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APP-037

June 20, 2014

**UNITED STATES OF AMERICA**
**NUCLEAR REGULATORY COMMISSION**

**ATOMIC SAFETY AND LICENSING BOARD**

**Before Administrative Judges:**

**William J. Froehlich, Chairman**
**Dr. Richard F. Cole, Special Assistant**
**Dr. Mark O. Barnett, Special Assistant**

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| In the Matter of: | ) | |
| POWERTECH USA, Inc. | ) | |
| (Dewey-Burdock Project | ) | Docket No. 40-9075-MLA |
| In Situ Uranium Recovery Facility) | ) | ASLBP No. 10-898-02-MLA-BD01 |
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**WRITTEN TESTIMONY OF ERROL LAWRENCE**

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## 1. WITNESS BACKGROUND INFORMATION

Q.1. Please state your name, position and employer, including duration of employment.
A.1. Errol Lawrence. I am a senior hydrologist employed by Petrotek Engineering Corporation since 2004. My curriculum vitae is included as Exhibit APP-038.

Q.2. Please state your education, professional registration and memberships.
A.2. I hold an M.S. in Geological Engineering from the Colorado School of Mines and a B.S. in Geology from Northern Arizona University. I am a registered professional geologist in Wyoming and Texas and a member of the National Ground Water Association, American Institute of Professional Geologists, and the National Water Well Association.

Q.3. What ISR projects have you worked on while with Petrotek and other entities?
A.3. I have worked on more than a dozen uranium ISR projects in the U.S., Paraguay, Turkey and Kazakhstan. In addition to the Dewey-Burdock Project, U.S. projects have included nine Wyoming Projects (Irigaray Ranch, Christensen Ranch, Willow Creek, Lost Creek, Moore Ranch, Allemand Ross, Reno Creek, Ludeman, and Smith Ranch/Highland) and two Texas projects (Holiday El-Mesquite and La Palangana).

Q.4. How many of these projects have involved groundwater characterization?
A.4. All of them to some degree.

Q.5. How have you been involved with groundwater characterization at uranium ISR facilities?
A.5. I have been involved in the preparation of permit and license applications, including evaluating the regional and site groundwater hydrology, evaluating site-wide baseline groundwater quality characteristics, developing conceptual hydrologic models, preparing numerical groundwater models, and designing and conducting pumping tests. I also have been involved with post-license groundwater characterization, including designing and conducting wellfield pumping tests and evaluating the effectiveness of groundwater restoration.

Q.6. What has been your role in the Dewey-Burdock Project?
A.6. I prepared the numerical groundwater model, which is provided as Exhibit APP-025. I also assisted in the preparation of revised Section 2.7.2 of the Technical Report (TR), which is the section of the license application that characterizes the regional and site groundwater conditions. This is provided as exhibit APP-015-B at 2-149 through 2-184b. I also assisted in the preparation of the June 2011 TR Request for Additional Information (RAI) responses, which are provided as Exhibit APP-016-A through APP-016-BB.

## 2. CONTENTION 2

Q.7. What is the nature of your testimony regarding this contention?

A.7. The following written testimony addresses the primary allegations posed by the intervenors with respect to Contention 2. These allegations address adequacy and completeness of the baseline groundwater quality data.

This testimony addresses the adequacy of the baseline groundwater quality data that is presented in the license application and summarized in the FSEIS. As described below and as documented by NRC staff's review in the FSEIS (Exhibit NRC-008-A and 008-B) and SER (Exhibit NRC-00134), the baseline groundwater quality data satisfy all applicable regulatory requirements and guidance, including NUREG-1569 (Exhibit NRC-0013) Section 2, 10 CFR Part 40, Appendix A, Criterion 7 and Regulatory Guide 4.14 (Exhibit NRC-0074).

This testimony shows that the baseline groundwater quality information collected by Powertech and presented in its license application meets or exceeds the minimum regulatory requirements.

### 2.1 The FSEIS and SER Demonstrate That the License Application Complies with Applicable NUREG-1569 Acceptance Criteria with Respect to Baseline Groundwater Quality

Q.8. How do you respond to the allegation that the application or FSEIS fail to comply with NUREG-1569 Section 2.7.1(4) (i.e., CI 2013 at 8-9, OST 2010 at 18, OST 2013 at 11)?

A.8. As documented below, the application complies with NUREG-1569 Section 2.7.1(4).

Q.9. What does NUREG-1569 Section 2.7.1(4) specify that a license application should contain?

A.9. NUREG-1569 Section 2.7.1(4) (at 2-21) states that the characterization of hydrology for a uranium *in-situ* recovery (ISR) license application should contain (emphasis added):

> "Assessment of available ground-water resources and **ground-water quality within the proposed permit boundaries and adjacent properties**, including **quantitative description of the chemical and radiological characteristics** of the ground water and **potential changes in water quality caused by operations**"

It is important to note that this and other guidance in NUREG-1569 apply to license applications, not EISs. Conformance with NUREG-1569 is the responsibility of the license applicant, and documentation of conformance is found in the SER prepared for each ISR license, not the SEIS. Therefore, this testimony addresses how the license application conforms with NUREG-1569 and, as applicable, how the information in the FSEIS is consistent with guidance in NUREG-1569.

Q.10. Does the license application assess "ground-water quality within the proposed permit boundaries and adjacent properties"?
A.10. Yes. The information in the license application is summarized in the FSEIS. Specifically, the FSEIS at 3-38 through 3-41 (Sec. 3.5.3.5) describes how the baseline groundwater quality assessment included sampling 19 wells quarterly for 1 year and an additional 12 wells monthly for 12 months.

Q.11. Where are these wells located with respect to the proposed license boundary?
A.11. FSEIS Figure 3.5-2 (FSEIS at 3-23) depicts the locations of the 31 wells sampled for baseline groundwater quality assessment. It shows that 22 wells were sampled inside the proposed permit (license) boundary and 9 wells were sampled outside of the proposed permit (license) boundary. This demonstrates that baseline groundwater quality was assessed within the proposed permit boundary and adjacent properties, in conformance with NUREG-1569 Section 2.7.1(4).

Q.12. You stated that the second specification of NUREG-1569 Section 2.7.1(4) is to provide a "quantitative description of the chemical and radiological characteristics of the ground water." Was this done in the license application?
A.12. Yes. The information is contained in the June 2011 TR RAI responses (Exhibit APP-016-A through 016-BB), which are cited repeatedly in FSEIS with respect to baseline groundwater quality (FSEIS at 3-38 through 3-41). Appendix 2.7-G to the TR RAI responses (Exhibit APP-016-M at PDF pages 926-1072) provides quantitative results for all baseline groundwater quality parameters for all wells, including chemical and radiological constituents. Baseline groundwater quality laboratory analytical results are provided in Appendix 2.7-H to the TR RAI responses (Exhibit APP-016-N through APP-016-Q). In all, results are reported for over 19,000 chemical and radiological parameters for groundwater samples (not including duplicate and split sample results), which represents a site-wide, quantitative description of baseline groundwater quality within and adjacent to the project boundary.

Q.13. Is this information summarized in the FSEIS?
A.13. Yes. This again is summarized in the FSEIS at 3-38 through 3-41, which describes the baseline chemical and radiological groundwater quality characteristics in relation to EPA maximum contaminant levels (MCLs) and secondary drinking water standards. Table 3.5-4 (FSEIS at 3-39) provides a quantitative description of baseline sample results that exceeded the MCL for chemical and radiological constituents including arsenic, lead, uranium, radium-226 and gross alpha. The accompanying text provides additional descriptions of the baseline chemical and radiological characteristics such as where secondary standards for pH, TDS and other chemical constituents were exceeded and where baseline water quality exceeded EPA's proposed radon MCL.

Q.14. You stated that the third specification of NUREG-1569 Section 2.7.1(4) is to describe "potential changes in water quality caused by operations." Was this done in the license application?
A.14. Yes. This is provided in TR Table 4.2-6 (Exhibit APP-021-C at 4-17), which presents estimated end-of-production groundwater quality within the production zone aquifers.

Q.15. Was this third specification of NUREG-1569 Section 2.7.1(4) addressed in the FSEIS?
A.15. Yes. Relevant information in the FSEIS includes:

- "Lixiviant is pumped down injection wells to the mineralized zones hosted in sandstones in the Fall River and Chilson Member of the Lakota Formations, where it will oxidize and dissolve uranium from the formations" (FSEIS at 2-30).
- Temporary increases within the production zone in the concentrations of "uranium and other metals that are typically associated with uranium in nature" (FSEIS at 4-109).
- Restoration when production is complete to Commission-approved background water quality, MCLs or NRC-approved alternate concentration limits (ACLs) (FSEIS at 4-62).
- Potential impacts to groundwater quality near a production zone but within the aquifer exemption area that could lead to a horizontal or vertical excursion (FSEIS at 2-31).
- NRC staff's determination that no impacts have ever occurred to non-exempted portions of the aquifer at NRC-licensed ISR facilities (FSEIS at 4-64).

Q.16. How do you respond to the allegation that the application or FSEIS fail to comply with NUREG-1569 Acceptance Criterion 2.7.3(4) (i.e., CI 2013 at 8-9, OST 2010 at 18, OST 2013 at 11)?
A.16. As documented below, the application complies with NUREG-1569 Acceptance Criterion 2.7.3(4).

