in that figure, the Basal Chadron Sandstone is not present beyond about 5 miles north and east of Crawford. The reason the Basal Chadron Sandstone trends southeast from Crawford is that the sandstone was deposited by a major drainage feature that was a west-east through-flowing valley about 25 miles wide entering present day Nebraska in northwest Sioux County and turning southeast in western Dawes County (Ex. NRC-024 at 212).

The Basal Chadron Sandstone is the only unit within the Chadron Formation that is considered an aquifer. Because the sandstone pinches out, the Basal Chadron Sandstone aquifer is not present between the CBR facility and the Pine Ridge Reservation, or at the Pine Ridge reservation. The remainder of the Chadron Formation between the pinch out of the Basal Chadron Sandstone and the Pine Ridge Reservation is described as low permeability siltstones and mudstones which will not transmit appreciable flow (Ex. NRC-030 at 279). Therefore, there is at least a 25 mile

barrier to flow within the Chadron Formation that separates the Basal Chadron Sandstone aquifer in the LA from any aquifers that supply drinking water at the Pine Ridge Reservation.

According to the United States Geological Survey (USGS), the primary aquifers that supply water on the Pine Ridge Reservation are the Ogallala and Arikaree (Ex. NRC-025 at 2, Ex. NRC-026 at 2). The White River Group, which includes the Chadron Formation, is described as impermeable and not an aquifer at the Pine Ridge Reservation (Ex. NRC-025 at 7, Ex. NRC-026 at 8, 10, 11).

In addition to natural barriers to ground water flow from the LA to the Pine Ridge Reservation and the absence of the Basal Chadron Sandstone aquifer between and at the Pine Ridge Reservation, well field management activities also prevent ground water from moving outside of the LA. As stated in Section 4.6.2.2.1 of the EA, within the wellfields at the CBR facility, more water is pumped out of the Basal Chadron Sandstone aquifer than is injected to create an overall inward hydraulic gradient (Ex. NRC-010 at 75). As described in EA Section 4.6.2.2.4, CBR has placed excursion monitoring wells in the overlying aquifer and in perimeter rings in the Basal Chadron Sandstone aquifer surrounding all mine units to detect excursions (Ex. NRC-010 at 78). The perimeter ring of monitoring wells provides early detection of any unwanted horizontal flow (horizontal excursion) of process fluids from the production zone. CBR is required to perform excursion monitoring, including biweekly monitoring of wells in the perimeter ring and overlying aquifer. If an excursion is detected, production and injection pumping rates are adjusted to correct this situation, and often injection wells are shut off and production is increased to draw fluids toward the mining area. The Staff has no evidence that any excursion has migrated beyond the LA based on over 20 years of excursion and private well monitoring.

Q.D.5 On page 3 of his 2008 Opinion, Dr. LaGarry states that secondary porosity "in the form of intersecting faults and joints" is common in northwestern Nebraska, and that faults and fractures "transect all major bedrock units." Do you agree with these statements?

A.D.5 (D. Back, T. Lancaster, E. Striz) We agree that there are faults and joints in northwestern Nebraska (in general), but we disagree with the implication that there are faults allowing contaminants to be transmitted from the CBR LA. The Staff is unaware of any measured, reproducible site data from any source that clearly demonstrates the presence of significant fractures and joints which transect and vertically or horizontally connect the Pierre Shale, Basal Chadron Sandstone, Middle and Upper Chadron, or Lower Brule confining layers in or near the CBR LA.

Section 3.4.2 of the EA describes the structural features in the region (Ex. NRC-010 at 27). These features are shown in Figure F.4-1 of CBR's Underground Injection Control (UIC) permit application for the NTEA (Ex. NRC-028 at F-35). The nearest major structural feature to the LA is the White River structural feature, located approximately 2 miles northwest of the LA along the White River (Ex. CBR-011 at 2-133). As discussed in A.D.10, there is no physical evidence from measured data that demonstrates the White River structural feature acts as a flow pathway between the Basal Chadron Sandstone aquifer and the overlying Brule aquifer.

As we discussed in A.D.3, there are five lines of physical evidence showing that the Basal Chadron Sandstone and Brule aquifers are not hydraulically connected by fault, fractures, or joints through the geologic confining units within or near the LA. In particular, evidence including private well monitoring data and distinct geochemical signatures indicates that the Brule and Basal Chadron Sandstone aquifers are also hydraulically isolated from one another outside the LA.

Furthermore, we have seen no physical evidence demonstrating a connection between any formations through faults and joints, but if any faults or joints do exist, it is highly improbable that they create continuous permeable pathways vertically or horizontally in any of the overlying confining units. As described in A.D.3, the confining unit above the Basal Chadron Sandstone aquifer is 60 to 150 m (200 to 500 ft) thick above the wellfield area, and the upper part of the Chadron Formation is bentonitic clay grading downward to green and frequently red clay that is primarily comprised of 44 percent montmorillonite (Ex. CBR-011 at 2-127). Within the CBR LA, clays present in the upper confining layers are and remain saturated. Therefore, swelling of the saturated clays in the confining units above the Basal Chadron Sandstone aquifer would prevent any localized fractures and joints from creating permanent continuous vertical permeable pathways that could connect the Basal Chadron Sandstone aquifer to the overlying aquifers.

Q.D.6 **On page 3 of his 2008 Opinion, Dr. LaGarry states that Swinehart et al. and Diffendal "reported faults that could transmit contaminants from Crawford to Chadron and from Crawford to Pine Ridge, South Dakota." Are you familiar with those papers?**

A.D.6 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with those papers.

Q.D.7 **Do you agree with Dr. LaGarry that the faults reported in the Swinehart and Diffendal papers could transmit contaminants from Crawford to Chadron and to Pine Ridge, SD?**

A.D.7 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's statement. To our knowledge, the lineaments described in the Diffendal paper have not been ground truthed to be something more than linear alignments of ground surface features. Although the lineament analysis performed by Diffendal depicts many lineaments, as

acknowledged by Diffendal additional field work would be required to ascertain whether the lineaments are caused by structural features (Ex. NRC-027 at 137).

With respect to the spacing and orientation of the faults depicted in the Swinehart paper, none of the faults extend from Dawes County to the Pine Ridge Reservation (Ex. NRC-024 at 227). The White River structural feature is present over limited sections of the White River and therefore even if conductive, would not provide a continuous migration pathway to the Pine Ridge Reservation (Ex. NRC-024 at 227).

We do not see any potential or have any evidence that contaminants that are contained in the LA have been or could be transmitted from the LA to Chadron or Pine Ridge, South Dakota through structural features. In fact, the only field-documented structural feature near the LA is the White River structural feature, which as discussed in A.D.10, has not been demonstrated to act as a conduit for ground water movement.

Q.D.8 **As support for this contention, the OST provided a 2007 letter from NDEQ to CBR providing technical comments on CBR's aquifer exemption petition for the NTEA. In that letter, NDEQ raised several questions regarding CBR's interpretation of the White River structural feature. Based on this letter, OST claims that "CBR, as identified by [NDEQ scientists], failed to account for the White River Fault/Fold that is present in the southern portion of the [NTEA], which may affect the control of any migrations outside the mining area." Are you aware of the NDEQ 2007 letter and the concerns raised in it with respect to the WR structural feature?**

A.D.8 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with the letter, and the concerns raised in it regarding the White River structural feature. One of NDEQ's concerns was that, because cross sections provided by CBR indicated more than 400 feet of offset along the White River structure, a more accurate accounting of relief along the structure was required (Ex. INT-011, Technical Review Comments at 9, 10). NDEQ

also expressed concern over whether CBR's explanation provided adequate justification for their fold interpretation (Ex. INT-011, Technical Review Comments at 9).

Q.D.9 Do you know whether, and how, those concerns were ultimately resolved?

A.D.9 (D. Back, T. Lancaster, E. Striz) We are aware that on April 7, 2011, NDEQ approved the aquifer exemption petition for NTEA (Ex. CBR-019 at 1). The order approving the aquifer exemption petition included NDEQ's response to comments received as part of the public hearing process for the aquifer exemption, including several comments expressing concerns similar to those raised in this contention about the White River feature (Ex. CBR-019, Attachment C). In responding to those concerns, NDEQ noted that based on CBR's 3D geological modeling, there were no indications of disruption of geologic units—such as structural thinning, structural thickening, missing units, or linear features associated with fault rupture—that could not be associated with other geological processes (Ex. CBR-019, Attachment C at 2). NDEQ stated that, based on drilling data from the NTEA site, "there is no evidence that a fault offsets the geologic contact with the Pierre Formation and overlying White River Group, nor individual members of the White River Group (i.e., Brule and Chadron formations)." (Ex. CBR-019, Attachment C at 3.) In addition, NDEQ explained that it enlisted the assistance of independent experts to review CBR's geologic interpretations, including interpretations of structural geology, and those experts concluded that CBR's interpretations were plausible (Ex. CBR-019, Attachment C at 6). Finally, with respect to the potential for the White River structural feature to act as a conduit between the aquifers, NDEQ concluded that the Basal Chadron Formation at the NTEA was hydraulically isolated from the other aquifers based on several lines of evidence, including CBR's 3D geological modeling using the geophysical logs, drill hole data showing no evidence of faults or contamination pathways between the Basal Chadron Sandstone and Brule

aquifers, the flowing artesian conditions observed in the proposed North Trend Expansion Area, and the results of a 2006 pumping test performed by CBR (Ex. CBR-019, Attachment C at 4-8).

Q.D.10 On page 3 of his 2008 Opinion, Dr. LaGarry states that CBR's license amendment application for the NTEA reports a fault along the White River "that could transport contaminants from the ISL mine to the White River, and from the river directly to Pine Ridge, South Dakota." Do you agree that the structural feature Dr. LaGarry refers to could transport contaminants to the White River and then from the river to Pine Ridge, South Dakota?

A.D.10 (D. Back, T. Lancaster, E. Striz) No, we disagree with Dr. LaGarry's assertion that the White River structural feature could transport contaminants from the CBR facility to the White River and ultimately to Pine Ridge, South Dakota. For contaminants to be transported from the LA to the White River, the structural feature would need to be present beneath the LA and extend to the White River, which is not the case. In plan view, as shown in Figure 2.6-13 in the LRA, this structure trends northeast to southwest and extends through Crawford, Nebraska, where it is the closest to the LA (approximately 2 miles away) (Ex. CBR-011 at 2-126).

Dr. LaGarry did not provide any evidence that shows ground water contaminants are migrating from the LA to the White River structural feature. The ISR operations in the Basal Chadron Sandstone aquifer are conducted under an inward hydraulic gradient. CBR is required by License Condition 10.7 to maintain this inward gradient in the wellfields to contain process fluids and prevent horizontal excursions (Ex. NRC-012 at 8, Ex. NRC-010 at 75, Ex. NRC-009 at 40). This inward gradient creates a cone of depression which has reversed the direction of ground water flow (originally northwest) towards the interior of the CBR LA, preventing any fluid movement offsite. Also, as discussed in A.D.3 and A.D.4, historical ground water monitoring has

demonstrated that production fluids are contained within Basal Chadron Sandstone aquifer at the CBR site.

Hypothetically, even if contaminants could reach the White River structural feature, there are many lines of evidence supporting the conclusion that from within the Pierre Shale to the ground surface, the White River structural feature is a monoclonal form that does not offset the geologic contact between the Pierre Shale and Basal Chadron or members of the Chadron and Brule Formations and, therefore, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer. These lines of evidence include the continuity of the Chadron Formation-Pierre Shale contact and overlying units across the structural feature based on 130 geophysical logs (Ex. NRC-028 at F-19 to F-25); the vertical gradient and potentiometric ground water surfaces of the Basal Chadron Sandstone aquifer and the Brule aquifer over the area of the structural feature (Ex. NRC-028 at G-15 and G-16); aquifer tests in the area that demonstrate the integrity of the overlying confining unit (Ex. NRC-028 at G-9 to G-11); and distinct geochemical variations among aquifers (Ex. NRC-028 at G-9).

As described in Section 3.5.2.3.3 of the EA, the Staff also performed a ground water modeling and maximum likelihood analysis, which indicated that the presence of a fault that penetrates the Pierre Shale through the Chadron and Brule Formations is not probable, and if one exists, it does not convey water from the Basal Chadron Sandstone aquifer to the Brule aquifer (Ex. NRC-010 at 38-39). This finding is in agreement with CBR's interpretation that the White River structural feature may be expressed as a fold in the formations of interest near the LA.

Finally, as discussed in A.D.9, NDEQ also concluded that the interpretation of this feature as a fold was plausible based on reviews of independent experts, and that there is no evidence of faults or contaminant pathways between the Basal Chadron Sandstone aquifer and the Brule aquifer within the NTEA.

Q.D.11 On page 3 of his 2008 Opinion, Dr. LaGarry claims that contaminated water could migrate from the CBR facility wellfields into adjacent areas through faults. In particular, he states that faults can receive contaminants from three sources: (1) surface spills into the White River alluvium, (2) waters transmitted through the Chamberlain Pass formation, and (3) underground excursions of lixiviant or uranium-laden water. Could you address his claim with respect to each of these posited pathways?

A.D.11 (D. Back, T. Lancaster, E. Striz) For reasons discussed in A.D.3, A.D.4 and A.D.5, we disagree with Dr. LaGarry's claim that contaminated water could migrate from the CBR facility into adjacent areas through faults. Dr. LaGarry has not provided any hard evidence that faults are receiving contaminants from the project site. As discussed in A.D.5 and A.D.7, there is no evidence of faults beneath the LA and adjacent areas. As discussed in response A.D.10, 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. With respect to his posited pathways for faults to receive contaminants, we address those pathways in our responses to Contention C in A.C.4 (surface spills) and A.C.5 (transmission through the mined aquifer). Finally, as discussed in A.D.3 and A.D.4, historical evidence has demonstrated process fluids are contained within the Basal Chadron Sandstone aquifer at the project site.

Q.D.12 On page 3 of his 2008 Opinion, Dr. LaGarry claims that once contaminants get into faults, they could migrate along the ground water gradient northeastward toward the Pine Ridge Reservation or southeastward toward Chadron and the High Plains aquifer. Could you please address this claim?

A.D.12 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim. Dr. LaGarry has not provided any hard evidence that faults are receiving contaminants from the project site. As discussed in A.D.5 and A.D.7, there is no evidence of faults beneath

the LA and adjacent areas. As discussed in response A.D.10, 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 discussed in A.D.3 and A.D.4, historical evidence has demonstrated that production fluids are contained within Basal Chadron Sandstone aquifer at the CBR facility.

Q.D.13 On pages 3-4 of his 2008 Opinion, Dr. LaGarry claims that uranium could be drawn upwards into parts of the High Plains Aquifer by high-capacity irrigation wells. Can you address this claim?

A.D.13 (D. Back, T. Lancaster, E. Striz) We disagree with Dr. LaGarry's claim. Again, as discussed in A.D.3 and A.D.4, historical evidence has demonstrated that production fluids are contained within Basal Chadron Sandstone aquifer at the project site. The High Plains aquifer is made up of the alluvium, Brule, Arikaree and Ogallala aquifers (Ex. NRC-029 at 4). For the reasons discussed in A.D.3, there is not a hydraulic connection between the Basal Chadron Sandstone and Brule aquifers. In addition, the Arikaree and Ogallala aquifers are not present in or near the LA and are only found several miles south, along (Arikaree) and south (Ogallala) of the Pine Ridge Escarpment (Ex. CBR-011 at 2-99). Therefore, there is no hydraulic connection between the Basal Chadron Sandstone aquifer and the Arikaree or Ogallala aquifers. Furthermore, the ground water flow direction in the Basal Chadron Sandstone aquifer was originally to the northwest, away from the CBR LA, but is currently directed into the LA in response to the cone of depression created by the drawdown within the LA mine units (Ex. CBR-011 at 2-183, 2-185). Therefore, ground water is not going to move from the LA southeast toward the Pine Ridge Escarpment.

Q.D.14 On page 4 of his 2008 Opinion, Dr. LaGarry cites a letter submitted to the NRC in 1989 (the Petersen letter) which claims that the uranium at the CBR facility occurs within faults, and states that if this is true, then as CBR mines the

uranium they are "uncorking" [i.e., opening up] flow pathways along those faults. Can you address this claim?

A.D.14 (D. Back, T. Lancaster, E. Striz) In his 2008 opinion, Dr. LaGarry states "Mr. Peterson's main contention is that the uranium mined by CBR occurs within the faults themselves, and is not a roll-front deposit as CBR maintains." But based on a comprehensive analysis of over 2000 uranium exploration boreholes and mineralogical analysis of the sediments, the Crow Butte uranium trend has been unequivocally described as a roll front deposit (Ex. NRC-030 at 280-81). Figure 8 of Ex. NRC-030 is a map showing the roll front locations in and near the CBR LA (Ex. NRC-030 at 281).

With respect to dissolution of uranium within the Basal Chadron Sandstone aquifer causing "uncorking" of the formation creating greater permeability, an increase in permeability is unlikely, and would be limited to only the Basal Chadron Sandstone aquifer where the uranium mineralization is exclusively deposited. Uranium dissolution would not change the overlying confinement. As described in A.D.3, there are five lines of evidence that support confinement of the Basal Chadron Sandstone aquifer. In addition, as described in A.D.5 and A.D.7, there is no evidence of continuous faults or fractures in the Basal Chadron Sandstone in or near the CBR LA which would provide a permeable pathway from the Basal Chadron Sandstone aquifer vertically or horizontally to the overlying Brule aquifer or to surrounding aquifers.