Q.17. What does NUREG-1569 Acceptance Criterion 2.7.3(4) specify that a license application should contain?
A.17. NUREG-1569 Acceptance Criterion 2.7.3(4) (Exhibit NRC-0013 at 2-24) states that the characterization of site hydrology is acceptable if it demonstrates that (emphasis added):

> "**Reasonably comprehensive chemical and radiochemical analyses of water samples, obtained within and at locations away from the mineralized zone(s)**, have been made to determine pre-operational baseline conditions. Baseline water quality should be determined for **the mineralized and surrounding aquifers**. These data should include **water quality parameters that are expected to increase in concentration as a result of *in situ* leach activities and that are of concern to the water use of the aquifer** (i.e., drinking water, etc.). The applicant should show that **water samples were collected by acceptable sampling procedures**, such as American Society for Testing and Materials D4448 (American Society for Testing and Materials, 1992)." (Note that only the first

paragraph of this acceptance criterion is reproduced here, since all allegations stem from this paragraph.)

Q.18. Does NUREG-1569 clarify what is meant by "reasonably comprehensive"?
A.18. Yes. NUREG-1569 makes it clear that "reasonably comprehensive" refers to the list of constituents analyzed in baseline groundwater quality samples. More specifically NUREG-1569 at 2-26 states, "The applicant should identify the list of constituents to be sampled for baseline concentrations. The list of constituents in Table 2.7.3-1 is accepted by the NRC for *in situ* leach facilities."

NUREG-1569 Table 2.7.3-1 (Exhibit NRC-0013 at 2-25) lists 34 parameters, including trace and minor elements such as arsenic, selenium and uranium; common constituents such as sodium, chloride and alkalinity; physical indicators such as pH and total dissolved solids; and radiological parameters that include gross alpha and gross beta.

Q.19. So it is your understanding that sampling for all constituents in Table 2.7.3-1 satisfies the specification to provide "reasonably comprehensive" sample parameters, including analyzing "water quality parameters that are expected to increase in concentrations as a result of *in situ* leach activities and that are of concern to the water use of the aquifer"?
A.19. Yes. The acceptance criterion specifically states that monitoring for these 34 constituents "is accepted by the NRC for *in situ* leach facilities" and therefore constitutes a "reasonably comprehensive" list of chemical and radiochemical analyses, including parameters that are expected to increase as result of ISR and that are of concern to the water use of the aquifer.

Q.20. And did Powertech sample for all of the parameters in Table 2.7.3-1?
A.20. Yes. A comparison between NUREG-1569 Table 2.7.3-1 (Exhibit NRC-0013 at 2-25) and Appendix 2.7-G in Powertech's TR RAI responses (Exhibit APP-016-M at PDF pages 926-1072) shows that baseline groundwater quality samples were analyzed for all 34 parameters in Table 2.7.3-1. In fact, Powertech analyzed many additional parameters in baseline groundwater quality samples including dissolved oxygen, oxidation-reduction potential, sodium adsorption ratio, ammonia, silica, aluminum, antimony, beryllium, strontium, thallium, lead-210, polonium-210, radon-222 and thorium-230.

Q.21. You mentioned that another specification of NUREG-1569 Acceptance Criterion 2.7.3(4) is that water samples should be "obtained within and at locations away from the mineralized zone(s)." Does the license application provide this information?
A.21. Yes. For example, TR Figure 2.7-32 (Exhibit APP-015-B at 2-200) depicts the locations of the sampled wells with respect to the generalized uranium recovery areas and indicates which wells are upgradient, near or downgradient of proposed ISR activities. The sample results for all of these wells are provided in TR RAI Appendix 2.7-G (Exhibit APP-016-M at PDF pages 926-1072).

Q.22. Is this information described in the FSEIS?
A.22. Yes. This is summarized in FSEIS Sec. 3.5.3.5 (at 3-38 through 3-41), which describes how groundwater samples were collected and analyzed from multiple aquifers, including the production zone aquifers (Fall River and Chilson), overlying aquifers (alluvium) and underlying aquifers (Sundance/Unkpapa). It describes how for the production zone aquifers some of the wells were within and some were upgradient or downgradient of the proposed uranium recovery areas.

Q.23. You also indicated that NUREG-1569 Acceptance Criterion 2.7.3(4) specifies that license applications should demonstrate that "water samples were collected by acceptable sampling procedures." Does the license application describe the standard sample collection procedures that were used?
A.23. Yes. Sampling methods are described in TR Sections 2.7.3.2.1 and 2.9.8.1 for baseline groundwater quality (Exhibit APP-015-B at 2-199, 201-202 and APP-015-C at 2-367 through 2-369). The methods used to sample each well included: (1) measuring static water level or shut-in pressure when possible prior to sample collection, (2) measuring the flow rate of flowing artesian wells, (3) purging at least three casing volumes from non-flowing wells (if sufficient yield was available) or more until field water quality parameters had stabilized, (4) using a calibrated water-quality sonde to measure field water quality parameters, (5) triple rinsing each sample container prior to filling and capping except for radon sample bottles, which were filled and capped immediately with no headspace, (6) collecting periodic field replicate samples at the same time following the same protocols as the original samples, (7) periodically preparing field blank samples using deionized water, and (8) properly labeling and storing sample containers in coolers on ice after collection. Indication that samples were handled properly is provided on chain-of-custody receipts and laboratory reports provided in Appendix 2.7-H to the TR RAI responses (Exhibit APP-016-N through APP-016-Q). These document the delivery of samples promptly after collection to the laboratory, at the recommended temperature, without sample bottle damage, under proper chain-of-custody control, and for analysis within parameter-specific holding times.

Q.24. Do you consider these to be acceptable sampling procedures that are consistent with ASTM D4448 and consistent with those used at other ISR facilities?
A.24. Yes. These are standard environmental sampling procedures commonly used at uranium ISR facilities and other industrial sites undergoing environmental monitoring of groundwater or surface water. A review of ASTM D4448 sample collection and handling procedures confirms procedures used at the Dewey-Burdock site are consistent with procedures identified in the ASTM method. The ASTM D4448 method describes the options for purging wells, measuring and documenting water quality stabilization criteria, choosing the appropriate sampling equipment and technique for each situation, managing sampling containers and preservation appropriately, and delivering samples to the laboratory promptly for analysis.

Further, support for the adequacy of sampling and analytical procedures for baseline groundwater quality characterization is provided by the agreement between the Powertech sampling results and the results of independent water quality sampling and analysis conducted in and around the project area by the U.S. Geological Survey (USGS) in 2011. USGS Open-File Report 2012-1070 (Exhibit APP-022 at 7-9 and Table 2) describes how the USGS collected 28 groundwater samples from monitor wells in and around the Dewey-Burdock project area in June 2011. Sample results are provided in Exhibit APP-022 at Table 2. In a publicly available presentation given by Dr. Raymond Johnson of the USGS, he noted that the USGS "Did independent water quality analyses" and "Did not find any major differences" (Exhibit APP-023 at slide 14). See the written testimony of Hal Demuth (Exhibit APP-013) at A.33 for additional information.

Q.25. Did NRC staff evaluate the license application's conformance with NUREG-1569 Acceptance Criterion 2.7.3(4)?

A.25. Yes. NRC staff's evaluation is found in the SER (Exhibit NRC-00134 at 63), which states (emphasis added):

> "The NRC has completed its review of the preoperational surface water and groundwater quality environmental monitoring at the Dewey-Burdock ISR project. This review included an evaluation using review procedures in standard review plan Sections 2.7.2 and 2.9.2 and the **acceptance criteria in standard review plan Sections 2.7.3** and 2.9.3. The applicant included descriptions of the sampling programs and parameters analyzed, as well as summaries of the data results. **Based on the number of samples collected and parameters analyzed, the applicant has acquired sufficient preoperational background surface water and groundwater quality data to satisfy Criterion 7 of Appendix A in 10 CFR Part 40. The information presented by the applicant is also consistent with guidance in NUREG-1569**."

## 2.2 The FSEIS and SER Demonstrate That the License Application Complies with 10 CFR Part 40, Appendix A, Criterion 7

Q.26. How do you respond to the allegation that the application does not provide "complete baseline data on a milling site and its environs" as required by 10 CFR Part 40, Appendix A, Criterion 7 (i.e., CI 2013 at 8, CI 2014a at 22, OST 2010 at 18, OST 2013 at 11, OST 2014a at 16)?

A.26. One of the requirements of 10 CFR Part 40, Appendix A, Criterion 7 is: "At least one full year prior to any major site construction, a preoperational monitoring program must be conducted to provide complete baseline data on a milling site and its environs." The following testimony addresses compliance with this requirement. The remaining requirements of Criterion 7, including Criterion 7A, apply to the construction and operating phases and address issues such as establishing Commission-approved background water quality for each wellfield and operational compliance monitoring programs. These latter requirements were not addressed

in the allegations, are not relevant to Contention 2, and are not addressed in this written testimony.

As shown in A.25 of this written testimony, NUREG-1569 Sections 2.7.3 and 2.9.3 acceptance criteria are used by NRC staff as the guidance for compliance with the pre-operational baseline characterization requirements in 10 CFR Part 40, Appendix A, Criterion 7. That same paragraph describes how NRC staff determined that the information in the license application satisfies 10 CFR Part 40, Appendix A, Criterion 7 and is consistent with NUREG-1569 Section 2.7.3 and 2.9.3 acceptance criteria.

See also A.16 through A.24 of this written testimony, which describe how the license application satisfies NUREG-1569 Acceptance Criterion 2.7.3(4), which is the only criterion in Section 2.7.3 that specifically addresses pre-operational baseline groundwater quality characterization.

Is it important to reiterate again that certain site-wide data are required prior to license issuance, while additional information will be obtained for each wellfield prior to operations. This is summarized in NUREG-1569 (Exhibit NRC-0013 at 1-1, emphasis added):

> "Reviewers should keep in mind that the development and **initial licensing of an *in situ* leach facility is not based on comprehensive information**. This is because *in situ* leach facilities obtain enough information to generally locate the ore body and to understand the natural systems involved. **More detailed information is developed as each area is brought into production**. Therefore, reviewers should verify that sufficient information is presented to reach only the conclusion necessary for initial licensing. However, reviewers should not expect that information needed to fully describe each aspect of a full operation will be available in the initial application."

Since NUREG-1569 is the primary guidance document for ISR facilities to comply with 10 CFR Part 40, Appendix A criteria and since Powertech has demonstrated conformance with applicable NUREG-1569 acceptance criteria for pre-operational baseline groundwater quality characterization (i.e., Section 2.7.3 and 2.9.3 acceptance criteria), it is clear that the license application has complied with the requirement in Criterion 7 to provide "complete baseline data on a milling site and its environs."

### 2.3 The NRC License Properly Relies on Regulatory Guide 4.14 When Specifying a 2-km Radius from Wellfields for Pre-Operational and Operational Water Supply Well Monitoring

Q.27. How do you respond to the allegation that Regulatory Guide 4.14 was improperly relied upon to derive the 2 km radius of review for water supply wells (i.e., Moran 2013 at 26-27, OST 2013 at 14)?

A.27. This allegation apparently refers to Powertech's commitment and the license requirement to conduct pre-operational and operational monitoring for private water supply wells within 2 km of wellfield boundaries. This requirement is documented in license condition (LC) 12.10 (Exhibit NRC-0012 at 13):

> "Prior to commencement of operations, the licensee will collect four quarterly groundwater samples from each well within 2 km (1.25 mi) of the boundary of any wellfield, as measured from the perimeter monitoring well ring. This data shall be submitted to the NRC staff for review and written verification. Furthermore, all domestic, livestock, and crop irrigation wells within 2 km (1.25 mi) of the boundary of any wellfield, as measured from the perimeter monitoring well ring, will be included in the routine environmental sampling program provided that well owners consent to sampling and the condition of the wells renders them suitable for sampling."

Q.28. Can you explain how the 2-km distance was determined?
A.28. This is explained in the SER (Exhibit NRC-00134 at 61-62). It describes how Regulatory Guide 4.14 recommends that groundwater samples "be collected quarterly from each well within two kilometers of the proposed tailings area that is or could be used for drinking water, watering of livestock, or crop irrigation" (Exhibit NRC-0074 at 4.14-2). The SER notes that this portion of Regulatory Guide 4.14 was developed "because conventional mill 'tailings areas' have the potential to be a source of contamination to ground water." It describes NRC staff's justification in applying this guidance to wellfields at ISR facilities, which are considered "'temporary source area[s]' of ground water contamination during production and restoration phases at an ISR facility."

Q.29. Is technical justification provided for the 2-km distance?
A.29. Yes. The SER (Exhibit NRC-00134 at 61-62) further describes how the use of the 2-km distance was validated in NUREG/CR-6705, which examined radiological plume dispersion from mill tailings disposal areas at Uranium Mill Tailings Remedial Action (UMTRA) sites in the U.S. and concluded that the average distance is less than 2 km for the 10-20 ppb uranium plume contour, which indicates that concentrations at this distance are lower than the EPA MCL of 30 ppb. The SER notes that NUREG/CR-6705 also concluded that dispersion of non-radiological contaminants mimics that of radiological contaminants.

Q.30. Is the 2-km radius commonly applied to ISR facilities?
A.30. The application of the 2-km review area from Regulatory Guide 4.14 to the Dewey-Burdock Project is consistent with other recently issued NRC licenses. For example, the license issued in 2011 for the Nichols Ranch ISR Project in Wyoming (SUA-1597) contained the pre-operational requirement in LC 12.10 to sample domestic and livestock wells located within 2 km of the proposed wellfield monitoring ring wells (Exhibit APP-039 at 13-14).

Applying the 2-km radius to the perimeter monitor well ring rather than the wellfield pattern area is a conservative application of the Regulatory Guide 4.14 guidance, since it is the ISR injection wells and not the perimeter monitor well ring that are the potential temporary source of groundwater contamination.

Q.31. How do you respond to the allegation that Regulatory Guide 4.14 should not apply to ISR facilities, since it was developed for conventional uranium mills (i.e., Moran 2013 at 27)?
A.31. The allegation that reliance on Regulatory Guide 4.14 for baseline characterization is not justified for ISR facilities fails to note that NUREG-1569 acceptance criteria repeatedly reference Regulatory Guide 4.14, including Acceptance Criterion 2.9.3(1) for site background radiological characterization. Therefore it is impossible to ignore Regulatory Guide 4.14 when preparing a license application that complies with NUREG-1569. Typically, baseline groundwater characterization programs are designed to comply with both NUREG-1569 and Regulatory Guide 4.14. For example, the groundwater quality parameter list used for the Dewey-Burdock Project contains all of the parameters in NUREG-1569 Table 2.7.3-1 (see A.20 of this written testimony) and all of the parameters in Regulatory Guide 4.14 Table 1 (Exhibit NRC-0074 at 4.14-8).

Q.32. How do you respond to the allegation that baseline groundwater quality should be collected from all known wells within at least 2 miles of the project boundary (i.e., CI 2010 at 27, CI 2013 at 8, Moran 2010 at 13, Moran 2013 at 7, 22)?
A.32. There is no regulatory requirement or technical basis to provide groundwater quality results from a radius of 2 miles or greater from the project boundary. A.27 through A.31 of this written testimony describe the justification for the 2-km groundwater sampling radius, and A.8 through A.25 describe conformance with NUREG-1569 guidance for baseline groundwater quality characterization, including sampling wells within and adjacent to the proposed license area, sampling the mineralized zone and surrounding aquifers, and providing all sample results in the license application.

### 2.4 The Application Provides Complete Baseline Water Quality Data Collected by Powertech and Demonstrates that Current Data are Similar to Data Collected by TVA 30 Years Earlier

Q.33. How do you respond to the allegation that the DSEIS and application do not include tables that statistically summarize complete baseline field and laboratory water quality data for the historic and recent data sets (i.e., CI 2013 at 13, Moran 2010 at 14, Moran 2013 at 7, 21-22, OST 2010 at 19)?
A.33. Tables that provide complete baseline field and laboratory water quality data for the groundwater quality sampling conducted by Powertech are provided in the license application in Appendix 2.7-G to the June 2011 TR RAI responses (Exhibit APP-016-M at PDF pages 926-1072). The RAI responses are considered integral to the license application and are referenced extensively in the FSEIS including the baseline groundwater quality description in Sec. 3.5.3.5 (FSEIS at 3-38 through 3-41). Appendix 2.7-G summarizes complete field and laboratory baseline water quality data for all samples collected by Powertech and its contractors (i.e., the recent data sets referenced in this allegation). It includes evaluations of minimum, maximum and average concentrations for each parameter and each well. In addition, Appendix 2.7-H to the TR

RAI responses (Exhibit APP-016-N through APP-016-Q) contains baseline laboratory analytical results with an index allowing the reader to locate results from each sample event and each well.

Historical data collected by Tennessee Valley Authority (TVA) between 1979 and 1984 are provided in TR Appendix 2.7-J (Exhibit APP-021-DD at PDF pages 285 through 295). This appendix provides sample results from nine wells in the Fall River and/or Chilson aquifers that were sampled by TVA from 1979-84 and subsequently sampled by Powertech from 2007-08. A comparison between historical and recent data sets provided in Sec. 2.7.3.2.2 of the revised TR (Exhibit APP-015-B at 2-217 through 2-230b) shows very little variation in groundwater quality between the historical and recent data sets. Figure 2.7-33 (Exhibit APP-015-B at 2-219) shows the location of the nine wells with historical and recent water quality data, including four inside the project boundary and five outside the project are but within about 2 km away. Table 2.7-40 (Exhibit APP-015-B at 2-223) provides a statistical comparison between the historical and recent data sets and shows that the concentrations of alkalinity, specific conductance, pH and total dissolved solids (TDS) were very similar. Figures 2.7-34 through 2.7-37 (Exhibit APP-015-B at 2-224 through 2-225) provide graphical comparisons of the historical and recent mean concentrations for these four parameters and show that the concentrations have remained very similar over time.

## 2.5 Baseline Water Quality Data Are Presented as Factual Data without Bias

Q.34. Please respond to the allegation that baseline water conditions have been biased in an attempt to show that the groundwater quality is already degraded (e.g., Moran 2010 at 11, 14, 16, Moran 2013 at 7, 19, 25).