Q.D.15 On page 4 of his 2008 Opinion, Dr. LaGarry also asserts that in the situation described in the Petersen letter (ISR removing minerals from faults), ISR activities could cause the faults to move, creating new contaminant pathways. Can you address this claim?

A.D.15 (D. Back, T. Lancaster, E. Striz) We disagree with this assertion. As discussed in the responses to A.D.3, A.D.4, A.D.5 and A.D.7, historical evidence has demonstrated that there are not continuous permeable fractures or faults at the CBR LA and production

fluids are contained within Basal Chadron Sandstone aquifer at the project site. The historical operation of the ISR has removed uranium from roll front deposits in the Basal Chadron Sandstone aquifer. It has also lowered the potentiometric surface of the Basal Chadron Sandstone aquifer. Because of this cone of depression, an inward gradient has been established in which water flows from outside CBR LA into the Basal Chadron Sandstone aquifer in the LA. We are unaware of any case where dissolution of uranium and the associated reduction of potentiometric head, such as that which exists at the CBR facility in the Basal Chadron Sandstone aquifer, would cause a fault to move.

Q.D.16 **In support of this contention, the OST submitted a letter from the NDEQ to CBR, dated November 8, 2007, providing technical review comments on CBR's aquifer exemption petition for the NTEA. Are you familiar with this document?**

A.D.16 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with that document.

Q.D.17 **The NDEQ letter stated that the White River fault/fold at the southern portion of the NTEA was inadequately defined and had to be accurately delineated for consideration of the aquifer exemption petition. The NDEQ provided specific technical comments regarding CBR's characterization of this feature on pages 9-10 and 15 of the NDEQ technical review comments. Can you please discuss the relevance of these comments to the issue of aquifer confinement at the main CBR facility and the Staff's assessment of environmental impacts on ground water?**

A.D.17 (D. Back, T. Lancaster, E. Striz) During the development of the EA and SER, the Staff was aware that NDEQ raised a number of issues during their preliminary review of CBR's 2007 Petition for Aquifer Exemption at NTEA as summarized above. As indicated in the NDEQ cover letter, however, the NDEQ comments were based on a preliminary review of the aquifer exemption petition (Ex. INT-011 at 1). Ultimately,

CBR was able to satisfy all of NDEQ's concerns raised above as demonstrated by NDEQ's granting of the aquifer exemption for NTEA (Ex. CBR-019 at 1).

In its review of the LRA, the Staff evaluated the description of the White River structural feature. As discussed in EA Sections 3.4.2 and 3.5.2.3.3, the Staff agreed with CBR's conclusion that the White River structural feature is a monoclonal form that does not offset the geologic contact between the Pierre Shale and Basal Chadron nor members of the Chadron and Brule Formations and, therefore, does not affect the hydraulic confinement of the Basal Chadron Sandstone aquifer (Ex. NRC-010 at 27, Ex. NRC-009 at 38-39). The Staff reached this conclusion based on CBR's 3D geological modeling (see A.D.9 above), the vertical gradient and potentiometric ground water surfaces of the Basal Chadron Sandstone and the Brule aquifer over the area of the structural feature (Ex. NRC-028 at G-9 to G-11), an aquifer pumping test in the area of the White River structural feature that demonstrated the integrity of the overlying confining unit (Ex. NRC-028 at G-9 to G-11) and distinct geochemical variations among aquifers (Ex. NRC-028 at G-9).

As discussed in Section 3.5.2.3.3 of the EA, the Staff performed ground water modeling and maximum likelihood analysis, which indicated that the presence of a fault that penetrates the Pierre Shale through the Chadron and Brule Formations is not probable, and if one exists, it does not convey water from the Basal Chadron Sandstone aquifer to the Brule aquifer (Ex. NRC-010 at 38-39). This finding is in agreement with CBR's interpretation that the White River structural feature may be expressed as a fold in the formations of interest near the LA.

As discussed above and in A.D.10, the White River structural feature does not provide a pathway between the Basal Chadron Sandstone aquifer and the Brule aquifer or the White River. Thus, the feature will not contribute to environmental impacts on ground water associated with continued operations at the CBR facility.

Q.D.18 With respect to the determination of whether there is adequate confinement of the mined aquifer at the CBR facility, what is the significance of the White River structural feature?

A.D.18 (D. Back, T. Lancaster, E. Striz) The White River structural feature has no significance with respect to determining whether there is adequate confinement of the Basal Chadron Sandstone aquifer at the CBR facility. As discussed in Section 3.5.2.3.3 of the EA, this feature is located approximately 2 miles from the northern boundary of the LA (Ex. NRC-010 at 38). Based on recent close spaced drilling CBR has stated that the feature could be interpreted as a fold because the Chadron confining layer is continuous and not offset across it (Ex. CBR-011 at 2-135).

In addition to the new geological data presented in the LRA, there is no hydrologic evidence that the White River structural feature, whether interpreted as a fault or fold, influences the ground water flow in the Basal Chadron Sandstone aquifer. A potentiometric surface of the Basal Chadron Sandstone aquifer north of and across this feature shows the ground water flows to the southeast in the Basal Chadron Sandstone aquifer under the proposed NTEA license area and across the feature (Ex. CBR-011 at 2-191). If a hydraulic connection existed at the White River structural feature that allowed for transfer of water between the Basal Chadron Sandstone and Brule aquifers, the potentiometric surface within the confined Basal Chadron Sandstone aquifer should exhibit some impact from the feature. The lack of any discontinuity in the potentiometric surface indicates the feature does not act as a flow or no-flow boundary within the Basal Chadron Sandstone aquifer. Also, as discussed in A.D.10, there is also no geochemical evidence in the immediate vicinity of the structure showing that it has any impact on integrity of the hydraulic confinement of the Basal Chadron Sandstone aquifer within the LA.

Q.D.19 In section 3.5.2.3 of the EA, the Staff describes computer modeling that was performed to assess whether the White River structural feature is a fault or a fold. Are you familiar with that modeling effort?

A.D.19 (T. Lancaster, E. Striz) We are familiar with the modeling.

Q.D.20 The intervenors assert that the Staff failed to use site-specific data for the license renewal area in its analysis and modeling of the White River feature, and instead used data solely from the NTEA application. Can you address this claim, and explain the reasons for using NTEA data, such as cross-sections representing the hydrostratigraphy of the White River feature, in the Staff's model?

A.D.20 (T. Lancaster, E. Striz) The MODFLOW ground water model and maximum likelihood analysis was developed to provide further validation of our conclusions about the White River structural feature (Ex. NRC-009 at 24). The model used geological layers developed from borehole data (geophysical logs) from the NTEA license amendment application because the White River structural feature is located along the southern license boundary of NTEA. As described in the SER, model input included well boring log data, hydraulic properties of the geologic units down to the Pierre Shale, well water level data, and boundary conditions (Ex. NRC-009 at 25). Because these models were developed for the NTEA, field data used for model development were obtained from the North Trend license amendment application (Ex. NRC-009 at 25). Site-specific data from the main CBR facility, such as geophysical logs, water levels, and hydraulic conductivity values, were not used in the model because they did not cover the area of the White River structure, which is 2 miles away from the northern boundary of the main facility.

Q.D.21 Can you explain the importance of the Staff's modeling of the White River feature in terms of reaching the conclusion that the Basal Chadron Sandstone

aquifer is adequately confined and thus environmental impacts would be SMALL?

A.D.21 (T. Lancaster, E. Striz) The Staff's modeling of the White River feature was conducted to provide support to the Staff's conclusion that no hydraulic connection likely exists to transfer any water between the Basal Chadron Sandstone and Brule aquifers, even outside of the LA. We acknowledge that any ground water modeling effort is non-unique and thus subject to uncertainty because modeling is inherently an approximation based on limited site data. The Staff conducted the modeling to provide a statistical evaluation of the probable hydrologic behavior of the structural feature based on available, site-measured data. As discussed in A.D.3, however, the Staff does not consider the modeling essential to support the conclusion that the Basal Chadron Sandstone aquifer is hydraulically isolated from the Brule aquifer because of the five lines of physical evidence discussed in A.D.3 that are based on unique, reproducible, site specific measurements, and that strongly support a conclusion of hydraulic isolation, and thus that environmental impacts would be small. The ground water modeling effort is just an additional line of evidence.

Q.D.22 In Section 4.6.2 of the EA, the Staff concluded that impacts on ground water quality from CBR operations would be small. Please explain the reasons for the Staff's conclusion.

A.D.22 (D. Back, T. Lancaster, E. Striz) The bases for the Staff's conclusion that impacts would be SMALL are summarized in Sections 3.5.2.3, 4.6.2.1, 4.6.2.2, 4.6.2.3 and 4.6.2.4 of the EA (Ex. NRC-010 at 37-39, 73-83). The Staff's conclusion is based on all the evidence of vertical confinement (see A.D.3 above), ability to maintain lateral confinement (see A.D.4 above), controls and procedures to prevent and contain spills and leaks (see Contention C testimony at A.C.4 and A.C.5), and over 20 years of

operational monitoring data showing no impacts from excursions, spills, or daily operations.

Environmental Justice

Q.D.23 In EA Contention 3, the intervenors asserted that the EA failed to take a hard look at "whether relicensing the CBR facility would cause disproportionate and adverse impacts on minority and low-income populations within the 50 mile environmental impact area around the facility when compared to the impacts on the non Environmental Justice population." As admitted by the Board as part of Contention D, the contention was recast as follows: "Based on this potential communication between the aquifers, the EA's environmental justice analysis, including analysis of cumulative effects, should be expanded to consider potential impacts on the aquifer which provides drinking water to the Pine Ridge Indian Reservation." Are you familiar with this contention and other documents that discuss it?

A.D.23 (N. Goodman) Yes. I am familiar with the contention, the pleadings, the oral argument transcript, and the Board's decision in LBP-15-11.

Q.D.24 Please describe your role in preparing the discussion of environmental justice in the EA.

A.D.24 (N. Goodman) I performed the Staff's environmental justice (EJ) analysis and wrote the discussion of EJ in the EA. In performing the analysis, I primarily relied on guidance in NUREG-1748, Appendix C (Ex. NRC-014 at C-1 to C-6).

Q.D.25 Where in the EA is EJ discussed?

A.D.25 (N. Goodman) EJ is discussed in Section 4.9 of the EA (Ex. NRC-010 at 89-92), and cumulative impacts associated with EJ are discussed in Section 4.13.9 (Ex. NRC-010 at 124-25).

Q.D.26 Was the Staff required to do an EJ analysis for this EA?

A.D.26 (N. Goodman) No, according to guidance in NUREG-1748, Appendix C, an EJ analysis is not required, and usually not performed, for an EA. In this case, the Staff performed an EJ analysis because the Staff was aware of the interest in this licensing action among several federally recognized Tribes within 100 miles of the CBR facility, and the Staff wanted to make sure that decision makers and the public knew that there were not significant EJ concerns from the relicensing of the CBR facility. Also, it is not unprecedented for an EA to include an EJ analysis. The Staff recently performed an EJ analysis in the EA for the renewal of the Nuclear Fuel Services (NFS) fuel fabrication facility in Tennessee, and applied the numerical guidance in NUREG-1748, Appendix C in determining the review area (Ex. NRC-032 at 3-7).

Q.D.27 **In admitting this contention, the Board identified the issue as "whether the EA's environmental justice analysis should be based on the extent of possible contamination impacts, and not limited to a four mile review." Please explain the basis for choosing a 4 mile review area for EJ.**

A.D.27 (N. Goodman) The Staff chose the 4-mile radius for its review area based on the guidance in NUREG-1748, Appendix C (Ex. NRC-014 at C-1 to C-6), which was endorsed by the Commission in its 2004 policy statement on EJ (Ex. NRC-031 at PDF 7-8). As explained in NUREG-1748, Appendix C, the first step in the EJ review is to identify the review area. For materials facilities located in rural areas, the guidance states that "a radius of approximately 4 miles (50 square miles) should be used." (Ex. NRC-014 at C-4.) The Staff's EJ guidance acknowledges that the 4-mile radius is a guideline, and states that "the geographic scale should be commensurate with the potential impact area." (Ex. NRC-014 at C-4.) After selecting the review area, the Staff reviews demographic data for that area using criteria established in the guidance, and "if no minorities or low-income populations are identified in the potentially affected area or environmental impact area," the review is complete (Ex. NRC-014 at C-5).

In its 2004 policy statement on EJ, the Commission specifically addressed the numerical guidance referred to above (the 4-mile radius for materials facilities in rural areas), along with similar guidance for power reactors that uses a 50-mile radius for EJ analyses related to licensing actions for those facilities (Ex. NRC-031 at PDF 7). The Commission stated that it was retaining the procedures for materials facilities and reactors "as articulated . . . in their respective office guidance," and stated that this guidance should be sufficient in most cases to include all areas with actual or potential impacts (Ex. NRC-031 at PDF-8).

For its review of the CBR facility, the Staff had no basis to deviate from the 4-mile guideline. The Staff's decision in this case was informed, in part, by the fact that this is an existing facility that has been operating for over 20 years without evidence of environmental impacts, as evidenced by regulatory oversight activities such as inspections and reporting requirements. For example, with respect to surface and ground water impacts in particular, the Staff receives semiannual reports on effluent and environmental monitoring of surface and ground water (e.g., Ex. CBR-018). Additionally, nothing in CBR's 2007 license application, and nothing that the Staff identified during its environmental review, suggested a reason to use a larger review area. Therefore, although the Staff was aware that there was an admitted contention in this proceeding asserting possible impacts to surface and ground water at the Pine Ridge Reservation, the Staff judged the 4-mile review area to be appropriate.

The guidance in NUREG-1748, Appendix C, acknowledges that the Staff might become aware of minority or low-income populations by means other than demographic data. In such cases, if the Staff believes that a distinct minority or low-income population may be adversely affected by the proposed action, "the reviewer should proceed with the environmental justice review even if that population was not identified through the use of demographic data" (Ex. NRC-014 at C-5). In this case, as

stated in Section 4.9 of the EA, the Staff was aware of the minority and low-income population at the Pine Ridge Reservation. However, the Staff determined, based on the distance from the facility to the Pine Ridge Reservation, that residents of the Pine Ridge reservation were not a population that may be adversely affected by renewal of the CBR license. This determination was based on the same reasons discussed above. Therefore, the Staff considered its EJ review complete.

Q.D.28 **The focus of the EJ contention, as admitted by the Board, is whether, "[b]ased on [the] potential communication between the aquifers, the EA's environmental justice analysis, including analysis of cumulative effects, should be expanded to consider potential impacts on the aquifer which provides drinking water to the Pine Ridge Indian Reservation." Could you please address why the Staff did not expand its EJ analysis in this way?**

A.D.28 (N. Goodman) As discussed in A.D.27, the Staff considered a review area within a 4-mile radius when determining the need for further EJ analysis. For the reasons discussed in A.D.27 the Staff judged that review area to be appropriate for the proposed renewal of the CBR license.

Furthermore, even if a minority or low-income population is identified within the area of review, there is no need for further EJ analysis unless impacts are determined to be significant. According to NUREG-1748, Appendix C, impacts are to be determined "in the usual manner," and if impacts are not significant, then "there are no disproportionate adverse or high impacts" on an EJ population (Ex. NRC-014at C-6). Thus, any further EJ analysis with respect to potential impacts on drinking water at the Pine Ridge Indian Reservation would have required a determination by the Staff that there were significant impacts to surface or ground water quality.

As discussed in Sections 4.6.1.2 and 4.6.2.2 of the EA, the Staff determined that impacts to surface and ground water from relicensing of the CBR facility would be

SMALL, and hence not significant. The basis for those determinations is discussed in Sections 3.5.2.3, 4.6.1.2 and 4.6.2.2 of the EA. Briefly, the Staff concluded that impacts would be SMALL because of the demonstrated confinement of the mined aquifer, the ability to control horizontal excursions within the mined aquifer, the ability to protect surface waters and shallow aquifers from spills and leaks, and the monitoring results from over 20 years of operation that show no impacts to surface waters or to water quality in nearby wells in the Brule and Chadron aquifers. In particular, monitoring of private wells near the CBR facility that provide drinking water from the Brule aquifer have not shown changes in water quality due to ISR operations. These reasons are addressed more completely in the earlier testimony in Contention D related to hydrogeology, and also in the Staff's testimony on Contention C regarding potential impacts to surface waters and shallow aquifers. And, in particular, the Staff explains in A.C.4 through A.C.8 and A.D.3 through A.D.15 how it considered Dr. LaGarry's various claims regarding potential contamination pathways. Accordingly, the Staff did not find it necessary to expand the review area for EJ based on potential impacts to surface or ground water quality at the Pine Ridge Reservation.

Q.D.29 **The Board also admitted the contention with respect to cumulative impacts, stating that 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. Please respond to this.**

A.D.29 (N. Goodman) As explained in Section 4.13 of the EA, the Staff identified the other three proposed ISR expansion facilities – North Trend, Marsland, and Three Crow – as potential future actions to be considered in the context of cumulative impacts (Ex. NRC-010 at 105). With regard to cumulative impacts of EJ, Section 4.13.9 of the EA explains that due to the proximity of those sites to the CBR facility, the Staff expects that demographic analyses for those projects would yield the same result obtained for

the license renewal, and that further EJ analysis would not be necessary (Ex. NRC-010 at 124). This statement presumed that the Staff would follow its guidance and use a 4-mile review area to EJ analyses of the proposed expansion areas.