A.34. Powertech does not use the term "degraded" in the license application with reference to baseline groundwater quality. The pre-license baseline water quality data are presented in the license application as factual data.

Appendices 2.7-G and 2.7-H in the TR RAI response (Exhibit APP-016-M through APP-016-Q) present all baseline groundwater quality sample results. Appendix 2.7-G contains summaries of all results by formation and by well and sample date. This appendix includes calculations of average, minimum, and maximum concentrations of each constituent by well and by formation. All sample results are presented for each sample event for each well.

FSEIS Sec. 3.5.3.5 (at 3-38 through 3-41) describes baseline groundwater quality sample results from the ore-bearing aquifers and other aquifers and describes which sample results exceeded EPA MCLs and secondary standards. For example, the FSEIS at 3-38 describes how 28 of 31 wells exceeded one or more MCL for arsenic, lead, uranium, radium-226 and gross alpha. The fact that over 90% of sampled wells across all aquifers exceed one or more EPA primary drinking water standard is supported by the data presented in the license application.

Q.35. Is it necessary for Powertech to demonstrate that baseline groundwater quality exceeds EPA MCLs in order to permit the Dewey-Burdock Project?

A.35. No. Whether or not the pre-operational baseline groundwater quality in the production zone and surrounding aquifers is above or below EPA MCLs does not affect how the Dewey-Burdock Project will be permitted. For example, baseline groundwater quality does not serve as a primary basis for Powertech's request to EPA to exempt a portion of the ore zone aquifer for ISR operations. Powertech's Class III UIC permit application describes the basis for the aquifer exemption request as allowed under 40 CFR § 146.4 (Exhibit APP-042-D at 17-1):

> "The following sections describe the basis for the requested aquifer exemption, which include:
>
> - The proposed exempted aquifer does not currently serve as a source of drinking water, and
> - The proposed exempted aquifer is capable of producing minerals and contains minerals that considering their quantity and location are expected to be commercially producible."

The FSEIS similarly describes the procedure for obtaining an aquifer exemption for Class III wells at 2-15:

> "An aquifer or aquifer portion that meets the criteria for a USDW may be determined to be an "exempted aquifer" if (i)(a) it does not currently serve as a source of drinking water and (b) it cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy producing, or (ii) can be demonstrated by a permit applicant as part of a permit application for a Class III operation to contain minerals that, considering their quantity and location, are expected to be commercially producible."

Q.36. Is it necessary for Powertech to demonstrate that baseline groundwater quality exceeds EPA MCLs in order to operate the Dewey-Burdock Project?

A.36. No. Whether or not the pre-operational baseline groundwater quality in the production zone and surrounding aquifers is above or below EPA MCLs also does not affect how the Dewey-Burdock Project will be operated. For example, LC 11.3 (Exhibit NRC-0012 at 10) requires Powertech to establish, prior to operating each wellfield, Commission-approved background (CAB) water quality for the ore zone, underlying aquifers, overlying aquifers (including alluvium, where present) and the perimeter monitoring areas. In the procedures for determining CAB, which are provided in Exhibit APP-043 and summarized in the written testimony of Hal Demuth (Exhibit APP-013) at A.19, no mention is made of EPA MCLs; CAB will be determined based on the post-licensing, pre-operational groundwater quality in and surrounding each wellfield.

Similarly, excursion monitoring upper control limits (UCLs) will be established as a function of the post-licensing, pre-operational baseline groundwater quality for the underlying aquifers, overlying aquifers and perimeter monitoring areas. Calculation methods for UCLs, as documented in Powertech's June 2011 TR RAI responses (Exhibit APP-016-D at 502-503) and

LC 11.4, do not consider whether the baseline groundwater quality is above or below EPA MCLs.

## 3. CONTENTION 3

Q.37. Please summarize the key issues regarding this contention.

A.37. During NRC staff's technical review of Powertech's license application they issued a letter indicating that Powertech's previous TR RAI responses lacked "sufficient detail for the staff to make a finding related to the protection of public health and safety" with respect to four issues (Exhibit APP-044 at 1):

- "Potential for surface water to be spring fed with production zone groundwater through unplugged exploratory drill holes.
- Potential hydraulic influence of operations on newly identified underground mine workings located within or in close proximity to newly revised wellfield areas.
- Potential inadequate hydraulic containment of production fluids from proposed operations.
- Potential inadequate hydraulic containment of production fluids from the hydraulic effects of potential breccia pipes."

As described in Powertech's June 28, 2011 cover letter transmitting its revised TR RAI responses, additional information was added to the application via the revised RAI response package to address each of these issues (Exhibit APP-016-A at 2). With the added information, the license application addresses all of the allegations that were made by intervenors under this contention in 2010 and subsequently applied to the DSEIS in 2013 and FSEIS in 2014. The following testimony summarizes information in the license application and FSEIS related to the four issues above and other allegations posed by the intervenors under this contention.

### 3.1 The FSEIS and SER Demonstrate That the License Application Complies with Applicable NUREG-1569 Acceptance Criteria with Respect to Hydrogeologic Characterization.

Q.38. How do you respond to the allegation that the application or DSEIS fails to comply with the specification in NUREG-1569 Acceptance Criterion 2.7.1(3) to "present sufficient information" with respect to the "effective porosity, hydraulic conductivity, and hydraulic gradient" of the site aquifers (CI 2013 at 20, OST 2010 at 22, OST 2013 at 16)?

A.38. Information on the hydraulic properties of the aquifers in and around the project area is presented in the FSEIS and application, including but not limited to the following:

- FSEIS Sec. 3.5.3.1 (at 3-32 through 3-33) describes the thickness, transmissivity, effective porosity, and specific capacity of regional aquifer systems, including the Inyan Kara, Minnekahta, Minnelusa, Madison, and Deadwood aquifers.
- FSEIS Sec. 3.5.3.2 (at 3-34 through 3-36) describes the thickness, transmissivity, storativity and flow direction of the aquifer systems in the project vicinity, including the

alluvium, Fall River aquifer and Chilson aquifer. It also describes the thickness and vertical hydraulic conductivity of confining units including the Graneros Group, Fuson Shale and Morrison Formation.

- The February 2012 numerical groundwater model provides a description of hydraulic properties of the site hydrogeologic units including transmissivity, storativity, horizontal and vertical hydraulic conductivity, hydraulic gradient and effective porosity (Exhibit APP-025 at 10-12).

Q.39. How do you respond to the allegation that the application or DSEIS fail to provide "other information relative to the control and prevention of excursions" as specified in NUREG-1569 Acceptance Criterion 2.7.1(3) (CI 2013 at 20, OST 2010 at 22, OST 2013 at 16)?

A.39. This is one of the four key issues identified by NRC staff in 2011 as requiring additional evaluation and one of the primary focus areas for the June 2011 TR RAI responses (Exhibit APP-016). Hydrogeologic information relative to the control and prevention of excursions is found throughout the FSEIS and license application, including but not limited to the following:

- The thickness and low vertical permeabilities of the upper and lower confining units are described in the FSEIS at 7-11:

  "The thicknesses of the upper confining Graneros Group {approximately 61 to 168 m [200 to 550 ft]} and the lower confining Morrison Formation {approximately 30 m [100 ft]} minimize concerns about vertical excursions of lixiviant."
- The estimated thickness of the Fuson Shale confining unit between the Fall River and Chilson aquifers is described in the FSEIS at 3-18:

  "The Fuson Shale, which is the shale-siltstone portion of the Fuson Member, ranges in thickness from 6 to 24 m [20 to 80 ft] within the proposed project area (Powertech, 2011)."
- Information regarding the low vertical hydraulic conductivity of confining units is provided in FSEIS Sec. 3.5.3.2, including $10^{-9}$ cm/sec in the Skull Creek Shale, which is part of the upper confining Graneros Group (FSEIS at 3-34) and $10^{-9}$ cm/sec in the lower confining Morrison Formation (FSEIS at 3-36). This information also is presented in the February 2012 numerical groundwater model (Exhibit APP-025 at 4-5) and TR Sec. 2.7.2 (Exhibit APP-015-B at 2-156 through 2-158).
- A summary of NRC staff's evaluation of the potential for vertical excursions is found in the FSEIS at 4-74:

  " Impacts from vertical excursions will be SMALL because (i) uranium-bearing production zones in the Fall River and Chilson aquifers are hydrologically isolated from adjacent aquifers by thick, low permeability shale layers (i.e., the overlying Graneros Group and underlying Morrison Formation); (ii) a prevailing upward hydraulic gradient occurs across the major aquifers; (iii) the applicant's required mechanical integrity testing program will mitigate the impacts of potential vertical excursions resulting from borehole failure; and (iv) the applicant commits to properly

plugging and abandoning or mitigating any previously drilled wells and exploration holes that may potentially impact the control and containment of wellfield solutions within the proposed project area."