The Staff has not yet completed its environmental reviews on the North Trend and Marsland expansion areas, and has not received an application for the Three Crow expansion area (a previously submitted application was withdrawn in 2010). Therefore, the Staff has not determined whether there will be significant impacts from those facilities on surface or ground water quality from those proposed actions. However, license amendments for those facilities will not be approved unless the Staff finds that CBR has satisfied regulatory requirements in 10 C.F.R. Part 40 and acceptance criteria in NUREG-1569, including sections 2.6 and 2.7 related to site characterization of geology, seismology, and hydrology (Ex. NRC-013 at 2-16 to 2-28). Based on this fact, and based on the Staff's knowledge of operating experience at the CBR facility and other ISR facilities, for the purposes of estimating cumulative impacts on EJ in this EA, the Staff had no reason to expect significant impacts to surface or ground water outside the proposed expansion areas. Therefore, the Staff had no reason to consider an EJ review area larger than the 4-mile radius in NUREG-1748, Appendix C, for those areas. Likewise, the Staff had no basis to expect EJ impacts (i.e., disproportionately high and adverse impacts) to residents of the Pine Ridge Reservation from the proposed expansion areas, based on the distances from those expansion areas to the reservation.

Finally, as stated in Section 4.13.1 of the EA, the 50-mile radius for cumulative impacts analysis is the area in which the Staff identified other past, present and reasonably foreseeable future actions that might contribute to cumulative impacts (Ex. NRC-010 at 104). Choosing that radius did not mean the Staff assumed that any

actions identified within that area would themselves cause significant impacts over that range.

CONTENTION F

Q.F.1 **In Contention F, CI claim that the EA fails to include results of recent research on regional and local geology. Are you familiar with this contention and the documents that support it?**

A.F.1 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with the contention, and with the 2008 and 2015 Opinions by Dr. Hannan LaGarry and the 2007 letter from the NDEQ regarding the aquifer exemption petition for the NTEA that were provided in support of the contention.

Q.F.2 **Where in the EA does the Staff discuss regional and local geology?**

A.F.2 (D. Back, T. Lancaster, E. Striz) The Staff describes regional geology in Section 3.4.1 of the EA (Ex. NRC-010 at 24-29) and regional hydrogeology in Section 3.5.2.1. 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). The Staff also discusses regional and site geology in Sections 2.3.3.1 and 2.3.3.2 of the SER (Ex. NRC-009 at 15-17), and Section 2.3.3.2 of the SER specifically addresses the new nomenclature proposed by Dr. LaGarry (Ex. NRC-009 at 15).

Q.F.3 **On page 2 of his 2008 Opinion, Dr. LaGarry states that he has published peer-reviewed articles on the Chadron Formation (citing Terry & LaGarry 1998) and the Brule Formation (LaGarry 1998), and local faults (Fielding et al 2007). Are you familiar with these articles?**

A.F.3 (D. Back, T. Lancaster, E. Striz) Yes, we are familiar with these articles.

Q.F.4 **On page 2 of his Opinion, Dr. LaGarry discusses the stratigraphy in northwestern Nebraska. Please explain whether, and to what extent, his**

stratigraphic description of northwestern Nebraska applies to the Crow Butte ISR facility site and vicinity.

A.F.4 (D. Back, T. Lancaster, E. Striz) The cross-sections provided in Figures 2.6-4 to 2.6-11 of the LRA provides the best depiction of the stratigraphy at and in the vicinity of the Crow Butte ISR facility (Ex. CBR-011 at 2-111 to 2-125). These figures show that all of the stratigraphic units that Dr. LaGarry describes are present at the site with the exception of the Ogallala Group. And as shown in Figures 2.6-9 and 2.6-11 of the LRA, the Arikaree Group is present only in the far southeast corner of the site (Ex. CBR-011 at 2-121, 2-125). As shown in the regional geologic map in Figure 2.6-1 of the LRA, the Arikaree Group is composed of sandstones and forms the Pine Ridge Escarpment located south and southeast of the License Area (Ex. CBR-011 at 2-99). The Ogallala Group, which is not present on the CBR site, overlies the Arikaree Group to the south of the CBR site and outcrops south of the Pine Ridge Escarpment (Ex. CBR-011 at 2-99). The modern river alluvium is derived from the weathering of any of the units described above and will be present along rivers and streams.

Q.F.5 **On page 3 of his 2008 Opinion, Dr. LaGarry states that the "simplified, 'layer cake' concept applied by many pre-1990's workers is incorrect and overestimates the thickness and areal extent of many units." Can you address this claim as it applies to the Staff's review of hydrogeology and environmental impacts on surface or ground water at the CBR site?**

A.F.5 (D. Back, T. Lancaster, E. Striz) The subsurface stratigraphy of the CBR license renewal site is composed of many layers, some of which are discontinuous, as a consequence of the fluvial depositional history of the formations. However, the analysis of ground water flow systems typically relies on the grouping of various regional stratigraphic units that have similar hydrogeological properties into "hydrostratigraphic units." These hydrostratigraphic units include aquifers and

aquitards which are used to characterize the behavior of the ground water flow system. This grouping has been successfully used in hydrogeology and is absolutely necessary as the available measured subsurface data can never be sufficient to capture the true complexity of the geology.

To identify the hydrostratigraphy, the Staff examined site-specific stratigraphic cross-sections in Figures 2.6-4 to 2.6-11 of the CBR LRA that cover the entire CBR site (Ex. CBR-011 at 2-111 to 2-125). These cross sections, which were obtained from geophysical logs, demonstrate the extent and thickness of the hydrostratigraphic units present at the site. In particular, starting from the surface, the geophysical logs clearly indicate the presence of a saturated permeable aquifer, known as the Brule aquifer. Beneath the Brule aquifer, the logs show a thick, continuous sequence of less permeable strata, classified as the Upper and Middle Chadron mudstones, which act as aquitards. Below these less permeable strata lies the Basal Chadron Sandstone (the production zone), which is indicated to be a continuous and permeable aquifer. Below the Basal Chadron sandstone, the geophysical logs demonstrate a continuous thick low permeability layer, the Pierre Shale, which is an aquitard. These logs and other hydrogeological characterization provided by the licensee (e.g., pumping tests, water levels, core testing) support a hydrostratigraphic "layer cake model" of hydrogeological characteristics of the subsurface which control the ground water flow behavior at the CBR site.

Q.F.6 On page 4 of his 2015 Opinion, Dr. LaGarry asserts that the EA uses "outdated 1960's era concepts and nomenclature." In a April 2007 letter concerning CBR's aquifer exemption petition for the proposed NTEA, the NDEQ also referred to CBR's use of "outdated" nomenclature. Can you address this claim regarding outdated nomenclature?

A.F.6 (D. Back, T. Lancaster, E. Striz) With respect to Dr. LaGarry's assertion that the EA uses outdated nomenclature, as noted in Section 2.3.3.2 of the SER, during its review the Staff was aware of Dr. LaGarry's proposed lithostratigraphic revisions for some of the geologic units within the CBR facility area (Ex. NRC-009 at 15). Although first proposed by LaGarry and Terry in articles published in 1998, the Staff found during its review that the USGS does not currently use the LaGarry or Terry revisions for Nebraska geological nomenclature (Ex. NRC-033, Ex. NRC-034, Ex. NRC-035). Specifically, as stated in Section 2.3.3.2 of the SER, the USGS does not identify the Chamberlain Pass Formation in Nebraska (Ex. NRC-009 at 15). Rather, the USGS states that the White River Group in Nebraska is composed of the Chadron formation and the overlying Brule (Ex. NRC-033). Because the USGS is the federal authority on geological nomenclature, the Staff defers to the currently used and accepted USGS definitions with respect to geological nomenclature. Therefore, the Staff retained the nomenclature that is currently used and accepted by the USGS for Nebraska in the SER and the EA.

During the development of the EA and SER, the Staff was also aware of the nomenclature issues raised in the 2007 NDEQ letter regarding CBR's aquifer exemption petition for the NTEA (Ex. INT-011 at 2, 3, 4, 6, 8, 10). For the reasons explained above, the NRC uses the accepted USGS nomenclature for its review. However, we also note that when NDEQ granted the aquifer exemption for the NTEA in 2011, NDEQ retained the original nomenclature, referring to the exempted aquifer as "portions of the Chadron Formation in Dawes County, Nebraska . . . including the Basal member of the Chadron Formation." (Ex. CBR-019 at 1.) In responding to comments regarding the nomenclature used in the aquifer exemption petition, NDEQ stated that its concerns were addressed by correlating the historical nomenclature with the more recent nomenclature that Dr. LaGarry and others have adopted (Ex. CBR-

019, Attachment C at 4, 8, 14). In addition, although NDEQ recognized the recent interpretations of the stratigraphic nomenclature for the White River Group, NDEQ allowed CBR to continue to refer to the mined aquifer as the "Basal Chadron" sandstone to be consistent with historical permitting and to prevent confusion as to where mining is occurring (Ex. CBR-019, Attachment C at 3).

Q.F.7 **What effect, if any, does the use of the nomenclature in the LRA and prior CBR applications, as opposed to Dr. LaGarry's proposed nomenclature, have on the Staff's evaluation of hydrogeology and environmental impacts on surface or ground water?**

A.F.7 (D. Back, T. Lancaster, E. Striz) The choice of nomenclature has no effect whatsoever on the evaluation of hydrogeology and environmental impacts on surface and ground water. As explained in Section 2.3.3.2 of the SER, "nothing in the naming conventions for the geologic units in Nebraska or at the Crow Butte facility changes the interpretation of the physical or hydraulic features of the rock units." (Ex. NRC-009 at 15). This statement is equally applicable in the context of assessing environmental impacts. Table E.2-2 of CBR's application for a Class III Aquifer Injection Permit for the North Trend Expansion Area, one of the documents the Staff consulted during its review, clearly illustrates that Dr. LaGarry's proposals relate only to nomenclature (Ex. NRC-036 at E-32). Therefore, the Staff's use of currently accepted USGS nomenclature instead of Dr. LaGarry's proposed nomenclature did not alter the Staff's evaluation of hydrogeology and potential environmental impacts on water resources at the CBR facility.

Q.F.8 **In its decision to admit this contention, the Board cited a document submitted by Mr. Paul Robinson. Are you familiar with that document?**

A.F.8 (D. Back, T. Lancaster) Yes, we are familiar with that document.

Q.F.9 **As an example of a failure to use recent research, the Board cited Mr. Robinson's statement that, in the LRA, CBR referred to two out-of-date U.S. Environmental Protection Agency (EPA) publications. These two EPA publications are cited in Section 2.9 of the LRA, which discusses baseline water quality measurements. Could you please address Mr. Robinson's statement?**

A.F.9 (D. Back. T. Lancaster) Certainly. We are familiar with the more recent editions of the EPA documents cited by Mr. Robinson. The first document, "Manual of Methods for Chemical Analysis of Water and Wastes," provides laboratory test procedures for the measurement of physical, inorganic, and selected organic constituents and parameters in water and wastewaters. This outdated manual was used by chemists to ensure that the laboratory analytical methods met the requirements of the EPA. The second document, "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities," provides guidance on establishing the need for ground water monitoring, assigning priorities, and implementing monitoring programs at solid waste disposal facilities.

Both documents were originally included in the reference section to Section 4.4 in the Environmental Report submitted in 1987 in support of the original license application (Ex. NRC-037 at 4.4(80)). Although both of these documents are also included in the list of references for Section 2.9 of the LRA, neither document is specifically cited in that section (Ex. CBR-011 at 2-275 to 2-306). As noted in Section 2.9.1 of the LRA, the preoperational baseline ground water quality data were initially provided in the 1987 license application for the CBR facility (Ex. CBR-011 at 2-275). Therefore, it appears that the LRA refers to the versions of the EPA documents that were in use at the time those original baseline measurements were taken, and the references to them were apparently provided for historical context.

CONTENTION 1

Consultation

Q.1.1 **In Contention 1, the intervenors argue that the Staff failed to adequately consult with interested Tribes, particularly OST. When did the Staff initiate consultation with potentially interested Tribes?**

A.1.1 (N. Goodman, P. Nickens) Formal consultation began on January 13, 2011, when the Staff sent consultation letters to all potentially interested Tribes, inviting them to participate as consulting parties (Ex. NRC-038 at 1). The letter to OST was sent to Theresa Two Bulls, OST President, and copied to Wilmer Mesteth, OST Tribal Historic Preservation Officer (THPO) (Ex. NRC-039). A list of the Staff's efforts to consult with OST in particular appears as Exhibit NRC-038.

Q.1.2 **What steps did the Staff take to identify Tribes who might be interested in the Crow Butte license renewal?**

A.1.2 (N. Goodman, P. Nickens) The Staff began by reviewing the projects with ongoing consultation efforts in the general vicinity of the Crow Butte facility: Nichols Ranch, Moore Ranch, and Lost Creek. The Staff then consulted its contracted cultural resources specialist, Paul Nickens, and the Division of Material Safety, State, Tribal, and Rulemaking Programs, Federal, State, and Tribal Liaison Branch, NMSS, for input on which additional Tribes would likely have an interest in the Crow Butte license renewal. Finally, the Staff asked all consulting Tribes whether they believed that any additional Tribes would like to participate in consultation. The Staff never told a Tribe that they could not participate in consultation. The Staff always took the approach that it was never too late to enter consultation, and any Tribe that wanted to be a consulting party at any point during the process would have been invited to do so.

Q.1.3 **How did the Staff typically communicate with interested Tribes?**

A.1.3 (N. Goodman, P. Nickens) The Staff employed multiple forms of communication in its effort to reach out to interested Tribes. Typically, consultation efforts included a certified letter sent to the Tribal President and copied to the THPO, with additional copy to the THPO via e-mail. The Staff would then follow up via telephone to confirm receipt of the letter and discuss any questions from the Tribe. The Staff also held face-to-face meetings and teleconferences for larger discussions.

Q.1.4 To what extent was the Nebraska State Historic Preservation Officer (SHPO) involved in consultation?

A.1.4 (N. Goodman, P. Nickens) There was very little involvement from the Nebraska SHPO. They communicated to the Staff in a phone call that they did not believe that historic properties were present at the Crow Butte facility, but encouraged the Staff to conduct its own consultation. The Nebraska SHPO further stated that they did not believe that it was necessary for them to join the Staff at any of the consultation meetings with the interested Tribes.

The Staff sent a letter to the Nebraska SHPO on June 20, 2013 with its finding of no historic properties (Ex. NRC-040). The Nebraska SHPO reviewed and concurred with the Staff's finding in a letter dated July 15, 2013 (Ex. NRC-041).

Q.1.5 Please describe the face-to-face meetings that were held with consulting Tribes to discuss nearby ISR projects.

A.1.5 (N. Goodman, P. Nickens) The Staff held three face-to-face meetings with consulting Tribes regarding ISR projects in the area (the Crow Butte license renewal and expansion projects, as well as the Dewey Burdock project). The first meeting took place June 7-9, 2011. The purpose of this meeting was to gather and share information with the consulting parties pertaining to section 106 of the NHPA. On June 7, attendees visited the Crow Butte facility and proposed expansion areas, although the main facility was the focus. An information-gathering meeting took place on June

8, where the Tribes had an opportunity to raise concerns, ask questions, and listen to four presentations that were given by the Staff. On June 9, attendees visited the Dewey Burdock facility. NRC Staff decision-makers were present at the meeting for all three days.

The second meeting took place February 14 and 15, 2012. The purpose of this meeting was to discuss how to identify historic and cultural properties at the Crow Butte site. THPOs and representatives from over 15 Tribes were present, and this meeting was considered an official government to government consultation meeting. The Tribes were given an opportunity to share their ideas for identifying properties and approaches that have worked in the past. A tribal member and independent contractor who many Tribes have relied on in the past to identify historic properties gave a presentation about the specific approaches that have been used.

The third meeting took place on May 23, 2013. The purpose of this meeting was to inform Tribal council members and leaders about the current ongoing projects, including the Crow Butte License Renewal. This meeting was a direct result of comments that NRC Staff received that proper government to government consultation included not only consulting with THPOs but Tribal leaders as well.

Q.1.6 **How did the Staff keep Tribes informed of the project's development, and what steps did the Staff take to solicit comments from the Tribes?**

A.1.6 (N. Goodman, P. Nickens) The Staff's process of informing the Tribes of documents was to send the Tribal President an official letter, with copy to the THPO, sent with a mail receipt. This letter was followed up with an e-mail to the THPO and the THPO office, attaching a copy of the letter and any enclosures that were included in the mailing. These e-mails were followed up with phone calls to the Tribes to ensure that they received the e-mails and to address any questions.

The Staff solicited comments in several ways. Comments were always taken during face-to-face meetings, and these meetings and Tribes' comments were recorded when allowed by the Tribes. If not allowed, the Staff took notes on any comments made during the meetings. The Staff also always solicited written comments via either e-mail or postal mail. Comment periods were usually 30 days, but would be extended if the Tribes requested additional time. The Staff also accepted comments through its Twitter feed, as well as phone calls.

Q.1.7 **How did the Staff consider and incorporate comments or suggestions from consulting Tribes?**

A.1.7 (N. Goodman, P. Nickens) All comments from the Tribes—whether received at a face-to-face meeting, in writing, electronically, or via phone call—were considered in the Staff's Section 106 consultation, and official documentation was sent to the Tribes informing them of receipt of the comment. The following examples are not exhaustive, but should illustrate how the Staff considered comments from consulting Tribes throughout the consultation process.

At the outset of the consultation process, the Tribes commented that face-to-face meetings would be the most effective form of communication. In response to these comments, the Staff held three face-to-face meetings to discuss the Crow Butte license renewal. Based on comments from OST and other Tribes, the Staff held the first of these meetings on the Pine Ridge Reservation.

Additionally, the Tribes felt very strongly that the only way to properly identify cultural properties was with a traditional cultural properties (TCP) survey. While ACHP regulations and guidance do not declare any single method by which cultural properties must be identified, the Staff considered the Tribes' comments and chose to conduct a TCP survey of the Crow Butte facility and proposed expansion areas.

During the preparation for the TCP survey, several Tribes commented that they wanted a second site visit to the Crow Butte facility. The Staff worked to accommodate this request, joining the attending Tribes in a government-to-government site visit.

Q.1.8 Was OST represented by a THPO during consultation?

A.1.8 (N. Goodman, P. Nickens) Yes, OST was represented by a THPO throughout the entire consultation process. Wilmer Mesteth and Michael Catches Enemy served as the THPO for OST at different stages of consultation.

Q.1.9 Did OST provide comments when they were solicited by the Staff?

A.1.9 (N. Goodman, P. Nickens) No, OST almost never responded to a formal consultation letter where comments were solicited. For example, one of the most extensive periods of communication between Tribes and the Staff for the Crow Butte project was during the development of a process for identification of cultural properties. While there were many back and forth communications between Tribes and the Staff over the phone and e-mail during this period, OST did not engage in these communications or comment on the plans as they developed. Nor did OST submit comments on the results of the TCP survey of the Crow Butte facility and expansion areas.

Q.1.10 Please describe the process for inviting Tribes to participate in the TCP survey of the Crow Butte facility and expansion areas. How did OST respond to the invitation?

A.1.10 (N. Goodman, P. Nickens) The process for inviting tribes to participate in the TCP survey began well before the October 31, 2012 letter. During the February 2012 meetings, the Staff's purpose was to begin the process of identifying cultural and historical properties and declaring the area of potential effect (APE). After the meeting ended, the Staff had several follow-up teleconference calls and individual calls with Tribes to discuss different ways to identify historic properties. Several methods were

discussed, including ethnographic studies, a Tribal Statement of Work, and an Applicant Statement of Work. Ultimately, the Staff chose to proceed with an open site approach that included funding for the Tribes. The Staff concluded that this method would offer the greatest freedom to the Tribes to approach the TCP survey as they wished, concentrating on the areas most important to them. After this decision was made, the Staff sent official TCP survey invitation letters to all consulting Tribes on October 31 and followed up with phone calls.

OST did not respond in any way to the invitation letter. OST also did not respond to any follow-up phone calls, other than to acknowledge that they had received the invitation letter.

Q.1.11 The Intervenors argue that the Staff did not consult with OST on a government-to-government basis, as required by ACHP regulations (and reiterated in the NRC's Tribal Protocol Manual (Ex. NRC-046; Ex. NRC-047). Is this accurate?

A.1.11 (N. Goodman, P. Nickens) No; the Staff did consult with OST on a government-to-government basis. For example, the February 2012 meeting was an official government-to-government meeting, as the Staff explained both in phone calls with the Tribes prior to the meeting and at the opening of the meeting itself. This meeting was closed to the public and open only to Tribes, the NRC, Nebraska SHPO officers, and the applicants. OST was represented at this meeting by several individuals, including the OST President, John Yellow Bird Steele; the OST THPO, Michael Catches Enemy; and two attorneys (Ex. NRC-042).

On March 12, 2013, the Staff sent letters to consulting Tribes inviting Tribal leaders to a "government-to-government meeting" to be held in Rapid City, SD in May 2013 (Ex. NRC-043). On March 29, 2013, OST President Bryan Brewer sent a letter to the Staff accepting the Staff's "invitation for government-to-government consultation" (Ex. NRC-044). No OST officials or representatives attended the May 2013 meeting.

Mr. Brewer did not notify the Staff that he would not be attending the meeting and did not respond to the Staff's attempts to reach out via phone.

Q.1.12 The Intervenors argue that OST asked that tribal representatives be allowed to participate in TCP surveys, but that the request was refused. Is this accurate?

A.1.12 (N. Goodman, P. Nickens) This is not accurate. At no time during the consultation process did the Staff refuse a request from OST to participate in a TCP survey.

The Staff sent a letter to the OST THPO on October 31, 2012, inviting the tribe to participate in a TCP survey of the Crow Butte facility and expansion areas and explaining that each participating Tribe would receive a $10,000 honorarium, a per diem for up to three individuals, and reimbursement of travel costs associated with the survey. On November 6, 2012, the Staff placed phone calls to the OST THPO in an effort to follow up on the invitation. While the Staff was told that the OST THPO would return the call the same day, no return call was received. However, the Staff was able to confirm that OST had received the invitation to participate in the TCP survey. On November 21, 2012, the Staff followed up further in a letter to John Yellow Bird Steele, OST President, enclosing the October 31 invitation letter.

OST did not respond to the October 31 invitation, the November 6 phone call, or the November 21 follow-up letter. At no time did OST contact the NRC Staff to express an interest in participating in the TCP survey.

Surveys

Q.1.13 The Intervenors argue that the Staff failed in its responsibility to identify cultural resources. What steps did the Staff take to identify cultural resources that may be affected by the CBR license renewal?

A.1.13 (N. Goodman, P. Nickens) Unlike several other regional ISR license applications for new projects either currently under review or recently licensed by NRC, the renewal of NRC License No. SUA–1534 allows only for continued operation of ISR milling

operations of the CBR facility. Commercial operations began at the CBR facility in 1991 and the final mine unit (MU-11) is now in operation. Consequently, the potential for adverse effects to historic properties from ongoing mining operations are nearing an end. As the project enters the decommissioning phase, ground-disturbing activities associated with aquifer restoration, well field closure and land surface reclamation, and removal of other ISR facility features could have a potential for adverse effects to known cultural resources during the license renewal period.

To identify historic or cultural properties that may be affected by renewal of the CBR license, the Staff conducted several levels of review. In the initial review level, the Staff evaluated the cultural resources data included in the License Renewal Application Environmental Report, along with similar data from a previous license renewal application review in 1998. Since it was apparent that baseline cultural resources data had been brought forward without critical review from the original field studies in the 1980s, the Staff undertook an evaluation of the initial reporting of cultural resources field identifications (Ex. CBR-027; Ex. CBR-028). This was done to verify the extent and intensity of the original field inventories in relation the current operating conditions, under which the existing license would be renewed. The Staff analysis further involved a literature review to identify any possible cultural or historic resources that may not have been considered during the original inventories, especially for any such resources that may have significance for the potentially affected Native American Tribes. In addition to reviewing the relevant published and unpublished literature, direct contacts were made with local experts, societies, neighboring Federal and State agency offices, and regional archives to identify any potentially significant resources that may not have been considered in the original evaluations.

The Staff effort next included contacts with the affected Tribes through a consultation process to aid in identifying potential places of cultural or religious

importance and any associated TCP survey that might be situated within the project APE for cultural resources. An important Tribal contribution was obtained in conjunction with a June 2011 field trip to the CBR facility associated with a Tribal consultation meeting at the Pine Ridge Reservation, South Dakota, wherein three Oglala Sioux attendees identified several potential places or natural resources that they felt either occurred on the CBR Facility or were within the viewscape of the ISR mining operations (Ex. NRC-050). Finally, the Staff's cultural resource expert, Paul Nickens, visited the CBR Facility in 2013 to gain an awareness of the project operations in relation to previously recorded cultural resource sites based on the Class III archeological survey and to assess the current status of certain cultural sites that were originally designated as being potentially eligible for listing in the National Register of Historic Places (NRHP) (Ex. NRC-051A; Ex. NRC-051B; Ex. NRC-051C). Under Administrative Condition 9.9 of NRC License No. SUA–1534, these potential historic properties were to be afforded protection during the term of the license, either through avoidance by project activities or by having physical protection involving fencing the perimeter of the site (Ex. NRC-012 at 6).

To further identify the presence of any potential places at the CBR ISR facility that may have traditional cultural or religious for the consulting Tribes, the Staff, along with the Applicant, offered open site access to the project area to any of the Tribes who wished to conduct their own field inventory for such resources. The open access offer extended to not only the current ISR facility area but three proposed expansion areas as well. Two of the consulting Tribes accepted the offer and conducted field inventories in the fall of 2012 (Ex. NRC-052). For the current CBR license renewal area, the Tribal experts did not identify any TCPs or places or natural resources of potential cultural or religious significance to their Tribes.

Q.1.14 Please describe the literature review that the Staff completed.

A.1.14 (N. Goodman, P. Nickens) The literature review completed to support the EA cultural resources analysis was thorough and exhaustive. It was designed to contribute to the potential identification of any additional cultural properties situated within or adjacent to the CBR APE, especially any such places or resources that could have possible cultural or religious significance for the consulting Tribes. A second objective was to review relevant literature to be able to construct historic contexts for the prehistoric, historic Euro-American, and historic Native American occupation and uses of the project area and its environs. Both of these efforts were intended to supplement and expand the regional information contained in the In-Situ Uranium Milling Generic Environmental Impact Statement (GEIS) (NUREG-1910).

The literature review was conducted in two phases: (1) identification of pertinent published and unpublished documents and other sources with specific relevance to the project area; and (2) onsite visits and interviews with local Federal and State government offices, societies, museums, archives, and knowledgeable persons. As part of the latter effort, queries were made at each venue about the potential existence of additional references/sources that might supplement the initial gathering of literature. The site visits and interviews completed to augment the document review are documented in Exhibits NRC-050 and NRC-051A, NRC-051B, and NRC-051C.

Q.1.15 **Section 3.9.4 of the EA states that "[t]he final source for previously known and recorded historic and cultural sites results from past field inventories of the project lands." What past field inventories does this refer to?**

A.1.15 (N. Goodman, P. Nickens) Archaeological and historic sites at the CBR facility were identified through intensive (100%) or Class III field inventories of the entire development area. Field inventories, covering a combined total of approximately 1,350 acres within the larger lease area, were conducted in two phases. In 1982, personnel from the University of Nebraska-Lincoln inventoried the proposed "research

and development area," and in 1987 staff archaeologists from the Nebraska State Historical Society completed a field inventory for the larger proposed development area, termed the "Commercial Size Area." The results of both field inventories were combined and reported in the document, "A Cultural Resources Study of the Crow Butte Uranium Prospect, Dawes County, Nebraska" (Ex. CBR-027; Ex. CBR-028). Having covered the entire CBR development area in a professional and thorough manner, the two field inventories, conducted in 1982 and 1987 and reported in 1987, are the only two comprehensive cultural resources inventories of the project area.

Q.1.16 What is a Class III archeological survey?

A.1.16 (N. Goodman, P. Nickens) A Class III cultural resources field inventory (also known as intensive or 100% coverage), as defined by the State Historical Society of North Dakota, is "a systematic, detailed field inspection done by, or under the direction of professional architectural historians, historians, archeologists, and/or other appropriate specialists." The Nebraska SHPO sets the following standards for a Class III Inventory:

- Surface inspection visibility will not be less than 10% for visual inspection methods. This visibility can be accommodated by dispersed patches of open surface and/or rodent/insect disturbance that provide adequate inspection opportunities. Surface visibilities below 10% will require implementation of a strategy to improve site discovery potential (e.g., shovel testing, stripping, vegetation clearing, etc.).
- Survey transects will be no farther apart than 100 feet (30 meters).
- Site evaluation for determination of National Register of Historic Places eligibility will be designed to minimize impact on the site. If test excavation is necessary and should it appear that testing would seriously impact a site (i.e., destroy it or

remove significant portions) consultation with the NE SHPO will be initiated prior to testing.

(Ex. NRC-049 at 6-7).

The 1982 and 1987 field inventories of the CBR project area involved Class III level coverage and are the only Class III inspections of the mine development area. (There was a 1985 field inventory of 21 proposed exploratory drill sites, but the small locales inspected at that time were subsumed in the 1987 field inventory coverage.) The CBR Class III field inventories complied in all respects with NE SHPO guidelines for archaeological field resource assessments.

Q.1.17 Why did the Staff rely on field inventories conducted in the 1980s? Is the age of the surveys problematic?

A.1.17 (N. Goodman, P. Nickens) The field inventories of the CBR ISR Facility development lands, conducted in 1982 and 1987 and reported on in 1987, were completed in accordance with all applicable laws, regulations, and guidelines extant at the time. Each of these laws remains in force today. In addition to the applicable authorities, the field surveys were conducted under provisions of the Secretary of Interior's Professional Qualifications and Standards and Standards for Archaeology and Historic Preservation (48 Fed. Reg. 22716 and 48 Fed. Reg. 44716-42, respectively). The identification and evaluation results from the 1980s field inventories were accepted and concurred with by the NE SHPO (Ex. NRC-041). That office considers the CBR field inventories, as reported in 1987, to be the most recent and credible cultural resources data for the area.

To assess the potential for changing land surface conditions—from either natural factors (e.g., erosion) or cultural causes (changing agricultural uses or mining operations)—to have created a more recent adverse effect on previously recorded cultural resources, Paul Nickens, the NRC-contracted cultural resources specialist,

completed a two-part analysis for the CBR LR EA. First, land use patterns for the time just prior to the initiation of the CBR uranium mining operations were compared to present conditions in the development area. Except for the overlaying of the mine units and ISR Facility operations, non-CBR land use characteristics remain the same. Second, he undertook a field visit in 2012 (Ex. NRC-051A; Ex. NRC-051B; Ex. NRC-051C) to evaluate current condition of those archaeological sites evaluated in 1987 as being "potentially eligible" for listing in the NRHP. All such properties were found to be in the same condition as when they were originally recorded, with the exception of archaeological site 25DW198. This potentially eligible site received additional subsurface testing in 2003 after its location was found to be in conflict with proposed mining operations (Ex. CBR-032).

In the Staff's professional judgment, the results from the 1982 and 1987 field inventories, as reported in 1987, are complete, thorough, and fully adequate for describing baseline conditions for the occurrence, distribution, and condition of archaeological and historical sites in the CBR LR EA. This evaluation is based on the finding that the original inventories were Class III in scope, providing intensive pedestrian coverage of the project area and were comprehensive in the identification, recording, evaluating, and reporting of the inventory results. Review of recent land use patterns, supplemented by a field visit to the CBR ISR project area in 2012, reveals that little or no physical change has occurred on the landscape since the Class III inventories were conducted, with the exception of ongoing CBR mining operations that have continuously avoided all known cultural site locations in accordance with Administrative Condition 9.9. The singular exception to this protective approach is the conflict between mining operations and archaeological site 25DW198, which received additional testing and final NRHP evaluation prior to any impacts occurring within the site boundary and was determined to be not eligible for listing in the NRHP.

Q.1.18 Please describe the TCP survey that the Santee Sioux and Crow Nations participated in. What areas did the survey cover? Were there any areas that the survey did not cover? If so, why?

A.1.18 (N. Goodman, P. Nickens) CBR ISR efforts near the operating facility also include three proposed expansion areas where mining operations are to move as production is completed the currently licensed mine units. If approved by the NRC, these proposed expansion areas—North Trend (NTEA), Three Crow (TCEA), and Marsland (MEA)—will be operated under amended NRC License No. SUA–1534, but each expansion area includes separate environmental and technical applications by CBR, and each application will be the subject of individual Staff environmental reviews.

To address Tribal concerns for field information to supplement the original Class III cultural resources inventories at the current license area (under review for renewal) and similar Class III inventories for the expansion areas (pending reviews), CBR opted to offer a period of open site access at each of the four areas to the consulting Tribes. The purpose of the open site access was so that Tribes, either individually or collectively, would have an opportunity to conduct their own pedestrian inventories of the CBR areas and identify any potential sites of cultural or religious significance for the Tribes located therein. Such sites/resources are commonly called “Traditional Cultural Properties” (TCPs).

Two of the consulting Tribes, the Crow Nation of Montana and the Santee Sioux Nation of Nebraska, accepted the Applicant’s offer. The Tribal crews, consisting of five persons from each Tribe, conducted field inventories (a “spiritual walk through,” in their terminology) of the CBR project areas between November 14 and December 1, 2012. During the Tribal inventories, a CBR representative, who had arranged access to privately owned lands within the proposed lease areas, and an NRC Staff person or contracted NRC cultural resources expert accompanied the field crews each day.

Inventory coverage varied between the four CBP project areas, based on the amount of previous land disturbance found within the individual project area. Decisions about which project lands received pedestrian inventory coverage was solely at the discretion of the Tribal experts. Completed coverage for each of the CBR project areas is summarized below. For those areas given pedestrian coverage, the Tribal field crews utilized 30-foot intervals between individual crewmembers, which is well within the NE SHPO specifications for a Class III cultural resources inventory (100-foot intervals).

With respect to the CBR license renewal area, the Crow Nation, accompanied by the CBR representative and NRC Staff person, inspected the current mining area to assess the need for pedestrian inventory. The Crow Nation crew determined that the current lease area was so disturbed by past agricultural and other historic land uses, including the ongoing mining operations, that there were essentially no areas that had not been disturbed by previous activities. They concluded that there was no need to inspect any acreage for the current license area by pedestrian inventory. This conclusion was presented to the Santee Sioux Nation field crew upon their arrival at the CBR project areas and they concurred with the Crow Nation's assessment. Consequently, no intensive Tribal field inventory was conducted at this project area.

The Marsland proposed expansion area lies about 11 miles south of the ISR facility and, although subjected to extensive past rangeland activities, it was found to be relatively undisturbed otherwise. The combined Crow and Santee Sioux field crews, accompanied by the CBR representative and either the NRC Staff person or the cultural resources expert on a daily basis, completed intensive (Class III) coverage of the entire MEA. This effort resulted in the location and identification of 12 potential places of Tribal significance.