- The thickness and continuity of the major confining units across the site are shown in project-wide Cross Section A-A'-A" in the license application (Exhibit APP-016-E at PDF page 5). This is a 10-mile cross section that begins at Point A near the western license boundary, crosses the initial Dewey wellfield and several Burdock wellfields as it rises to Point A' near the eastern license boundary. The cross section then continues to the southwest through the initial Burdock wellfield. This cross section has been condensed to an 8.5x11" figure in Exhibit APP-017 at 2. The figure shows that the Graneros Group is present above the Fall River Formation across the project area, except where it has been eroded and is absent in the eastern edge of the project area. In the Dewey area (western portion of the project area), the Graneros Group is up to 550 feet thick. Between the Fall River and Chilson aquifers is the Fuson Shale, which ranges in thickness from 20-80 feet across the project area. Beneath the Chilson is the Morrison Formation, which ranges in thickness from 60-140 feet across the project area.

Q.40. How do you respond to the allegation that the application or DSEIS fails to comply with the specification in NUREG-1569 Section 2.7.2 to "develop an acceptable conceptual model of site hydrology adequately supported by the data presented in the site characterization" (CI 2013 at 20, OST 2010 at 22, OST 2013 at 16)?

A.40. This allegation apparently refers to the following statement from NUREG-1569 Sec. 2.7.2 (Exhibit NRC-0013 at 2-21, emphasis added):

> "At a minimum, the reviewer should evaluate whether the **applicant has developed** an acceptable conceptual model of the site hydrology and whether the conceptual model is adequately supported by the data presented in the site characterization."

Clearly conformance with NUREG-1569 Sec. 2.7.2 is demonstrated by NRC's review of the applicant's conceptual model, not whether or not the conceptual model was "developed" in the FSEIS.

A conceptual model of groundwater flow in potentially affected aquifers is presented in the license application, specifically in Sec. 3 of the February 2012 numerical groundwater model (Exhibit APP-025 at 2-6), which, in fact, is titled "Conceptual Model."

Q.41. Is the conceptual model in the numerical groundwater model report the only model of site hydrology developed for this project?

A.41. No. Powertech's license application exceeds the minimum guidance in NUREG-1569 Sec. 2.7.2 by providing two numerical groundwater models in addition to the conceptual model. The first is a numerical model prepared by Petrotek in 2010 to evaluate wellfield-scale issues such as balance, bleed, flare (which is defined on p. 196 of the SER as "lixiviant that might have

migrated beyond the extraction zone, but not as far as the monitoring wells"), and excursion detection/reversal. The 2010 model was provided as Appendix 6.6-B to the TR RAI responses (Exhibit APP-016-BB at PDF pages 65-92). The second numerical model was a site-wide model prepared by Petrotek in 2012 to evaluate hydraulic responses of the Fall River and Chilson aquifers to ISR production and restoration operations (Exhibit APP-025).

Q.42. Did NRC staff document their review of the site-wide numerical groundwater model?
A.42. NRC staff's review of the February 2012 numerical groundwater model is summarized in the FSEIS at 4-64 through 4-65:

> "NRC staff reviewed the applicant's numerical groundwater model and calibration, and it determined that the model was appropriately developed and sufficiently calibrated."

More detailed information is found in Appendix B of the SER (Exhibit NRC-00134 at PDF pages 250-258), which contains the detailed results of NRC staff's evaluation of the February 2012 numerical groundwater model. On PDF page 253, the NRC staff's evaluation is summarized, including their finding that the modeling effort was sufficient to "[e]nhance understanding of the Fall River and Chilson aquifer systems with respect to:

- regional and local flow patterns
- recharge and discharge boundaries
- overall water budget (available and sustainable resources)"

Q.43. Did NRC staff document their review of the conceptual hydrologic model developed for this project?
A.43. Yes. Conformance with the regulatory requirements regarding the conceptual model is demonstrated in the SER (Exhibit NRC-00134 at 22, emphasis added):

> "Staff reviewed the regional geologic information supplied by the applicant and finds that the description presented by the applicant is consistent with published data for the regional geologic setting and supports its **conceptual model** of the subsurface. Based on this review, the staff concludes that the applicant has adequately described the regional geologic setting in accordance with the requirements of 10 CFR 40.41(c)."

Further support for the adequacy of the conceptual model with respect to NUREG-1569 guidance is provided the SER (Exhibit NRC-00134 at 27, emphasis added):

> "The applicant used a combination of published data and site-specific borehole data to develop a conceptual geologic model of the proposed facility. During its review, the staff used published information to confirm the validity of the applicant's **conceptual model**. Based on the staff's review, the applicant's description of regional and site geology is consistent with Section 2.6.3 of the standard review plan [NUREG-1569] and in compliance with 10 CFR 40.41(c)."

### 3.2 Uranium Mineralization Is Contained within Fluvial Sandstones Similar to Those at ISR Facilities That Have Operated Safely for Decades

Q.44. Please respond to the allegation that there is a lack of confinement due to sedimentary formations where sandstones inter-finger with silts and shales, allowing groundwater to flow between inter-fingering facies (CI 2013 at 23, Moran 2010 at 20, Moran 2013 at 15, OST 2010 at 23).

A.44. The Fall River Formation and the Chilson Member of the Lakota Formation, which are the targets for uranium ISR at the project area, are of fluvial depositional origin and consist of interbedded channel and overbank deposits.

The favorable geologic environment, with its thinning channel sandstones interbedded with lower-permeability siltstones and mudstones, creates confining clay units to help control water flow and isolate the uranium-bearing sand from the overall fluvial sand package.

Q.45. Please describe the interbedded siltstones and mudstones within the Fall River and Chilson.

A.45. As described in Powertech's license application (e.g., Exhibit APP-016-B at 1-3), the interbedded clay beds that are found locally within the Fall River and Chilson sandstones may be sufficiently continuous to further subdivide the Fall River and Chilson into discrete, mappable fluvial sandstone packages (i.e., Upper Fall River, Lower Fall River, Upper Chilson, etc.). These interbedded clay beds therefore may act as upper and lower confining units for uranium orebodies that occur in the discrete sandstone intervals. These interbedded clay beds will provide additional confinement beyond the major confining units described previously (Graneros Group, Fuson Shale and Morrison Formation).

Q.46. Is the fluvial depositional system at the Dewey-Burdock Project similar to that at operating or historically operated ISR facilities?

A.46. Yes. Through my experience working with more than a dozen permitted ISR facilities in Wyoming, Nebraska and Texas, the vast majority of the operating and historical ISR facilities have been developed within fluvial depositional systems similar to those present at the Dewey-Burdock Project.

The GEIS (NUREG-1910) provides supporting information that the fluvial depositional systems found at the Dewey-Burdock Project are also found at most or all ISR facilities (Exhibit NRC-0010-A at 3.1-8, emphasis added):

> "Several features are **common to most major sandstone roll-front uranium deposits and their host rocks in Wyoming, South Dakota, Nebraska, and New Mexico** (Rackley, 1972; McLemore, 2007). These features are: (1) **sandstones of fluvial origin** (i.e., produced by the action of a stream or river); (2) common association with arkosic (i.e., sediments with a considerable amount of the mineral feldspar) or micaceous sediment; (3) **siltstones and mudstones interbedded with sandstones**; (4) association with organic materials; (5) presence of pyrite in unweathered deposits; (6) gray color of

the sandstones and light-gray or green color of the mudstones in unweathered deposits; (7) association with volcanic debris in the host formation or in overlying formations; (8) the discordant roll front features or solution fronts; and (9) the sharp contact between mineralized zones and adjacent carbonaceous-free or oxidized zones. The first seven features are related directly to the source rock, sedimentation, and the sedimentary environment; the last two features are related to the mineralizing process."

Based on successful containment of ISR solutions at historically operated ISR facilities, these sedimentary formations should be viewed as positive. The GEIS summarizes the natural conditions and operational controls that have allowed for successful containment of ISR solutions for decades at NRC-licensed ISR facilities (Exhibit NRC-0010-B at G-183, emphasis added):

> "The integrity and confinement of ore-bearing aquifers in each milling region are discussed in broader aspects in Sections 3.2.4.3, 3.3.4.3, 3.4.4.3, and 3.5.4.3. As discussed in Section 2.4.1.2, the production bleed of 1–3 percent provides for lateral confinement of recovery solutions. Furthermore, as discussed in GEIS Section 8.2.5, excursion monitoring wells are placed around ISL facilities for early detection of any problems with horizontal and vertical confinement. If an excursion occurs, the reporting requirement for the licensee is in place, as discussed in GEIS Section 8.3.1. Several cases of successful corrective actions for reported horizontal and vertical excursions at ISL facilities are discussed in GEIS Section 2.11-4. **NRC staff is not aware of any incidents in which nonexempt portions of an ore-bearing aquifer have been contaminated by ISL operations under NRC regulation**."

### 3.3 There is No Evidence That Faults or Fractures Will Substantially Impact Groundwater Flow

Q.47. Please respond to the allegation that there is a lack of confinement due to fractures or faults (CI 2010 at 38-39, CI 2013 at 24, LaGarry 2010 at 2-3, Moran 2013 at 15-16, OST 2010 at 23).

A.47. There is no evidence from USGS mapping or subsurface mapping (based on thousands of drill holes) as well as the differing chemistry of the various formations present that would support the hypothesis that the project area is cut by faults or fractures that would substantially impact groundwater flow.

Q.48. Please summarize information in the license application regarding faults and fractures.