Lands within the proposed NTEA were not available for access at the time of the Tribal fieldwork due to a landowner issue. A drive-through of the area was conducted along established roads to give the Tribal representatives a picture of the extant level of previous land disturbance. There was recognition that some portions of the NTEA had not been substantially altered and that some field inventory should be completed at a future time. The parties (NRC, CBR, and the two Tribes) agreed that a programmatic agreement would be effected to ensure both future access and the opportunity for Tribal crews to conduct inventories at a future date.

Following departure of the Crow Nation field crew, the Santee Sioux crew, accompanied by the CBR representative and the NRC-contracted cultural resources expert, evaluated the TCEA project area and determined that there were some areas with relatively little disturbance. These areas were covered by pedestrian Class III inventory. One locale of potential significance for the Tribes was located.

Following completion of the Tribal TCP field inventories, the Santee Sioux Nation Tribal Historic Preservation Office prepared a written report summarizing the Tribal efforts (Ex. NRC-052).

Q.1.19 Please describe the weather conditions during the TCP survey.

A.1.19 (N. Goodman, P. Nickens) Weather conditions for the first part of the Tribal inventory activities (November 14-21, 2012) were unseasonably warm, with no precipitation. Following the Thanksgiving holiday weekend, field inventory activities were scheduled to resume on Monday, November 26. During the night of November 25, the area received about four inches of snowfall. On the morning of November 26, the Tribal field crews, the CBR representative, and the NRC-contracted cultural resources expert met to assess to snow cover conditions. All parties agreed that the ground visibility was not amenable for conducting a pedestrian inventory; the snow cover was 100 percent in all CBR project areas. By late Thursday afternoon, November 29, the Tribal

experts and the NRC cultural resources expert decided that visibility of the ground surface had improved to a point where effective field inventory activity could resume. Tribal field inventories of the CBR project areas concluded on December 1, 2012. As shown in Exhibit NRC-053 (at 1-2), there was not significant snow or ice coverage on the above dates.

Q.1.20 How did the Staff follow up on the Santee Sioux Nation's report of the TCP survey?

A.1.20 (N. Goodman, P. Nickens) The Staff provided all consulting parties a copy of the unredacted TCP survey and allowed a comment period of 30 days. The Staff also provide an unredacted version of the NRC's field survey and provided the tribes an additional 30 days to comment on the presence of TCPs in the project area. The Staff also posted a redacted version of the TCP report and NRC field survey on the NRC website, along with the EA sections pertaining to cultural resources and letters both to and from the SHPO, allowing them an opportunity to comment on how Staff used the SSN report these documents for its findings and determinations. And Staff always accepted comments, both oral and written, at any time during the consultation process.

Q.1.21 The Intervenors cite a letter from Dr. Louis A. Redmond to support their assertions that the Staff's identification of cultural resources was deficient. What is your response to the claims in Dr. Redmond's letter?

A.1.21 (N. Goodman, P. Nickens) This document is a letter from Dr. Louis A. Redmond to David C. Frankel, Counsel for the Consolidated Interveners, dated 28 January, 2013. In the letter, Dr. Redmond states that he identified four potential problems in the data, based on his review of the cultural resources sections from the CBR Environmental Report (2012) for the proposed Marsland Expansion Area. First, he noted that based on his experience from working in the general area between 1992 and 1995, his observation was that archaeological sites could invariably be found in proximity to

water resources, ponds, creeks, and springs. Second, Dr. Redmond, noting that the MEA Class III cultural resources surveys were completed between November 2010 and February 2011, stated that there was, in all likelihood, widespread snow cover at that time, perhaps exceeding the percentage of surface visibility for adequate Class III field inventory. Third, based on his interpretation that buried cultural sites could be present in the MEA, he suggests that there should have been some type of subsurface testing strategy employed during the Applicant's Class III coverage. Finally, Dr. Redmond stated that in addition to the Sioux Tribes, several other Native American Tribes may have utilized the Nebraska Panhandle area in the past.

Taken as a whole, Dr. Redmond's opinion, based solely on reading cultural resources sections of the MEA Environmental Report, has little significance for the MEA project area and none for the License Renewal area. For the MEA, his reliance on a single source that only summarizes the results of Class III inventories leads to incorrect assumptions. For example, a review of the two Class III reports prepared for the MEA shows that the issue of ground visibility during the field inventories is clearly discussed, and numerous photographs taken throughout the course of the field investigations graphically depict an absence of snow cover (Ex. NRC-054A through NRC-054O; Ex. NRC-055). Further, Dr. Redmond's assertion that cultural sites "invariably" occur in proximity to water resources is overstated. While cultural sites do frequently appear near water resources, this is not the case for the MEA. Both the Applicant's cultural resources contractor and two Tribal field crews have intensively inventoried (Class III) the entire MEA project area. Not only has a single prehistoric site not been located by these crews, the intensive field inventories have failed to locate even a single prehistoric artifact (commonly termed "isolated finds") on the landscape. An absence of prehistoric aboriginal or historic Native American period

artifacts was verified during subsequent field assessments of the 12 sites of potential Tribal importance identified by Tribal field crews (Ex. NRC-056A through NRC-056E).

For the CBR License Renewal project area, Dr. Redmond's opinions concerning possible resource identification issues at the MEA tract, situated some 11 miles to the south, has no relevance. By his account given in the 2013 letter, he has not reviewed CBR's Environmental Report supporting the license renewal or the 1987 Class III cultural resources report for the CBR license renewal area and, as he infers, his comments apply only to the MEA.

Q.1.22 Was subsurface testing ever conducted in an attempt to identify cultural resources?

A.1.22 (N. Goodman, P. Nickens) Subsurface testing has not been employed to *identify* cultural resource sites at the CBR project area; no such need has ever been identified as being professionally useful or necessary. Limited subsurface testing procedures were conducted to support NHRP significance *evaluations* of cultural sites identified by the 1982 and 1987 CBR Class III field inventories, and one recorded archaeological site later received additional subsurface testing. During the two field inventories, five of the 21 newly identified prehistoric and historic archaeological sites were accorded some form of subsurface testing (Ex. CBR-027; Ex. CBR-028). Limited shovel tests and soil probes were conducted at one historic homestead site to aid in determining the potential for subsurface artifacts. At one prehistoric site, an erosion bank was profiled to evaluate the stratigraphic context for an exposed bone and associated charcoal. At three sites, all dated to the prehistoric period, controlled test pits (ranging from two to four in number) were excavated to evaluate the potential for the existence of subsurface cultural deposits.

One of the potentially eligible archaeological sites from the 1987 evaluation, site 25DW198, received additional evaluative field testing in 2003, when it was found to be

in an area of CBR well drilling activities (Ex. CBR-032). Before the fieldwork commenced, a site-testing plan was prepared and sent to the NE SHPO, who concurred with the approach. Site 25DW198 was again subjected to an intensive inventory of the previously mapped site surface and the adjacent areas, followed by excavation of four subsurface test units. Based on the findings of this field effort, a recommendation was made that the site lacked the potential to yield information important to the region's prehistory and that it was not eligible for listing in the NRHP. The NE SHPO concurred with this recommendation, and the archaeological site was removed from the CBR project list of potentially eligible archaeological sites.

Q.1.23 What cultural resources did the Staff identify from the sources available?

A.1.23 (N. Goodman, P. Nickens) As a result of the previous Class III field inventories, a total of 21 prehistoric and historic period archaeological sites were identified within the CBR license development area (Ex. NRC-010 at 52-53). Cultural affiliation of the recorded sites included eight with Native American components, 12 historic period locations, and a buried bone deposit of undetermined cultural association. Of these, 15 of the recorded sites, including five Native American, nine historic period, and one with undetermined affiliation, contained limited scientifically important cultural remains or were not determined to be of significant historic value based on archival research. These sites were evaluated as being not eligible for nomination and potential listing on the NRHP. Six sites, including three Native American and three historic period Euro-American locales, were evaluated as being potentially eligible for the NRHP. One of the sites originally evaluated as being potentially eligible was subsequently re-evaluated and found to be not eligible.

The 2012 TCP Survey conducted by the Crow and the Santee Sioux Nations did not cover any acreage within the current lease area. This was based on an assessment by the Tribal field crews that there was very little undisturbed land within

the project area where potential places of traditional cultural or religious significance could be located. Although both Tribes had previously been provided unredacted copies of the 1987 CBR Class III archaeological and historical inventory report, they did not express interest in visiting prehistoric Native American archaeological sites that had been identified earlier in the CBR ISR development area.

Review of relevant literature revealed that no NRHP-listed properties, National Historic Landmarks, or marked Nebraska Historical landmarks exist within the boundary of the CBR lease area. Although properties within each of these categories are present in the general vicinity of the CBR lease area, none of these would be adversely affected by CBR ISR operations. For potential TCPs, two earlier limited reviews for the CBR project area did not reveal the existence of known or potential specific TCPs within or close to the CBR project area (Ex. CBR-029; Ex. NRC-057). The Staff describes potential places of cultural importance for Tribes in Section 3.9.8 of the EA (Ex. NRC-010 at 56-57).

Q.1.24 How did the Staff determine whether the license renewal project would significantly impact cultural resources?

A.1.24 (N. Goodman, P. Nickens) Following relevant requirements found in the National Environmental Policy Act (NEPA), NHPA, and guidance contained in NUREG-1748 (Ex. NRC-014), analysis of the potential for adverse effects for known cultural resources to arise because of renewing NRC License No. SUA–1534 required addressing several questions. First, what are the previously recorded cultural resources sites that occur within the license renewal area, and, further, are there any additional cultural resources, including any of importance to the consulting Tribes, which potentially could occur in the APE? Second, is the extent and quality of the cultural resources data, including that from literature reviews and associated site visits/interviews, cultural resources field inventories, and from the consulting Tribes

adequate to allow an adequate evaluation of potential impacts to historic properties? Finally, given the operational status of the CBR ISR project, would there be any potential adverse impacts to known or potential cultural resources within the CBR license renewal APE?

Staff technical analysis concluded that based on information obtained through the NHPA Section 106 consultation process, the TCP cultural report submitted by the Tribes, the previous Class III archeological inventories, and independent Staff literature reviews, overall impacts to historic and cultural resources from the relicensing of the CBR facility would not be detectable or would be so minor that they will neither destabilize nor noticeably alter any important attribute of the identified cultural resources.

As outlined in Section 4.8 of the EA (Ex. NRC-010 at 86-88), construction of project infrastructure (facilities and roads) was undertaken early in the initial license period. Ongoing construction during the operational phase involves construction of injection and production wells, including well houses and piping systems for delivery to the production facility. Throughout the operation phase of the project, CBR has practiced avoidance of all recorded cultural resources, an approach that would continue in the license renewal period. The practice of avoiding potential impacts for the six “potentially eligible” cultural resource sites would continue for the aquifer restoration and plant decommissioning phases of the project. Activities associated with restoration of the ground water in mine units occur at existing wells within established well fields and would result in little or no potential impacts to known cultural resource sites. While general earth-disturbing activities would be associated with decommissioning of the well fields and other facilities, the known cultural resource sites would be avoided during those activities.

Culturally important medicinal herbs may be found in the CBR facility. To evaluate this likelihood, the Staff compared the CBR ISR project area plant species list with a list of plants known to be used as medicinal herbs in contemporary times by the Oglala Sioux, resulting in a list of nine plant species used today by the Oglala (Ex. NRC-010 at 87-88). Although some of the plants identified in the analysis may grow today at the CBR project area, each of these plant species are also known to be found over a wide range across the Northern Plains. Therefore, these resources would not be significantly impacted by the license renewal project.

Q.1.25 How do the Staff's identification efforts in the CBR license renewal review compare to other ISR project reviews?

A.1.25 (N. Goodman, P. Nickens) To evaluate the Staff's cultural resources identification efforts for the CBR license renewal EA cultural resources technical analysis, including the overall NHPA Section 106 consultation process and affected Tribes consultation effort, it was compared to similar recent ISR environmental reviews from the nearby region. The comparative examination was performed in accordance with environmental review guidance contained in NUREG-1748. The similar recent ISR environmental reviews include the Dewey-Burdock ISR Project in South Dakota, and the Ross, Nichols Ranch, Lost Creek, and Moore Ranch ISR Projects, all located in Wyoming. As proposed new projects, each of these projects involved EIS-level reviews, issued as Supplements 1-5 to the ISR GEIS (NUREG-1910).

Even though it was completed as an EA-level analysis for renewal of an existing NRC ISR license, the Staff cultural resources review for the CBR LR EA meets or exceeds the scope for similar reviews at other regional ISR projects in all respects. Review elements compared include the type and intensity of cultural resources identification and evaluation methods, NRHP Section 106 consultation process, Tribal

consultation procedures, and assessing potential adverse effects from the proposed action on historic properties.

CONTENTION 6

Q.6.1 **In Contention 6, the intervenors argue that the EA violates NEPA in concluding that the short-term impacts from consumptive ground water use during aquifer restoration are MODERATE. Where in the EA does the Staff consider impacts from consumptive ground water use during aquifer restoration?**

A.6.1 (D. Back, T. Lancaster, E. Striz) The Staff described the aquifer restoration process in Section 2.3.1 of the EA (Ex. NRC-010 at 10) and analyzed impacts to ground water quantity from aquifer restoration activities in Section 4.6.2.3 of the EA (Ex. NRC-010 at 81-83). Because potential impacts to ground water quantity during aquifer restoration are similar to those during operations, except for increased ground water consumption during restoration, the Staff's analysis incorporates the discussion in Section 4.6.2.2 of the EA as well (Ex. NRC-010 at 74-81).

Q.6.2 **What information did the Staff review in determining the impacts to ground water quantity from restoration?**

A.6.2 (D. Back, T. Lancaster, E. Striz) The Staff relied primarily on the information presented in the LRA and semi-annual effluent monitoring reports. The most relevant sections in the LRA are Section 2.2.4, which describes water use in the general area (Ex. CBR-011 at 2-23 to 2-29); Sections 2.6 and 2.7, which describe area geology and hydrology, respectively (Ex. CBR-011 at 2-97 to 2-226); and Section 7.12.1.3, which presents drawdown versus distance calculations for variable pumping rates (Ex. CBR-011 at 7-36 to 7-46). Additionally, the Staff's determinations in the EA were informed by the Staff's previous analysis in Sections 3.1.3.5.2, 3.1.3.5.4, 3.1.3.5.6, and 6.1.3.3 of the SER (Ex. NRC-009 at 40, 41-43, 138-39). The Staff also used the conclusions

already drawn in NUREG-1910, the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, as a starting point for its evaluation.

Q.6.3 Please explain the difference between a SMALL, MODERATE, and LARGE environmental impact.

A.6.3 (D. Back, T. Lancaster, E. Striz) The Staff used the definitions of SMALL, MODERATE, and LARGE environmental impacts outlined in NUREG-1748 (Ex. NRC-048 at 4-14). As defined in NUREG-1748, SMALL impacts "are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource." MODERATE impacts "are sufficient to alter noticeably, but not to destabilize important attributes of the resource." LARGE impacts "are clearly noticeable and are sufficient to destabilize important attributes of the resource."

Q.6.4 What information did NUREG-1910 contribute to the Staff's analysis of impacts to ground water quantity from aquifer restoration?

A.6.4 (D. Back, T. Lancaster, E. Striz) NUREG-1910 analyzed impacts to ground water associated with consumptive use during restoration on a generic basis, concluding that such impacts are expected to be SMALL to MODERATE:

> Potential impacts would be from consumptive use and potential deep disposal of brine slurries after reverse osmosis, if applicable. The volume of water removed from the aquifer and related impacts would be dependent on site-specific conditions and the type of water treatment technology the facility uses. In some cases, groundwater consumptive use for the aquifer restoration has been reported to be less than groundwater use during the ISL operation, and drawdowns due to aquifer restorations have been smaller than drawdown caused by ISL operations. Potential environmental impacts associated with water consumption during aquifer restorations are determined by (1) the restoration techniques chosen, (2) the volume of water to be used, (3) the severity and extent of the contamination, and (4) the current and future use of the production and surrounding aquifers near the ISL facility or at the regional scale—SMALL to MODERATE, depending on site-specific conditions.

(Ex. NRC-045 at xliv-xlv). As discussed above in A.6.2, the Staff used this analysis as a starting point for its analysis of the site-specific impacts from CBR's restoration activities.

Q.6.5 Please describe the steps involved in CBR's restoration of a mine unit.

A.6.5 (D. Back, T. Lancaster, E. Striz) A description of the aquifer restoration process is provided in Section 2.3.1 of the EA (Ex. NRC-010 at 10) and Section 6.1.3.3 of the SER (Ex. NRC-009 at 138-39). The current ground water restoration plan for the CBR facility mine units consists of four activities: ground water transfer; ground water sweep; ground water treatment; and ground water circulation. The degree to which each phase is incorporated into the restoration process for a particular mine unit is determined by CBR.

The first phase, ground water transfer, consists of the exchange of ground water between a new mine unit and that of a mine unit at the end of production. The second phase, ground water sweep, consists of pumping ground water from the mine unit without any corresponding injection back into the mine unit under restoration. This causes an influx of baseline quality water to sweep the affected extraction area. The applicant stated in Section 6.1.4.2 of the LRA (Ex. CBR-011 at 6-21 to 6-29) that the duration of the sweep phase depends upon the presence of mine units along the mine unit perimeter, capacity of the wastewater disposal system, and success of the transfer phase to lower the total dissolved solids concentration. The extracted water is sent to the wastewater disposal system during this activity. The third phase is the ground water treatment phase, which consists of pumping ground water from a mine unit, treating the ground water to remove the constituents mobilized during the production, and injecting some or all of the treated water back to the mine unit. Treatment consists of ion exchange (IX), reverse osmosis (RO) or Electro Dialysis Reversal (EDR). A reductant may be added during the treatment phase. The last phase the

applicant may employ is ground water circulation, which involves recirculating water pumped from the aquifer back into the aquifer to homogenize the ground water quality.

Q.6.6 Is there a limit on how many mine units CBR is permitted to restore simultaneously?

A.6.6 (D. Back, T. Lancaster, E. Striz) Yes. As described in Section 6.1.3.5 of the SER (Ex. NRC-009 at 140), 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. This restriction limits the total consumptive use of ground water from restoration activities at any given time.

Q.6.7 What were the steps of the Staff's analysis of the likely short-term impacts to ground water quantity from aquifer restoration at CBR?

A.6.7 (D. Back, T. Lancaster, E. Striz) The Staff followed three steps in assessing the potential short-term impacts from ground water restoration: (1) performing a water balance analysis, (2) conducting a drawdown analysis, and (3) integrating the Staff's water balance and drawdown analyses with CBR's potential environmental impact analysis.

Q.6.8 Please explain the water balance analysis conducted by the Staff.

A.6.8 (D. Back, T. Lancaster, E. Striz) As described in Section 4.6.2.3 of the EA (Ex. NRC-010 at 83), the NRC performed a water balance analysis of the CBR facility. This analysis is presented in Section 3.1.3.5.4 of the SER (Ex. NRC-009 at 41). The results indicate that between 2002 and 2010, the arithmetic mean of the consumptive water use (i.e., water discharged to deep disposal well and ponds) was about 105 gallons per minute (gpm). As noted, however, in the SER (Ex. NRC-009 at 42), these rates were expected to increase. Section 6.1.4.2 of the LRA (Ex. CBR-011 at 6-21 to 6-29) indicates that there were nine pore volumes used to restore Mine Unit 1 and that for the remainder, Mine Units 2-11, 11 pore volumes will be used. As discussed in

Section 4.6.2.3 of the EA (Ex. NRC-010 at 83), however, given the historical flow rates, it is anticipated that CBR may need to extract more than 11 pore volumes for each remaining mine unit. Ground water restoration is occurring at Mine Units 2 through 6, and submission of the restoration reports for approval for restoration of Mine Units 2 and 3 is projected for 2015, of Mine Unit 4 for 2019, of Mine Unit 5 for 2022, and of Mine Unit 6 for 2021.

NRC staff concluded from the water balance analysis that long term consumptive use would be higher than the historical average of about 105 gpm. This understanding was used in conjunction with the drawdown analysis discussed below in A.6.9 to estimate drawdowns at higher consumptive use rates.

Q.6.9 Please explain the drawdown analysis conducted by the Staff.

A.6.9 (D. Back, T. Lancaster, E. Striz) A key component of the Staff's evaluation of potential short-term impacts caused by ground water restoration was an assessment of historical impacts. To accomplish this goal, the NRC Staff compared pre-operational and 2009 potentiometric surfaces of the Basal Chadron Sandstone aquifer in Section 3.1.3.5.6 of the SER to determine the impact caused by the mining activities (Ex. NRC-009 at 43). The Staff estimated that after many years of production, drawdown (i.e., decrease in aquifer pressure) within the Basal Chadron Sandstone aquifer in the mine units is approximately 47 feet. This is supported by the water level and potentiometric surface maps included with CBR's response to a 2009 request for additional information (RAI) (Ex. NRC-058). Since the reported original Basal Chadron Sandstone aquifer potentiometric surface was approximately 300 to 500 feet above the ore zone, NRC staff concluded that the consumptive use of ground water resulted in about 47 feet of drawdown, which represents approximately 10% of the available height of water above the top of the Basal Chadron Sandstone (Ex. NRC-009 at 43).

The Basal Chadron Sandstone aquifer is a confined aquifer, and a reasonable assumption is that the drawdown and pumping rates have a linear relationship at steady state. Therefore, if a historical average consumptive use rate of 105 gpm resulted in 47 feet of drawdown, then a consumptive use rate of 210 gpm should approximately result in about 94 feet of drawdown, or 20% of the available height of water above the Basal Chadron Sandstone, though the Staff recognizes that there will necessarily be deviations between the predicted and actual values. Based on the consumptive use rate and drawdown estimates (i.e., 105 gpm per 47 feet), it would take a consumptive use rate of about 900 gpm for the potentiometric surface to decrease 400 feet to the top of the Basal Chadron Sandstone. The NRC Staff does not consider this consumptive use rate realistic, and thus concluded that the Basal Chadron Sandstone aquifer will remain saturated.

Q.6.10 How did the Staff integrate its water balance and drawdown analyses with CBR's potential impact analysis presented in the LRA?

A.6.10 (D. Back, T. Lancaster, E. Striz) In Section 7.12.1.3 of the LRA (Ex. CBR-011 at 7-36 to 7-46), in 1983, CBR used a ground water flow model from the initial license application to predict potential impacts on the potentiometric surface in Basal Chadron Sandstone aquifer water wells outside of the CBR license area (Ex. NRC-059 at 2-10). In the model, CBR assumed a consumptive use rate of 105 gpm from years 11 through 20. The well nearest to the license area that is screened in the Basal Chadron aquifer is located approximately 0.5 miles from the license area boundary. For this well, CBR predicted that the potentiometric surface would decrease approximately 27 feet. Based on the actual long-term average (2002-2010) consumptive water use of about 105 gpm and an average drawdown of 47 feet over the license area, the NRC Staff considered the modeled drawdown estimate of 27 feet at a well located 0.5 miles from the license area boundary to be reasonable. In Table 7.12-2 of the LRA (Ex.

CBR-011 at 7-43), CBR presents well depths, static water levels and predicted drawdowns at the other private wells in the vicinity of the license area and screened in the Basal Chadron Sandstone aquifer. From that information, CBR also calculates the percent to which the available water level would be reduced due to consumptive water use. The highest reduction is 16.7%, and the average for all of the wells is 9%.

In 2009, the NRC Staff sent an RAI to CBR with a request to recalculate the drawdowns with current operational data to assess any changes (Ex. NRC-059 at 11-12). As shown in Table 2A of CBR's response (Ex. NRC-059 at 13), CBR recalculated drawdowns based on actual consumptive water use rates of approximately 210 gpm, which is twice that assumed in their 1983 analysis. Under the same steady state assumption, the drawdowns would be expected to double. In most of the wells, however, actual drawdowns were somewhat less than would be predicted based on the actual consumptive use rates. This analysis demonstrates that far larger consumptive use rates would likely be needed before the average reduction of available drawdown would reach even 50%. Furthermore, although such rates would result in noticeable environmental effects, they would not destabilize the resource; therefore, even assuming such large consumptive use rates, the impacts are appropriately defined as MODERATE.

Q.6.11 Did the Staff consider other factors that could affect its conclusion that short-term impacts to water quantity from aquifer restoration activities are likely to be MODERATE?

A.6.11 (D. Back, T. Lancaster, E. Striz) Other considerations included the potential impact of consumptive water use on the potentiometric surface of the Brule aquifer and potential cumulative impacts from other nearby ISR operations. As explained in A.D.3, the overlying Brule aquifer is not hydraulically connected and consumptive use of water

from the Basal Chadron Sandstone aquifer has had and continues to have very little if any impact on the Brule aquifer.

With respect to potential cumulative impacts, Section 4.13.6.2 of the EA (Ex. NRC-010 at 115) describes how limitations on mining activities are designed to minimize localized impacts during all phases of the uranium recovery lifecycle. As discussed in A.6.6, the Class III UIC permit for the CBR facility stipulates that no more than 5 mine units are allowed at any one time in the extraction stage; no more than 5 mine units are allowed at any one time in the restoration stage; and no more than three mine units are allowed at any one time in the development stage in advance of active extraction. The NRC staff expects that UIC permits for the proposed expansion areas will contain similar limitations. Although the permits constrain water usage, the CBR facility and proposed expansion areas would be close enough that there may be overlapping cones of depression within the Basal Chadron Sandstone aquifer. Overlapping cones are additive; therefore, for every foot of drawdown caused by operations both at the current facility and another ISR facility, the drawdown would increase by 2 feet at the point of intersection. As discussed above, however, due to the separation distances, consumptive water use at both locations would have to be many hundreds of gallons of water per minute before the water resource would be destabilized. Based on these assumptions and complementary analysis, the NRC staff concluded that although the effects of consumptive water use would be noticeable, they would be insufficient to destabilize important attributes of the resource. Therefore, expected short-term cumulative impacts to ground water quantity from aquifer restoration activities are appropriately categorized as MODERATE.

CONTENTION 9

Q.9.1 In Contention 9, as admitted by the Board, the intervenors argue that the EA's discussion of mitigating the impacts to ground water quality and quantity from

restoration activities is inadequate. Where in the EA does the Staff discuss impacts to ground water from restoration activities?

A.9.1 (D. Back, T. Lancaster, E. Striz) The Staff described the aquifer restoration process in Section 2.3.1 of the EA (Ex. NRC-010 at 10) and analyzed impacts to ground water quantity and quality from aquifer restoration activities in Section 4.6.2.3 of the EA (Ex. NRC-010 at 81-83). Because potential impacts to ground water quantity during aquifer restoration are similar to those during operations, except for increased ground water consumption during restoration, the Staff's analysis incorporates the discussion in Section 4.6.2.2 of the EA as well (Ex. NRC-010 at 74-81).

Q.9.2 What did the Staff determine to be the likely impacts to ground water quantity and quality from restoration activities?

A.9.2 (D. Back, T. Lancaster, E. Striz) Considering both the expected consumptive use rates needed for restoration of the remaining mine units at CBR and the fact that water levels in the Basal Chadron Sandstone aquifer will recover over time after restoration is complete, the Staff concluded in Section 4.6.2.3 of the EA (Ex. NRC-010 at 83) that impacts to ground water quantity from restoration activities may be MODERATE in the short-term but will be SMALL overall. The Staff also concluded in Section 4.6.2.3 of the EA (Ex. NRC-010 at 82) that adverse impacts to ground water quality in shallow and production aquifers, as well as surrounding aquifers, are likely to be negligible during restoration.

Q.9.3 If a finding of no significant impact depends on the implementation of a mitigation measure, then the EA must discuss the effectiveness of that mitigation. Does the Staff's conclusion regarding impacts to ground water quantity—that such impacts may be MODERATE in the short term and will be SMALL overall—depend on mitigation measures?

A.9.3 (D. Back, T. Lancaster, E. Striz) No, the Staff's finding does not assume the implementation of any mitigation measures.

Q.9.4 What is the basis for the Staff's conclusion that water levels in the Basal Chadron Sandstone aquifer will eventually recover following restoration activities?

A.9.4 (D. Back, T. Lancaster, E. Striz) After restoration is complete in all mine units and approved by the NRC, all ground water extraction and injection will be discontinued and the potentiometric surface in the Basal Chadron Sandstone aquifer will slowly recover. The recovery of the aquifer water levels in private wells was estimated by CBR from the drawdowns realized using consumptive use ground water rates ranging from 56-105 gpm (Ex. CBR-011 at 7-38). These recovery estimates were conservative, as no recharge to the Basal Chadron Sandstone aquifer was assumed to take place. As shown in Figures 7.12-2 through 7.12-5 in the LRA (Ex. CBR-011 at 7-43 to 7-46), the water levels will recover to within 10 feet of the pre-operational values within 5 years after all extraction and injection has stopped. A drawdown of 10 feet represents approximately 2% of the pre-operational water level in the Basal Chadron Sandstone aquifer. Therefore, the long term impact from ground water consumptive use is considered small.

Since this analysis was submitted, the applicant has stated the consumptive use of ground water will be increased to accomplish restoration. The NRC staff estimates the value could be around 210 gpm based on the consumptive use rates provided by CBR and shown in Table 3.1-2 of the SER (Ex. NRC-009 at 42) and a CBR RAI submittal (Ex. NRC-059 at 11-13). This consumptive rate will incur a theoretical drawdown roughly twice that estimated by CBR in Figures 7.12-2 through 7.12-5 of the LRA (Ex. CBR-011 at 7-43 to 7-46). Since the drawdown is greater, the water level recovery will take longer to approach pre-operational levels; however, because

recovery would still occur, the overall long term impact from ground water consumptive use would still be SMALL.

Q.9.5 Is the natural recovery of an aquifer over time a "mitigation measure"?

A.9.5 (D. Back, T. Lancaster, E. Striz) No, the NRC Staff does not consider natural processes such as aquifer water-level recovery to be mitigation. The Staff's understanding is consistent with NUREG-1748 (Ex. NRC-014 at 3-13) and CEQ guidance (Ex. NRC-060 at 4-5), which describe mitigation as measures that are actively implemented to avoid adverse environmental effects. While natural beneficial processes are considered when assessing potential impacts of a specific action, particularly in the long term, they are not mitigation measures.

Q.9.6 Does the Staff's conclusion that impacts to ground water quality during restoration will be negligible depend on mitigation measures?

A.9.6 (D. Back, T. Lancaster, E. Striz) Yes, mitigation measures are employed during restoration activities to reduce impacts to ground water quality in surrounding aquifers, and the Staff discusses those measures in the EA. As described in Section 4.6.2.3 of the EA (Ex. NRC-010 at 81-83), these measures include extensive and frequent ground water monitoring of excursion monitoring wells located in aquifers above and surrounding the mine units, as well as leak detection systems for ponds to detect any release of contamination to ground water. In addition, spill and leak detection programs are in place to detect any releases to the surface or subsurface from infrastructure such as piping. If an excursion, spill, or leak is detected, CBR is required to take corrective action to prevent and remediate contamination. In addition, all liquid waste and liquid waste disposal operations are conducted and monitored to be protective of ground water quality as described in Section 4.6.2.2 of the EA (Ex. NRC-010 at 74-81) and in Section 4.2.3.1 of the SER (Ex. NRC-009 at 58-63). These

mitigation measures ensure that there is a negligible impact to ground water quality in aquifers surrounding the mine units during restoration activities.

No mitigation measures are required once restoration to the ground water protection standards in 10 C.F.R. Part 40 Appendix A, Criterion 5B(5) is completed and approved for every mine unit at the CBR facility. As required in LC 10.6 (Ex. NRC-012 at 8), CBR must restore ground water in every mine unit to the ground water protection standards explicitly stated in 10 C.F.R. Part 40, Appendix A, Criterion 5B(5). In addition, LC 10.6 also requires CBR to demonstrate not only that the ground water protection standards in 5B(5) are met, but also that the ground water quality in each restored mine unit shows no statistically significant increasing trend for all constituents of concern for the most recent four consecutive quarters which would lead to an exceedance of these standards. As the Commission has established that the ground water protection standards in 5B(5) are protective, no further mitigation is necessary after restoration to protect ground water quality in surrounding aquifers.

Q.9.7 Does the NRC rely on Nebraska state standards or permits when approving mine unit restorations at CBR?

A.9.7 (D. Back, T. Lancaster, E. Striz) No, the NRC does not rely on Nebraska state standards or permits when approving mine unit restorations at CBR. NRC has and continues to conduct its own independent review and approval of all mine unit restoration submittals for all NRC licensees.

Under License Condition 10.6 (Ex. NRC-012 at 8), CBR is required to meet the ground water protection standards in 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, Alternative Concentration Limits (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 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.

In the past, 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 6-8 to 6-10) 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). Therefore, the NRC no longer applies a "class of use" standard as a secondary restoration goal.

Q.9.8 In its ruling admitting Contention 9, the Board stated that "[a]n NPDES permit may form the basis of a mitigation strategy, but again, this strategy must

actually be discussed." Did the Staff's analysis of the impacts to ground water quality or quantity from restoration activities rely on an NPDES permit?

A.9.8 (D. Back, T. Lancaster, E. Striz) No, an NPDES permit does not form the basis of a mitigation strategy for ground water quality or quantity impacts. The NPDES permit governs surface water and discharge to soil limits, but is not relevant to the Staff's conclusions regarding impacts to ground water quality or quantity.

It is true that an option for disposing of pond water during the later stages of ground water restoration is to treat the water until NPDES discharge limits are met and then discharge to surface water (Ex. NRC-010 at 12). However, to date, CBR has not exercised this option, and CBR has no plans to treat and discharge water under an NPDES permit.

CONTENTION 12

Impacts Related to Tornadoes

Q.12.1 In Contention 12, as admitted and narrowed by the Board, the CI and the OST argue that the EA omits a discussion of the impacts of tornadoes on the license renewal area. Are you familiar with this argument raised in Contention 12?

A.12.1 (N. Goodman) Yes. I have reviewed the CI's and OST's petitions, their statements regarding this contention in the oral argument held on February 17, 2015, and the Board's order admitting Contention 12 in part, and I am familiar with the intervenors' argument. Because no additional facts or expert opinion was submitted to support this aspect of Contention 12, my initial direct testimony is based upon my understanding of the intervenors' argument as presented in these sources.

Q.12.2 In admitting Contention A, the Board referred to discussions in the EA regarding wind events. Where in the EA does the Staff address wind in relation to the license renewal of the Crow Butte facility?