A.48. The project area is located within a structurally "quiet zone," south of the Dewey Fault Zone, southwest of the Barker Dome Anticline and north of the Long Mountain Structural Zone. This location of the project area in relation to structural zones mapped by the USGS is shown in Exhibit 2.6-5 in the June 2011 TR RAI responses (Exhibit APP-016-F) and Figure 2.6-1 in the revised TR (Exhibit APP-015-B at 2-89).

Based on detailed subsurface mapping (based on thousands of drill holes) of the Fall River Formation, Fuson Shale, Chilson Member of the Lakota Formation and the Morrison Formation, no faulting was observed in the project area. Further, as described in the written testimony of Hal Demuth (Exhibit APP-013) at A.31, Powertech constructed geologic cross sections through each of the potential wellfields in the project area using geophysical logs. These cross sections do not support the conclusion that there is faulting within any potential wellfield area.

See also the written testimony of Hal Demuth (Exhibit APP-013) at A.32 through A.37, which summarizes the evidence of hydraulic isolation of the various aquifers within the project area, including water chemistry differences and potentiometric water level elevation differences.

Q.49. Please summarize information in the FSEIS related to faults.
A.49. FSEIS Sec. 3.4.3 summarizes information supporting the lack of faults and low seismic potential of the project area at 3-20:

> "The Dewey Fault is located approximately 1.6 km [1 mi] north of the proposed Dewey-Burdock permit area (Figure 3.4-3). The Dewey Fault is a nearly vertical northeast-to-southwest-trending normal fault with a combined displacement and drag of approximately 152 m [500 ft] on the north side. Given the location and displacement characteristics of this fault, there will be no effect on proposed site activities. The Long Mountain Structural Zone located 11 km [7 mi] southeast of the proposed project area contains several small, shallow faults in the Inyan Kara Group. No faults have been identified within the proposed permit area (Powertech, 2009a). Additionally, according to the USGS Quaternary Fault and Fold Database, no capable faults (active faults) with surface expression occur within a 100-km [62-mi] radius from the center of the proposed site, demonstrating a historically low seismic potential (USGS, 2006a)."

Q.50. Please summarize information in the SER related to faults.
A.50. NRC staff's review of published information on faults in the project vicinity is found in the SER (Exhibit NRC-00134 at 26):

> "A review of the cross sections cited above indicated that no faults or major joints were identified on the Dewey-Burdock Project. Although the applicant identified the Dewey fault north of the Dewey-Burdock Project, no faults, geologic bed displacements, or joints were identified on any cross section or isopach map. A review of USGS information confirms that while faults and folds occur north and east of the site, no such structures are found onsite …"

Q.51. Will Powertech be required to evaluate each wellfield for the presence of faults or fractures prior to operations?
A.51. Yes. Prior to operating each wellfield, Powertech will be required to perform delineation drilling and detailed mapping of the orebodies targeted for ISR operations and the lithology of

overlying and underlying sand units and confining units. This information will be used to revise the geologic conceptual model and design the monitoring well network for each wellfield. Following installation of the monitoring well network, pumping tests will be conducted to demonstrate that the production zone is hydraulically isolated from overlying and underlying aquifers. This testing will assure that no previously unknown faults or fractures with potential to impact the control and containment of ISR solutions are present. NRC and EPA will require submittal of these data and interpretations for their review prior to operating each wellfield.

### 3.4 There is No Evidence of Breccia Pipes in the Project Area

Q.52. Please respond to the allegation that there will be a lack of confinement due to breccia pipes (CI 2010 at 13-14, 17, CI 2013 at 20, Moran 2014 at 22-23, OST 2010 at 22-23, OST 2013 at 16).

A.52. This is one of the four key issues identified by NRC staff in 2011 as requiring additional evaluation and one of the primary focus areas for the June 2011 TR RAI responses (Exhibit APP-016). The license application provides clear evidence that breccia pipes do not exist in the project area. This evaluation is supported by information in the FSEIS and SER.

Q.53. Please summarize information in the license application regarding breccia pipes.

A.53. A detailed analysis on the potential for breccia pipes is included in the response to TR RAI P&R-12(a) in the June 2011 TR RAI responses (Exhibit APP-016-B at 45-58). The information in this RAI response, summarized below, provides clear evidence that breccia pipes do not exist in the project area.

Section 6.2.3 of the Class III UIC permit application (Exhibit APP-042-C at 6-14) summarizes Powertech's evaluation of the potential for breccia pipes in and around the project area:

> "Breccia pipes have been studied and mapped in the southern Black Hills and are known to originate in anhydrite and gypsum sequences within the upper portion of the Minnelusa Formation. Dissolution of these evaporite sequences by underlying Minnelusa and/or Madison artesian water created solution cavities into which overlying Permian sediments collapsed. The aerial extent of dissolution is limited to a few miles downgradient from the Minnelusa outcrop. The probable maximum downgradient limit of dissolution, or dissolution front, has been mapped by the USGS and is more than 6 miles northeast of the project area. There is no evidence of dissolution of the Minnelusa in the project area based on evaluation of an electric log from an abandoned oil and gas test well within the project area. In areas where there has been no dissolution, there is no geologic foundation for the creation of breccia pipes in overlying sediments.
>
> "Further evidence against the presence of breccia pipes is presented in Appendix E [which contains the same information as the TR RAI P&R-12(a) response] and includes exploration drilling, field investigations for breccia pipes, an evaluation of Inyan Kara water temperatures, regional pumping tests, and evaluation of CIR imagery. Further,

calibration of the groundwater model submitted to the NRC in February 2012 (Petrotek, 2012) does not support inflow to the Inyan Kara from deeper formations through breccia pipes."

Exhibit 2.6-4 in the June 2011 TR RAI responses (Exhibit APP-016-E at PDF page 6) depicts the dissolution front in the Minnelusa Formation as mapped by the U.S. Geological Survey in the 1950s, and Exhibit 2.6-5 in the TR RAI responses (Exhibit APP-016-F) depicts the location of the project area in relation to this dissolution front. This dissolution front represents the probable maximum downgradient limit of dissolution, as described above.

Q.54. Please summarize information in the FSEIS regarding breccia pipes.
A.54. NRC staff's evaluation of the potential for breccia pipes is summarized in the FSEIS at E-144, emphasis added:

> "Based on information on breccia pipes presented in SEIS Section 3.4.1.2, **NRC agrees that the limit of collapsed breccia in the Minnelusa Formation does not extend into the Inyan Kara Group either regionally or within the proposed project area**. Text in SEIS Section 3.5.3.1 was revised to include information from SEIS Section 3.4.1.2, which indicates that the probable maximum downgradient limit of collapsed breccias is approximately 8 km [5 mi] northeast of the proposed project area (Braddock, 1963)."

Q.55. Please summarize NRC staff's review of the potential for breccia pipes in the SER.
A.55. NRC staff similarly documented the lack of evidence for breccia pipes within the project area in the SER (Exhibit NRC-00134 at 227, emphasis added):

> "The staff reviewed information from the applicant and outside sources to assess the potential for breccia pipes to occur at the Dewey-Burdock Project. According to USGS Professional Paper 763, **breccia pipes do not occur at the Dewey-Burdock Project** (Garland B. Gott, D. E. W., and C. Gilbert Bowles, 1974). Furthermore, detailed isopach maps, structure maps, and cross sections provided by the applicant do not indicate the presence of collapse structures on the Dewey-Burdock Project (see SER Section 2.3.3.2). Considering these varying sources of information, **the staff concurs with the applicant's assessment that breccia pipes do not occur at the Dewey-Burdock Project**."

### 3.5 Sufficient Controls Will Be in Place to Prevent Lack of Confinement Due to Unplugged or Improperly Plugged Exploration Holes

Q.56. Please respond to the allegation that there is lack of confinement due to unplugged or improperly plugged exploration holes or wells (CI 2010 at 39, CI 2013 at 20, LaGarry 2010 at 3, Moran 2010 at 20, OST 2010 at 22, OST 2013 at 16).
A.56. In my direct experience in working with over a dozen operating ISR wellfields in Wyoming, Nebraska and Texas, most or all of these facilities contain hundreds or thousands of historical exploration drill holes yet have been successful at maintaining control of ISR solutions

and preventing impacts to groundwater outside of the exempted aquifers. The primary reasons for this are that most historical drill holes were plugged and abandoned using techniques sufficient to prevent vertical migration of wellfield solutions; natural processes seal open drill holes; and adequate procedures are in place to locate unplugged or improperly plugged holes during wellfield delineation and testing and prevent potential impacts.

Q.57. Please describe the evidence that historical drill holes were plugged and abandoned sufficiently to prevent vertical migration of wellfield solutions.
A.57. Documentation is presented in Powertech's large scale mine (LSM) permit application to SDDENR that the vast majority of historical drill holes within the project area were plugged and abandoned in accordance with State of South Dakota requirements effective during drilling. Historical TVA drilling and Powertech's exploration drilling were conducted through SDDENR-issued Permits to Explore. These permits required exploration holes to be plugged with bentonite or cement grout. A letter from TVA (operating under its subsidiary Silver King Mines) to SDDENR documenting the historical hole plugging procedures states the following (Exhibit APP-045 at PDF pages 166-168, emphasis in original):

> "In addition, to the best of our knowledge <u>all</u> of the TVA test holes, whether drilled prior to or after issuance of the EX-5 [exploration permit] in 1979, were properly plugged according to the applicable state regulations at the time of drilling. In fact, during the course of the drilling program your department asked SKM to work with the Department to develop and upgrade the State plugging standards. As a result of that combined effort, during which the Department was actively involved in working with SKM and monitoring the drilling program, the State plugging standards changed and evolved. Once again, however, at any given time the hole plugging was conducted in full compliance with the then existing State requirements."