A.12.2 (N. Goodman) The Staff discusses wind characteristics at the Crow Butte site in Section 3.3.4 of the EA (Ex. NRC-010 at 23). In addition, the Staff describes the potential impacts of wind on soil and air quality in Sections 4.3.2 and 4.4 of the EA. The EA concludes that the potential impacts of wind on these resources would be SMALL (Ex. NRC-010 at 65, 68).

In Section 4.3.2, the EA states that soil erosion due to wind at the Crow Butte facility has the potential for adverse impacts, but notes that the potential effects are greatest at the construction stage, which has already been completed for this facility (Ex. NRC-010 at 65). The EA describes the methods by which Crow Butte will seek to mitigate the potential impacts on soil resources from wind, including continuing to monitor wind erosion and minimizing the clearing of land, road grading, and removal of vegetation at the site (Ex. NRC-010 at 65). In Section 4.4, the EA states that impacts on air quality could result from existing fugitive dust caused by wind erosion, but notes that the application of water to unpaved roads reduces the amount of fugitive dust to levels equal to or less than the existing condition (Ex. NRC-010 at 66). Finally, in Section 2.3.2, discussing land reclamation in the context of site restoration, reclamation, and decommissioning, the EA discusses the measures that will be used to limit surface erosion by wind, among other factors (Ex. NRC-010 at 10-11).

While these sections of the EA discuss the site characteristics and potential environmental effects related to wind, they do not include a discussion of wind effects related to tornadoes. This is because wind is a more pervasive meteorological feature at the Crow Butte site, and is commensurately more likely to present an identifiable environmental impact at the site than wind associated with a tornado. Furthermore, wind and tornadoes are different in nature. The difference is such that CBR engages in mitigative practices, such as the application of water to unpaved roads, to address the impacts of wind at the site (Ex. NRC-010 at 10-11, 66). There are no such

mitigative practices used to address the potential environmental impacts of tornadoes. Indeed, the NRC has generically considered the potential consequences of tornadoes at ISR facilities and determined that no changes to an ISR facility or operations would be required to mitigate these consequences (Ex. NRC-017 at 4-55 to 4-66).

Q.12.3 Does the Staff discuss the potential environmental impacts related to tornadoes elsewhere in the EA?

A.12.3 (N. Goodman) The EA does not contain a specific discussion of the potential environmental impacts of tornadoes. However, the Staff disagrees with the implication that its environmental review is defective because the EA fails to specifically discuss the potential environmental impacts that may result from a tornado at the site. The Staff did not, and does not now, believe that the potential environmental impacts from the possibility of a tornado in the area of the Crow Butte facility necessitates, for the first time for this facility, a specific discussion of tornadoes in the EA.

Q.12.4 Why does the Staff believe that the EA sufficiently assesses the potential environmental impacts of license renewal without a specific assessment of the impacts of tornadoes?

A.12.4 (N. Goodman) The addition of a discussion relating to tornadoes would not affect the Staff's conclusions in the EA regarding the potential environmental effects resulting from issuance of a renewed license. NUREG-1748, which guides the Staff's environmental assessment of the renewal application, states that it may not be necessary for the evaluation of potential environmental impacts to require a discussion of severe weather phenomena such as tornadoes (Ex. NRC-014 at 6-12). Furthermore, the GEIS assessed meteorological conditions and potential environmental impacts for the area encompassing the Crow Butte site and, having considered public comments regarding tornadoes when the draft GEIS was issued for comment, chose not include a discussion of the impacts of tornadoes in the final GEIS

(Ex. NRC-045 at G-215). While the GEIS notes that a discussion of tornadoes may be warranted on a site-specific basis, the Staff did not find that the inclusion of such a discussion was necessary in the EA. The information that the Staff examined regarding tornadoes in the area of the Crow Butte facility indicated that tornadoes are a very low probability event. Specifically, in the SER, the Staff notes that CBR identified the probability of a tornado in the region near the Crow Butte facility is approximately 4.8×10^{-4} per year (Ex. NRC-009 at 158). The LRA states that tornadoes are rare in the licensed area (Ex. CBR-011 at 2-92). This information did not indicate that a site-specific assessment of tornadoes was warranted in this EA. Simply put, the intervenors have not provided any information to suggest that a site-specific discussion of tornadoes was required to adequately assess the potential environmental impacts of the renewal of CBR's license for the Crow Butte project.

Impacts Related to Land Application of Treated Process Wastewater

Q.12.5 In Contention 12, the CI and OST also argue that the EA inadequately discusses the potential impacts from land application of ISR mining wastewater. A significant element of this contention is the intervenors' argument that the EA's discussion of wastewater contaminants does not include any discussion of the potential environmental effects of selenium contamination, particularly on wildlife. Are you familiar with these arguments?

A.12.5 (N. Goodman) Yes. I have reviewed the CI's and OST's petitions, their statements regarding this contention in the oral argument held on February 17, 2015, and the Board's order admitting Contention 12 in part, and I am familiar with the intervenors' argument. I have also reviewed a letter from the U.S. Fish and Wildlife Service (FWS) (Ex. INT-018) and a FWS report (Ex. INT-019) attached as exhibits to the CI's petition.

Q.12.6 Did the Staff determine that a discussion of land application of ISR wastewater is not warranted in the EA?

A.12.6 (N. Goodman) The Staff did not determine that a discussion of land application of treated wastewater is not warranted, as land application is discussed in several places in the EA. Section 2.2.2 of the EA describes the three permitted wastewater disposal options available to the Crow Butte facility: evaporation in solar evaporation ponds, deep well injection, and land application (Ex. NRC-010 at 9). In Section 2.4.1, the EA describes disposal options for ISR wastewater from evaporation ponds after restoration, including evaporation. The EA states that evaporation of water may be enhanced through the use of sprinkler systems for land application. The EA then explains that Crow Butte is not allowed to use land application after wet weather events under the terms of its current National Pollutant Discharge Elimination System (NPDES) permit from the NDEQ (Ex. NRC-010 at 12). Finally, the EA notes that Crow Butte has stated that it has no current plans for treating and discharging the pond water under an NPDES permit and that Crow Butte will be required to apply for additional permits from the State of Nebraska for any land application activity associated with the disposal of evaporation pond wastewater that is not included in Crow Butte's NPDES permit (Ex. NRC-010 at 12-13).

The EA next discusses the potential environmental impacts of aquifer restoration on surface water, including from the land application of wastewater. In Section 4.6.1.3, the EA describes the licensee's process for disposing of ISR process wastewater, which begins with treating the wastewater using a reverse osmosis (OS) unit to reduce the total dissolved solids and other constituents in the ground water, which produces water with reduced constituents (permeate) and brine. The EA explains that Crow Butte currently disposes of the treated wastewater (permeate) and brine by injection of the wastes into the two waste disposal ponds and then into two NDEQ-permitted non-hazardous on-site deep disposal wells. The EA then explains that, in accordance with a license amendment issued by the NRC in 1993 and its NPDES permit, Crow Butte is

also permitted to use land application to dispose of the treated wastewater. The EA states that the licensee has not used the option and has not indicated that it will in the future (Ex. NRC-010 at 72-73). The EA concludes that the potential impacts to surface water resources during the restoration phase of the Crow Butte project would be SMALL (Ex. NRC-010 at 73). The EA also concludes that the overall potential impacts to wildlife from relicensing of the Crow Butte project would be SMALL (Ex. NRC-010 at 94-98).

Q.12.7 Why did the Staff not include a specific discussion of the impacts related to selenium that may be present in wastewater disposed of by land application?

A.12.7 (N. Goodman) The Staff did not think that it was necessary to include a specific discussion of the potential impacts related to selenium in land-applied ground water. The EA's assessment of land application and impacts from restoration is bounding for selenium, which is one of the constituents present in the treated wastewater disposed of by land application. As noted in the EA, CBR possesses an NPDES permit for land application issued and enforced by the NDEQ (Ex. NRC-010 at 12). CBR must comply with the limits on constituent concentrations in land-applied wastewater imposed both by its NPDES permit and by its source and byproduct materials license (Ex. NRC-012 at 9-10). Consequently, a specific assessment of selenium as a constituent of the treated wastewater disposed of by land application would not alter or affect the Staff's analysis or conclusions in the EA regarding the potential environmental impacts resulting from restoration of the Crow Butte project. This is especially so because the regulatory limit specified in LC 10.17 for the concentration of selenium in process wastewater at this facility is equivalent to the EPA's regulatory limit for the concentration of selenium in water for human consumptive use.

Q.12.8 Can you explain the limits that are applicable to concentrations of selenium in treated water acceptable for land application for the Crow Butte project?

A.12.8 (N. Goodman) The concentration of selenium in the process wastewater that Crow Butte is permitted to dispose of by land application cannot exceed a level equivalent to the EPA's maximum contaminant levels (MCLs) for selenium in drinking water. This is a requirement tied directly to CBR's source and byproduct materials license. Specifically, Condition 10.17 of CBR's license states that

> All liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes, shall be returned to the process circuit; discharged to the solar evaporation ponds; disposed by land irrigation in accordance with the licensee's proposal submitted on August 3, 1988, as modified by its submittal on June 7, 1993; or deep well injected . . . [.]

(Ex. NRC-012 at 9-10) (emphasis added). In other words, CBR is required by its license to perform land application in accordance with the submittals referenced in this license condition. In its updated 1993 land application submittal, CBR proposed that the MCL for selenium be set at 0.05 mg/L for any one day (Ex. NRC-062 at 13-14). This standard is derived directly from the MCL for selenium set by NDEQ in Title 118 for ground waters in the State of Nebraska (Ex. NRC-062 at 13-14, Ex. NRC-063 at 4-2).

Moreover, this standard is identical to the EPA's MCL for selenium in drinking water. The EPA has set an MCL for selenium at 0.05 mg/L (Ex. NRC-064 at PDF 3). The EPA's MCLs are based on the best available science to prevent potential health problems. The EPA's enforceable MCL for selenium is also equal to the EPA's health goal for selenium in drinking water, which is based solely on possible health risks and exposure over a lifetime with an adequate margin of safety (Ex. NRC-065 at 1). Consequently, there is no evidence to suggest that the environmental impacts of selenium, specifically, would be sufficiently significant or probable to require a separate discussion in the EA.

Q.12.9 In support of their argument that the EA must specifically assess the environmental impacts of selenium in treated process wastewater disposed of by land application, the intervenors claim that the FWS has stated that it does not recommend land application using center pivot irrigation for the disposal of in-situ mining wastewater. Can you address this claim?

A.12.9 (N. Goodman) The intervenors refer to a letter from the FWS to the NRC, dated September 5, 2007, on the topic of selenium contamination associated with ISR mining (Ex. INT-018). The letter conveys comments on the draft ISR GEIS that was in development by the NRC at the time (Ex. INT-018 at 1). It relies upon a study of the effects of land application of ISR wastes at an ISR facility in Wyoming, which is also attached as an exhibit to the CI's petition (Ex. INT-019).

The FWS study cited by the intervenors was conducted at the Highland ISR site in Converse County, Wyoming (Ex. INT-019 at 3). The authors concluded that application of ISR wastewater containing elevated selenium on a grassland can lead to bioaccumulation of selenium in the food chain, including red-winged blackbirds, lark buntings, and western meadowlarks (Ex. INT-019 at 16). However, the authors were unable to determine whether elevated selenium concentrations caused reproductive or other effects on red-wing blackbirds. The authors were also unable to determine the effects of selenium on lark buntings and western meadowlarks (Ex. INT-019 at 16).

More significantly, the environmental conditions reported in this study do not support a conclusion that there would be comparable impacts at the Crow Butte site. The authors state that the Highland project examined for the study has reported waterborne selenium concentrations from 1,000–2,000 mcg/L (1–2 mg/L) in their in situ mining wastewater, but do not indicate whether that wastewater was disposed of via land application (Ex. INT-019 at 1). The authors report that those values were taken from a permit filed with the Wyoming Department of Environmental Quality.

Specific to the wastewater applied via land application examined in this study, however, the authors documented selenium concentrations ranging from 340–450 mcg/L (0.34–0.45 mg/L) in eight water samples taken from the center pivot irrigator (Ex. INT-019 at 13). Notably, those values greatly exceed the enforceable MCL limit of 0.05 mg/L for selenium in process wastewater applicable to land application at the Crow Butte project (Ex. NRC-062 at 13-14).

In addition, documented selenium levels at both the Highland and Crow Butte sites indicate that selenium concentrations in ground water at the Highland project are naturally elevated compared to selenium concentrations at the Crow Butte project. A comparison of selenium values at various stages of the ISR process for both Highland and Crow Butte reveals that selenium is present in much higher concentrations at all stages of the ISR process at Highland as compared to Crow Butte (Ex. NRC-016 at 19-21). For example, the average post-mining value for selenium at Highland A-Wellfield was 0.990 mg/L, whereas the comparable value for selenium at Crow Butte Mine Unit 1 was 0.124 mg/L (Ex. NRC-016 at 19, 21). Similarly, the average value for selenium in ground water at the end of restoration at Highland A-Wellfield was 0.070 mg/L, whereas the comparable value for selenium at the end of restoration at Crow Butte Mine Unit 1 was <0.002 mg/L (Ex. NRC-016 at 19, 21). The values reported for selenium at Highland A-Wellfield also greatly exceed those reported at another Wyoming facility, the Ruth Pilot R&D study (Ex. NRC-016 at 19, 22). These data suggest that the results of the FWS study of the Highland project, such as they are, are not clearly indicative of environmental impacts to be expected at the Crow Butte site.

Furthermore, because the letter from FWS provided comments as input on the draft GEIS, the Staff considered the information from the FWS based on the Highland study in its preparation of the final GEIS (Ex. NRC-045 at A-13). Sections 4.2.5.2 and

4.2.12.2 of the GEIS discuss potential impacts of land application on ecological resources and conclude they will be small (Ex. NRC-045 at 4.2-34, 4.2-62). The GEIS cites requirements at NRC licensed ISR facilities to monitor and control irrigation areas to maintain levels of constituents, including selenium, within allowable release standards, and use of a licensee's environmental monitoring program to ensure water is within allowable release limits and to monitor soils for radionuclides and metals (Ex. NRC-045 at 4.2-62). CBR committed to both of those requirements in its 1993 application to amend its license to allow land application, and this commitment, as well as the proposed release limits for selenium documented in that application, are tied down in License Condition 10.17 (Ex. NRC-062 at 5-6, Ex. NRC-012 at 9-10).

In sum, the information presented by the intervenors in the FWS letter and the FWS study of the Highland project does not indicate that there will be any significant or probable environmental consequences from the land application of treated process wastewater at the Crow Butte site that are not already considered in the Crow Butte EA.

Q.12.10 In admitting Contention 12, the Board stated that it found support for this contention within the intervenors' discussions of other proposed environmental contentions. On pages 67 and 81 of their respective petitions, the CI and OST state that selenium-contaminated ground water could seep into low areas or basins in upland sites and create wetlands which would attract migratory birds and other wildlife. Can you address their claim?

A.12.10 (N. Goodman) The intervenors have not provided information to show that this is a concern for the Crow Butte site. They rely upon the FWS letter (Ex. INT-018) to support this claim. However, that letter does not discuss the potential for the creation of wetlands from land application of treated process wastewater. Even if what the intervenors claim could happen were to occur, for the reasons described in A.12.9 of

our testimony, above, it is not apparent that this scenario would lead to any measurable environmental impacts at the Crow Butte site.

Q.12.11 On pages 68 and 82 of their respective petitions, the CI and OST state that the 1982 Baseline Study by NDEQ found low levels of selenium in ground water, which would mean that any high levels of selenium found now would clearly be due to Crow Butte operations. Can you address this claim?

A.12.11 (N. Goodman) It is not apparent how this information relates to the EA's analysis or conclusions regarding the potential environmental impacts resulting from the land application of treated process wastewater. We note, however, that it does appear to support the Staff's findings, explained in A.12.9 of our testimony, that selenium appears to be present at relatively low levels at the Crow Butte site.

CONTENTION 14

Q.14.1 In Contention 14, the intervenors claim that the EA violates NEPA because it fails to analyze the impacts of earthquakes, especially as it concerns secondary porosity and adequate confinement. Are you familiar with this contention and the documents provided in support of it?

A.14.1 (T. Cao, T. Lancaster, E. Striz, N. Goodman) Yes, we are familiar with the contention and with the 2015 Opinion of Dr. Hannan LaGarry provided in support of the contention.

Q.14.2 Does the EA discuss earthquakes and the impacts from earthquakes?

A.14.2 (T. Cao, T. Lancaster, E. Striz, N. Goodman) Section 3.4.3 of the EA, "Seismology," describes the seismic characteristics of the area where the CBR facility is located, including a discussion of historical earthquakes and their effects (Ex. NRC-010 at 28). Section 3.4.3 also notes that the CBR facility is located in the "Stable Interior" of the United States, and in seismic zone 1, which is a zone of low seismic hazard (Ex. NRC-

010 at 28). Sections 3.4.1 and 3.4.2 of the EA describe the stratigraphy of the area and regional structure (Ex. NRC-010 at 24-27).

The impacts from earthquakes are not explicitly addressed in the EA. However, the issue raised in this contention—the concept of earthquakes creating new flow pathways for ground water—is implicitly addressed in the discussion of confinement of the mined aquifer in Section 3.5.2.3 of the EA (Ex. NRC-010 at 37-39).

Q.14.3 In Contention 14, the intervenors claim that the description of seismology in Section 3.4.3 of the EA is inadequate because it does not discuss two recent 2011 earthquakes that occurred in South Dakota. Could you please address this claim?