The 1989 TVA letter documents mitigation efforts in the "alkali area," where water seepage to the surface in an isolated area is attributed to historical exploration holes. Seepage in the alkali area is readily apparent at the ground surface, since the potentiometric water level elevation of the Fall River and Chilson are above ground surface in this area, as they are throughout much of the project area. This suggests that if a similar situation were to exist at other locations within the project area, it would be readily detectable. If Powertech chooses to operate an ISR wellfield in the alkali area, it will first need to demonstrate to NRC and EPA that the production zone is sufficiently isolated hydrologically from overlying and underlying aquifers such that ISR operations can be conducted safely in accordance with the NRC license.

Q.58. Please summarize Powertech's evaluation of potential unplugged or improperly plugged exploration holes.
A.58. One of NRC staff's key areas of focus for the TR RAI was the need for additional evaluation of the potential for surface water to be spring fed with production zone groundwater

through unplugged exploration holes. In response, Powertech conducted an alluvial drilling program along the two major drainages in the project area (Beaver Creek and Pass Creek) in May 2011. The response to TR RAI 2.7-9 in the June 2011 TR RAI responses (Exhibit APP-016-C at 201-210) describes how the results of the drilling program did not indicate any areas of discharge to the alluvium from underlying aquifers, but rather were consistent with limited recharge to the alluvium from surface waters in the upland portions of the project area.

The same RAI response describes how an evaluation of color infrared imagery (CIR) was conducted to evaluate possible discharge to the alluvium from bedrock aquifers. The CIR imagery evaluation did not reveal any areas indicative of groundwater discharge into the alluvium from unplugged or improperly plugged exploration holes.

The lack of improperly plugged or unplugged boreholes in the project area also is supported by the natural tendency of drill holes to self-seal if left open. This is described in the response to TR RAI P&R-9 (Exhibit APP-016-B at 32).

Q.59. Please elaborate on this natural tendency for drill holes to self-seal.
A.59. Depending on their location relative to the outcrop of the Fall River Formation, historical drill holes penetrated up to 500 feet or more of marine (bentonitic) shale in the Graneros Group prior to encountering the Fall River Formation. An historical drill hole, uncased and left open for decades, would be likely to self-seal through collapse and swelling of the bentonitic shales. In fact, uncased holes often swell so rapidly that they can be difficult to log even immediately after drilling.

Q.60. Please describe the procedures by which Powertech will identify and mitigate any unplugged or improperly plugged exploration holes in the vicinity of each wellfield.
A.60. Powertech has committed to specific procedures to identify any unplugged or improperly plugged exploration holes or wells in the vicinity of each wellfield in its response to TR RAI P&R-9 in the June 2011 TR RAI responses (Exhibit APP-016-B at 31-33). These include: (1) using historical records such as Powertech's database of the historical TVA drill holes in and around the project area; (2) using color infrared imagery (CIR); (3) field investigations; and (4) potentiometric surface evaluation and pump testing conducted for each wellfield.

The P&R-9 RAI response describes Powertech's commitment to plugging and abandon or otherwise mitigate any unplugged holes or wells that have the potential to impact the control and containment of wellfield solutions (Exhibit APP-016-B at 31).

Q.61. Please describe NRC staff's review of Powertech's procedures to locate and mitigate potential impacts from unplugged or improperly plugged exploration holes.
A.61. Documentation of NRC staff's review of the exploration hole mitigation measures presented in Powertech's license application is provided in the SER (Exhibit NRC-00134 at 28):

> "The staff has reviewed the borehole information provided by the applicant and determined that it sufficiently describes the risks associated with unplugged borings. The

staff concurs that, other than the alkali pond, no other evidence indicates that previously unplugged borings are current groundwater flow pathways. As discussed in SER Section 2.4, groundwater in the Fall River and Chilson Aquifers is under artesian conditions; therefore, groundwater would be expressing itself at the ground surface if unplugged borings were still conduits. The applicant has presented a satisfactory plan for identifying and addressing unplugged borings during operations to avoid potential cross contamination."

### 3.6 The License Application and FSEIS Adequately Characterize the Interaction between Surface and Groundwater

Q.62. Please respond to the allegation that there will be potential discharge to surface water or shallow groundwater due to artesian flow (CI 2010 at 38, LaGarry 2010 at 3-4).

A.62. This testimony addresses the general potential for groundwater discharge to surface water, which was one of the key focus areas in Powertech's June 2011 TR RAI responses (Exhibit APP-016). See also A.56 through A.61 of this written testimony, which specifically address potential lack of confinement due to unplugged or improperly plugged exploration holes. In response to NRC's request to provide additional information regarding the potential for groundwater to discharge to alluvial aquifers, Powertech performed extensive investigations to determine whether groundwater presently discharges to surface water or shallow groundwater (alluvium) within the project area. These included field investigations, use of CIR imagery, potentiometric surface evaluation and alluvial drilling, all of which support the conclusion that water from the Fall River and Chilson aquifers does not discharge to the ground surface or shallow groundwater except in isolated, known areas. The detailed results are presented in Powertech's response to TR RAI 2.7-9 (Exhibit APP-016-C at 201-210). With one exception, groundwater discharging to the surface from the Fall River and Chilson aquifers is limited to existing flowing artesian wells, which will be controlled and mitigated during ISR operations. The only other feature is the "alkali area" described previously.

The other interaction between groundwater and surface water is the well-understood interaction along the major site drainages. This includes recharge of the Fall River and Chilson aquifers from Pass Creek north of the project area and recharge to and discharge from alluvial aquifers from/to Beaver Creek and Pass Creek.

Q.63. Please describe the use of CIR imagery to evaluate the potential for groundwater discharge to surface water.

A.63. CIR imagery was obtained from the National Agriculture Image Program (NAIP) of the USDA Farm Services Agency. This imagery is commonly used to delineate areas of active vegetative growth that are typically associated with irrigation or subirrigation in this semiarid region. The CIR imagery was evaluated for anomalies that would suggest groundwater discharge at or near the surface. Several flowing artesian wells that at times are allowed to discharge groundwater to the surface were visible, as was the "alkali area" discussed in A.57 of this written testimony. CIR imagery evaluation along with extensive field investigations did not reveal any

other areas where groundwater is presently discharging to the ground surface or shallow groundwater. CIR imagery is shown on Exhibit APP-016-C at 204-205 and 207.

Q.64. Please describe how potentiometric surface information was used to evaluate the potential for groundwater discharge to surface water.
A.64. Throughout much of the project area, the potentiometric surfaces of the Fall River and Chilson aquifers are above ground surface. This is shown in Exhibit APP-016-C at 208-209. These areas were mapped and evaluated to assess the potential for groundwater discharge to the alluvium. Other than the "alkali area" and several flowing artesian wells, no existing groundwater discharge to the alluvium was found. The fact that the potentiometric surfaces of these aquifers is above ground surface throughout much of the project area and much of the area where historical exploration drilling occurred is advantageous in identifying potential unplugged boreholes or wells, since surface discharge would be readily identifiable. The obvious evidence of groundwater discharge in the alkali area suggests that if similar situations existed at other locations in the project area they would be readily detectable.

Q.65. Please describe how alluvial drilling was used to evaluate the potential for groundwater discharge to surface water.
A.65. A.58 of this written testimony describes the alluvial drilling program that Powertech conducted in 2011 to determine the extents, thickness and saturation of the alluvium along the two major drainages in the project area. The results of the drilling program did not indicate any areas of discharge to the alluvium from underlying aquifers, but rather were consistent with limited recharge to the alluvium from surface waters in the upland portions of the project area.

Q.66. Please respond to the allegation that there is inadequate discussion in the license application, DSEIS or FSEIS on the interaction between surface and groundwater, especially when the hydrogeologic system is under pumping stress (CI 2013 at 16, Moran 2013 at 23, OST 2013 at 15).
A.66. In addition to the response to TR RAI 2.7-9 described above, Powertech prepared the following responses to address NRC's request to further evaluate the interaction between surface and groundwater.

- TR RAI P&R-5 response, which describes the recharge to the Fall River Formation that occurs where it outcrops on the eastern side of the license area and subcrops beneath the Pass Creek alluvium. This RAI response also addresses the interaction between surface and groundwater at the historical mine pits in the eastern portion of the license area and the "alkali area" described previously. (Exhibit APP-016-B at 22-25)
- TR RAI 5.7.8-12 and 5.7.8-14 responses, which describe how Powertech will monitor the alluvium in wellfields underlying the alluvium both prior to and during ISR operations to demonstrate confinement and to ensure that there is not leakage between bedrock aquifers

and alluvium from anomalies such as improperly plugged boreholes (Exhibit APP-016-D at 510-517, 519-522).