A.14.3 (T. Cao, T. Lancaster, E. Striz, N. Goodman) Section 3.4.3 of the EA describes the affected environment as it pertains to seismic activity (Ex. NRC-010 at 28-29). The purpose of this section is to provide information on the typical seismic activity in the area and the level of seismic hazard. Section 3.4.3 of the EA discusses several historical earthquakes in Nebraska, including several within 100 miles of the facility, and provides modified Mercalli index intensities (at locations near the epicenters) for those earthquakes (Ex. NRC-010 at 28-29). The EA also states that the facility lies within seismic zone 1 (Ex. NRC-010 at 28).

The EA does not discuss two recent earthquakes identified by the intervenors that occurred in South Dakota in November 2011 and were felt at Crawford, Nebraska. Those earthquakes were located approximately 40 km (25 mi) north-northwest of the CBR facility (Ex. NRC-066 at 2). Adding those earthquakes to the description in Section 3.4.3 of the EA would not change the accuracy of the description in terms of typical seismic activity and level of seismic hazard. The magnitudes of those earthquakes as reported by the United States Geological Survey (USGS), 3.3 and 4.0, correspond to modified Mercalli index (MMI) values of III and IV (Ex. NRC-067 at 1)

and thus fall within the range of earthquakes identified in Table 3-8 of the EA (Ex. NRC-010 at 28). Also, as stated in the EA, the CBR facility is in seismic zone 1. In Section 2.3.3.3 of the SER, the Staff concluded that the CBR facility and nearby regions are located in seismic zones 0 or 1 (Ex. NRC-009 at 17). As noted in the SER, according to the 1997 Uniform Building Code (UBC) seismic zone map, the CBR facility is in the same seismic zone as the area of South Dakota where the two 2011 earthquakes occurred (Ex. NRC-070). For these reasons, the discussion in the EA is adequate for the purposes of describing the affected environment in terms of seismic activity, despite the omission of those two earthquakes.

Q.14.4 **In admitting Contention 14, the Board indicated that discussion of seismology in Section 3.4.3 of the EA may be inadequate because it does not consider earthquakes that occurred in neighboring states. Could you please address this claim?**

A.14.4 (T. Cao, T. Lancaster, E. Striz, N. Goodman) As discussed in A.14.3, the purpose of Section 3.4.3 of the EA is to provide information on the typical seismic activity in the area and the level of seismic hazard. Section 3.4.3 of the EA discusses historical earthquakes in Nebraska but does not discuss earthquakes that occurred in neighboring states, such as southern South Dakota or eastern Wyoming. However, adding information on historical earthquakes within, for example, 100 miles of the CBR facility, regardless of which state the earthquake occurred in, would not affect the accuracy of the EA's description of typical seismic activity and level of seismic hazard. To illustrate this, we have compiled a table based on data from the NUREG-2115 and USGS earthquake catalogs that lists historical earthquakes within 100 miles of the CBR facility and a histogram of their magnitudes (Ex. NRC-066 at 1-3, Ex. NRC-068, Ex. NRC-069). These data show that the vast majority of earthquakes within 100 miles of the CBR facility have magnitudes less than 4, corresponding to a MMI value of

III (at the epicenters) (Ex. NRC-066 at 1-3, Ex. NRC-067 at 1). The data also illustrate that earthquakes in this area are very consistent in depth, with nearly all occurring at 5 km (3 mi) below the surface. (Ex. NRC-066 at 1-2). Thus, there is no significant difference in the characteristics of earthquakes discussed in the EA and other historical earthquakes that have occurred outside of Nebraska (in South Dakota or eastern Wyoming).

Section 3.4.3 of the EA also notes that the CBR facility is in seismic zone 1. As shown in the 1997 UBC seismic zone map referred to in A.14.3, the areas of Nebraska and neighboring states within 100 miles of the CBR facility are in either seismic zone 0 or 1 (Ex. NRC-070). For these reasons, the discussion in the EA is adequate for the purposes of describing the affected environment in terms of seismic activity.

Q.14.5 **In this contention, the intervenors assert that small earthquakes may lead to changes in secondary porosity that could create new flow pathways that would allow underground migration of contaminants from the CBR facility. Please explain the term secondary porosity.**

A.14.5 (T. Cao, T. Lancaster, E. Striz) Porosity is the volume fraction of the void space in a rock. When rocks are initially formed, they exhibit some primary porosity. The primary porosity in a particular type of rock, as well as the size and distribution of the voids, depend on a number of factors, such as how the rocks were formed. Secondary porosity refers to changes to the primary porosity after the rock was initially formed. Secondary porosity may increase or decrease the primary porosity. It is created by various chemical mechanisms, such as dissolution or precipitation of minerals or physical mechanisms such as weathering or application of stresses sufficient to cause fractures or joints.

It is important to understand the relationship between porosity and permeability. The latter term (permeability) is measure of the ability of a specific rock matrix to

transmit fluids. It is dependent on the characteristics of the rock matrix alone. These characteristics include not only the porosity (i.e., volume fraction of void space) but also the size of the voids and the extent to which they are interconnected. The relationship between porosity and permeability is not directly proportional. Any decrease or increase in porosity does not translate into a proportional change in permeability. In conclusion, a rock formation may display a secondary porosity increase with chemical or physical changes, but if the newly formed voids are not interconnected over the scales of interest, the permeability will not show a similar increase.

Q.14.6 Based on the geology and hydrogeology at and near the CBR facility, would you expect that permanent changes in secondary porosity would occur in the upper confining layers as a result of earthquakes?

A.14.6 (T. Cao, T. Lancaster, E. Striz) The geology and hydrogeology in the vicinity of the site is described in Sections 3.4.1 and 3.5.2 of the EA, as well as Sections 2.6.1 and 2.6.2 of the LRA (Ex. NRC-010 at 24-27, 37-38, Ex. CBR-011 at 2-97 to 2-137). As described in the EA, the lower confining unit (Pierre Shale) is relatively uniform, essentially impermeable shale that is 457 to 610 m (1500 to 2000 feet) thick (Ex. NRC-010 at 26). The upper confining units over the wellfield area—the Middle and Upper Chadron and the lower Brule Formation—consist of 60 to 150 m (200 to 500 feet) of low permeability clay and siltstones (Ex. CBR-011 at 2-137, Ex. NRC-010 at 38). The upper Chadron is described as light grey green bentonitic clay grading downward into green and frequently red clay, which is comprised of 44 percent montmorillonite. (Ex. CBR-011 at 2-127). The upper Chadron was also noted to contain gray white bentonitic marker beds. The light green gray sticky clay of the Chadron was stated to serve as a marker bed which was present virtually all drill holes within the CBR License Area. Because the saturated clays in these formations are not brittle, if they

were subjected to an earthquake large enough to generate small fractures in these layers, the layers would "self-heal" and would not undergo any permanent changes in secondary porosity.

Q.14.7 **On pages 2-3 of his 2015 Opinion, Dr. LaGarry argues that small earthquakes that do not significantly damage surface infrastructure "represent shifting and flexing of the earth's crust, and are continuously creating, closing, and redistributing the secondary porosity of the region's rock and changing the flow pathways of the region's groundwater." In admitting this contention, the Board cited that statement from Dr. LaGarry and characterized the issue as follows: "Intervenors allege that every earthquake, regardless of size, can change the ground's porosity such that water flow is affected." Could you address Dr. LaGarry's statement and the more general claim that every earthquake, regardless of size, can affect porosity and water flow?**

A.14.7 (T. Cao, T. Lancaster, E. Striz) Dr. LaGarry's assertion that small earthquakes (i.e., earthquakes similar in magnitude to the two 2011 earthquakes identified by the intervenors) can change porosity and flow pathways is contrary to the results of seismological studies and observations which show that such changes only occur after large earthquakes, especially those with surface ruptures. Such changes do not arise from small earthquakes with magnitude 4 or lower.

There are two types of changes in secondary porosity that can occur after an earthquake: transient changes and permanent changes. Here only permanent changes are relevant, because transient changes are recoverable in days or even shorter. There are two possible causes for permanent porosity changes. One is the primary rupture caused by the earthquake and the other is the ground shaking due to the seismic wave generated by the earthquake rupture.

(a) Earthquake rupture

Some large earthquake ruptures can reach the ground surface and cause changes to water levels (which imply secondary porosity has developed) and sometimes even changes to flow directions (Ex. NRC-071); however, this is only true for earthquakes with magnitude 6 or above (Ex. NRC-071). For events of magnitude 4 or smaller, which are typical for the area, the probability of a surface rupture, (calculated using Equation 5 in Ex. NRC-071) drops to less than one percent. Therefore, based on the historical seismicity level in the area surrounding the CBR facility, a rupture reaching the surface and causing permanent porosity changes can effectively be ruled out.

Primary rupture refers to the principal fault rupture on the main continuous fault. An earthquake of magnitude 4 has a rupture area of about one square kilometer or an area with one kilometer dimension (Ex. NRC-072). Therefore, the rupture will not extend beyond one kilometer above the location of the earthquake within the earth's crust (hypocenter). For an earthquake depth of 5 km (3 mi), which is typical of the area where the CBR facility is located, the top 4 km above the hypocenter will not be affected by the primary rupture. Within the license area, the maximum depth to the lower confining layer (the Pierre Shale) is approximately 213 m (700 ft), and the thickness of the Pierre Shale is up to 610 m (2000 ft) (Ex. NRC-010 at 26). Thus, in the worst case scenario, if an earthquake of magnitude 4 were to occur directly below the CBR facility site, the earthquake rupture would not cause permanent porosity changes in the mined aquifer (Basal Chadron Sandstone) or in the confining layers above and below.

(b) Ground shaking

For the CBR facility and surrounding area, the latest USGS seismic hazard map indicates that the maximum peak ground acceleration (in terms of the acceleration of gravity, g = 9.8 m/s^2 or 32.2 ft/s^2) with a 10% probability of being exceeded in 50 years

(equivalent to an occurrence rate of once every 475 years) is about 2-3% *g* (Ex. NRC-073). This is considered a very low acceleration and will not cause cracking or permanent porosity changes in the upper few kilometers of the ground. For a crack or fracture to occur the stress due to the passing wave has to exceed the strength of the rock. The following calculation demonstrates that this will not happen for earthquakes that typically occur near the CBR facility.

Table 3-6 in Section 3.4.3 of the EA provides typical ground shaking intensities, based on the MMI scale, near the epicenters of historical earthquakes in the area (Ex. NRC-010 at 28). Typical intensities are III to IV, which correspond to magnitudes of 3.0-3.9 and 4.0-4.5 at the epicentral regions, respectively, and feel similar to the vibration from a passing truck (Ex. NRC-067 at 1). This level of shaking can be felt almost every week in the United States, especially in California, without any damage. Furthermore, these intensities are consistent with a maximum acceleration value of 2-3% *g* (Ex. NRC-074).

For an earthquake with shaking equivalent to an MMI of IV at the epicenter, the peak ground velocity (PGV) is in the range of 1.1 to 3.4 cm/s (Ex. NRC-074). The peak dynamic stress in the seismic waves, σ, can be estimated from the PGV using the relationship $\sigma = \mu v/c$, where v is the PGV, c is the shear wave velocity (~3 km/s) and μ is the shear modulus (~ 3×10^{10} Pa) (Ex. NRC-075). For a PGV in the range of 1.1 to 3.4 cm/s, the peak dynamic stress values would range from 0.10 to 0.34 MPa (14.5 to 49 psi). However, previous studies in intact laboratory samples have suggested that stresses of the order of 100 MPa (14500 psi) are necessary to cause large changes in permeability. The pressure used in hydraulic fracking, a process that is designed to create significant permeability changes in rocks, is in the range of 100 MPa (14500 psi). As shown above, the stresses created by small earthquakes are

about three orders of magnitude less than the stress needed to cause secondary porosity changes that may permanently influence permeability.

Q.14.8 Can you address whether there is any evidence that small earthquakes that have occurred within 100 miles of the CBR facility since it began operations have had any effect on confinement of the Basal Chadron Sandstone at the site?

A.14.8 (T. Cao, T. Lancaster, E. Striz) Yes, we can. As described in Section 4.6.2.2.4 of the EA, CBR has placed monitoring wells in the overlying Brule aquifer and in perimeter rings in the Basal Chadron surrounding all mine units at a distance of 300 feet from the mine unit boundary (Ex. NRC-010 at 78). These monitoring wells are sampled biweekly for indicator parameters to detect excursions which may arise from changes in flow paths in and around the mine units (Ex. NRC-010 at 78). Since 1990, when the CBR facility began operating, a number of earthquakes have occurred within 100 miles of the facility (Ex. NRC-066 at 2). If those earthquakes had influenced water flow paths, or had affected aquifer confinement, the biweekly excursion monitoring data should have detected changes in excursion patterns which could be attributed to earthquake events. In Section 4.6.2.2.4 of the EA, NRC staff describes the excursions which have been detected from 1995 to 2010 (Ex. NRC-010 at 79-80). The horizontal excursions detected at the perimeter ring monitoring wells were caused by imbalance of production and injection rates and corrected by adjusting those rates. Other horizontal excursions were attributed to interactions with neighboring mine units. Excursions in the overlying aquifer were not found to be related to vertical excursions from the production zone. In conclusion, there was no pattern in the number or location of excursions which could be attributed to permeable flow paths, either horizontal or vertical, created by earthquakes.

In addition, as stated in Section 3.5.2.3.1 of the EA, CBR has conducted several aquifer pumping tests since 1989, with the most recent occurring in 2002 (Ex. NRC-

010 at 37). Any effects of earthquakes on the confinement of the aquifer would have been revealed in the results of those tests. Other indicators of confinement, such as differences in water quality between Brule and Basal Chadron wells, and lack of drawdown in water levels in the Brule aquifer in response to drawdown in the Basal Chadron aquifer, also demonstrate the hydraulic isolation between the two aquifers (Ex. NRC-010 at 75, Ex. NRC-009 at 23). In particular, water quality data from Brule and Basal Chadron wells located outside of the LA (within one kilometer of a wellfield) show that water quality has remained consistent with radiological background levels for each aquifer (Ex. NRC-010 at 81). And, as discussed in A.14.6 above, the confining layers above the Basal Chadron Sandstone consist of saturated clays that would "self-heal" in the event of an earthquake large enough to create fractures.

In summary, the Staff is not aware of any evidence that earthquakes occurring in the region since the CBR facility began operation have had any effect on the hydraulic isolation (confinement) of the Basal Chadron Sandstone aquifer from the Brule aquifer. On the contrary, as discussed in detail in A.D.3 in the Staff's testimony for Contention D, there are numerous lines of evidence demonstrating continued confinement at the CBR facility.

Q.14.9 To what extent would you expect the 2011 earthquakes in South Dakota (cited by the intervenors) to cause changes in subsurface rocks and ground water flow pathways in the vicinity of the Crow Butte ISR facility?

A.14.9 (T. Cao, T. Lancaster, E. Striz) According to the USGS, the two earthquakes in South Dakota identified by the intervenors had magnitudes 3.3 and 4.0, occurred 5 km (3 mi) below the surface, and were located approximately 40 km (25 mi) from the CBR facility (Ex. NRC-066 at 2). For the reasons discussed in A.14.7 above, based on their magnitude, depth, and distance, these earthquakes would not have had any permanent effect on secondary porosity at or near the CBR facility. The fact that an

earthquake is felt in an area does not mean that there is sufficient energy to cause fractures in subsurface rocks.

More generally, if an earthquake of similar magnitude and depth to the 2011 South Dakota earthquakes occurred at or near the CBR site, it would not have an effect on secondary porosity near the surface for the reasons discussed in A.14.7 above. In that response, we explained why earthquakes of magnitude 4 or below occurring 5 km (3 mi) below the surface, which are typical magnitudes and depths for this region, would not affect secondary porosity within several kilometers of the surface because the primary rupture would not extend up far enough to cause fracturing. We also explained that the ground shaking from such earthquakes would not cause sufficient stresses to cause changes in porosity due to fractures. Finally, in A.14.8 we explained that there is no evidence from monitoring data that new flow pathways have been created as a result of earthquakes.

Q.14.10 Please discuss the probability that an earthquake of sufficient magnitude would occur close enough to the Crow Butte ISR facility to cause changes in subsurface rocks and ground water flow pathways.

A.14.10 (T. Cao, T. Lancaster, E. Striz) The USGS seismic hazard map for the area where the Crow Butte ISR is located, referred to in A.14.7 above, is probably the best quantitative measure of the probability of seismic hazards for the site (Ex. NRC-073). The USGS seismic hazard map shows maximum ground acceleration values (in terms of the acceleration of gravity, *g*) with a 10% probability of being exceeded in 50 years. For the Crow Butte facility and vicinity, this value is about 2-3% *g*, which is considered low compared with other part of the central-eastern United States. Earthquakes that cause this level of ground motion are small in magnitude with no surface ruptures. As explained in A.14.7 above, such an earthquake would not create or cause changes in

secondary porosity of subsurface rocks or create new ground water flow pathways even if it were to occur near the Crow Butte ISR facility.

Q.14.11 What, if any, environmental impacts do you expect from small earthquakes that might occur at or near the CBR facility?

A.14.11 (T. Cao, T. Lancaster, E. Striz, N. Goodman) We expect no significant environmental impacts. As discussed in A.14.7 above, earthquakes of the magnitude and depth that occur in this area will not affect on secondary porosity at the site. And, as discussed in A.14.8 above, there is no evidence that earthquakes that have occurred in the region since the CBR facility began operating have had any effect on aquifer confinement or horizontal containment of mining fluids, and there is no reason to believe that they would during the license renewal period.