Further, the February 2012 numerical groundwater model (Exhibit APP-025) evaluated potential interaction between surface water in the historical mine pits and groundwater during wellfield operation. The modeling results demonstrated that potential drawdown in the Fall River will be minimal in the vicinity of the Triangle Pit. This limited drawdown is due to the distance from planned ISR wellfields in the Fall River Formation to the Triangle Pit (typically greater than 2 miles) and the presence of the Fuson Shale with a thickness of 20 to 80 feet throughout the project area.

The potential interaction between the Fall River aquifer and Chilson aquifer in the vicinity of the historical mine pits also is addressed by LC 12.7 (Exhibit NRC-0012 at 12), which requires Powertech to install a monitoring well network for the Fall River aquifer in the eastern portion of the license area (Burdock area) for those wellfields in which the Chilson is the extraction zone.

Q.67. Please describe how surface and groundwater interaction is addressed in the FSEIS.
A.67. The potential interaction between surface and groundwater is described extensively in the FSEIS, including:

- Sec. 4.5.1.1.2 (FSEIS at 4-44 through 4-46) describes how Beaver Creek and Pass Creek do not have a natural hydraulic connection to the underlying Fall River and Chilson aquifers across the project site. It also describes the alkali area as an area of known discharge of groundwater to the surface.
- Sec. 3.5.3.2 (FSEIS at 3-34) describes how the 2011 alluvial drilling program did not indicate any areas of discharge to the alluvium along Beaver Creek and Pass Creek from the underlying Fall River aquifer.
- The FSEIS (FSEIS at E-147) describes NRC staff's evaluation of potential impacts to regional springs, including Cascade Springs, and describes how the proposed Madison aquifer withdrawals in the project area and disposal via deep well injection into the Minnelusa will have no impact on groundwater quantity or quality at Cascade Springs, which is 25 miles away and upgradient from the proposed project.

### 3.7 Historical Mine Workings Were Limited to the Fall River Formation and Will Not Impact ISR Operations in the Underlying Chilson Member of the Lakota Formation

Q.68. Please respond to the allegation that there will be a lack of confinement due to historical mine workings (CI 2013 at 23, Moran 2010 at 20, Moran 2013 at 15, OST 2010 at 23).
A.68. Historical mine workings were another key area of focus for Powertech's TR RAI responses, which provide additional evaluation of historical mine workings and strong evidence against the allegation that historical mining will lead to lack of confinement for uranium ISR. Specifically, the response to TR RAI P&R-2 in the June 2011 TR RAI responses (Exhibit APP-

016-B at 4-17) describes how all historical mine workings within and near the project area are located in shallow, near-surface Fall River Formation sandstones. These include open-pit surface mines and shallow underground mines, all of which occur within or beyond the eastern extents of the project area. Based on the location and depth of surface mine pits, these were constructed within Fall River Formation sandstones at or above the water table and above the Fuson Shale confining unit. TVA maps and interviews with people with direct experience in the design and operation of the underground mines confirm that underground mines were similarly limited to the Fall River Formation sandstones. The information presented in the RAI response demonstrates that there are no underground mines within the project area that are not adjacent to, or extensions of, the open pits, all of which target Fall River Formation sandstones.

Since historical mining did not take place in or below the Fuson Shale, it did not create flow pathways between the Fall River and Chilson aquifers.

Q.69. Please describe the thickness of the Fuson Shale confining unit in the vicinity of the historical mine workings.

A.69. In the vicinity of the historical mine workings, the thickness of the Fuson Shale, which is the confining unit between the Fall River Formation and Chilson Member of the Lakota Formation, is approximately 50 feet. This is demonstrated by the isopach map in the license application showing the thickness of the Fuson Shale (Exhibit APP-015-D at PDF page 18 [Plate 26-8]).

Q.70. Did NRC staff review the Fuson isopach map?

A.70. Powertech provided the exploratory drilling data used to create the Fuson isopach map to NRC staff in November 2010. The FSEIS at 4-64 describes NRC staffs verification of Powertech's Fuson isopach map:

> "Using exploratory drilling data the applicant provided (Powertech, 2010b), NRC staff independently constructed isopach maps (i.e., maps showing the thickness of a bed or formation throughout a geographic area) for the Fuson Shale underlying the Burdock area using different statistical methods (e.g., kriging, inverse distance). The resultant isopach maps for the Fuson Shale were in good agreement with the isopach map for the Fuson Shale the applicant presented …"

Q.71. Please describe Powertech's plans for ISR near the historical mine workings.

A.71. Powertech has committed to not developing ISR wellfields in the Fall River Formation in the vicinity of the historical mine workings. This commitment can be found in Exhibit APP-016-B at 4 and Exhibit NRC-00134 at 29. Based on this commitment and the fact that historical mining was limited to the Fall River Formation and did not compromise the Fuson Shale, there are no flow pathways for ISR wellfield solutions to exit the production zone through historical mine workings.

Q.72. Please describe NRC staff's review of Powertech's plan to avoid potential impacts from the historical mine pits.

A.72. NRC staff's evaluation of the potential impacts from historical mine workings is found in the SER (Exhibit NRC-00134 at 29) and is summarized as follows:

> "All mining occurred in the Fall River sands, which overlie the Fuson Shale; the Fuson Shale is approximately 50 feet thick in the Triangle Mine area. According to cross section information (Application Exhibit 2.7-1f), the Fuson Shale is continuous across the area of the Darrow mine pits and underground mine workings … In its request for additional information, the staff requested that the applicant confirm its plans for uranium extraction in the area of the Darrow mine pits (NRC, 2010). The applicant states that it will not conduct any uranium recovery operations in the Fall River Formation in the area of the surface and underground mines. However, it will conduct such operations in the Chilson Member, which is separated from the Fall River Formation by the Fuson Shale … The staff reviewed the information provided by the applicant regarding the location and history of surface and underground mining operations at the Dewey-Burdock Project. The applicant satisfactorily described mine features, mining horizons, and potential impacts on the proposed site operations. Based on the information provided by the applicant, the staff is reasonably assured that the proposed ISR operations at the Dewey-Burdock Project will not be affected by the presence of historic surface and underground mines."

### 3.8 Hydrogeologic Data Presented in the License Application and FSEIS Reliably Portray the Direction of Groundwater Flow in the Relevant Water-bearing Units

Q.73 Please respond to the allegation that hydrogeologic data presented in the DSEIS or FSEIS are inadequate to reliably portray or predict directions of groundwater flow in the relevant water-bearing units (Moran 2013 at 13).

A.73. Information in the FSEIS consistently and adequately portrays the direction of groundwater flow within the project area and the surrounding region. Specific examples include:

- "Potentiometric surfaces for the Fall River and Chilson aquifers indicate groundwater flows from northeast to southwest (Powertech, 2009b). The directional groundwater flow at the proposed site is consistent with regional groundwater flow; regional flow moves outward radially from the Black Hills, which results in northeast-to-southwest regional flow in the general vicinity of the proposed project site." (FSEIS at 3-36)
- "As described in SEIS Section 3.5.3.1, regional groundwater flow moves outward radially from the Black Hills, which results in a northeast to southwest regional flow direction in the vicinity of the proposed project site." (FSEIS at 5-32)
- "Groundwater in regional aquifer systems in southwestern South Dakota flows radially outward from the Black Hills toward the surrounding plains, which results in a northeast-to-southwest regional flow direction in the general vicinity of the proposed project site (see SEIS Section 3.5.3.1). As described in SEIS Section 3.5.3.2, groundwater in local aquifer systems in the vicinity of the proposed project flows from northeast to southwest

consistent with regional groundwater flow. For example, potentiometric surfaces for the Fall River and Chilson aquifers indicate groundwater flows from northeast to southwest (Powertech, 2009b)." (FSEIS at E-181)

Q.74. Please indicate where information regarding groundwater flow direction can be found in the license application.
A.74. Potentiometric surface maps of the Fall River and Chilson aquifers are provided in Exhibit APP-016-C at 192-193. These maps were prepared based on water level measurements collected during a 5-day period in April 2011. These figures clearly show that the potentiometric head decreases from northeast to southwest in the Fall River and Chilson within the project area. Groundwater flow typically is perpendicular to the potentiometric surface contours, going from high potentiometric head to low potentiometric head.

Further information is provided in the February 2012 numerical groundwater model (Exhibit APP-025). One of the primary purposes of the model was to enhance understanding of regional and local flow patterns in the Fall River and Chilson aquifers. Examples of how this was done are provided in the model report, including:

- Updating potentiometric surface maps for the Fall River and Chilson aquifers using average water level elevations during the 2010-2011 monitoring period (Exhibit APP-025 at PDF pages 36-37 [Figures 3-2 and 3-3]).
- Evaluating regional flow patterns in the Inyan Kara Group (which contains the Fall River and Chilson aquifers) based on published USGS studies (Exhibit APP-025 at 2).

Q.75. Please describe the groundwater flow velocity in the Fall River and Chilson.
A.75. When assessing potential groundwater impacts, which is the subject of this contention, groundwater flow velocity is just as important as groundwater flow direction. The February 2012 numerical groundwater flow model describes how the groundwater flow velocities in the Fall River and Chilson aquifers are estimated to be 6.1 feet per year for the Fall River aquifer and 7.3 feet per year for the Chilson aquifer (Exhibit APP-025 at 6). This means that even in the hypothetical scenario that the groundwater flow direction were directly southeast toward the nearest town of Edgemont (which is not the case) and even if the non-exempt portion of the aquifer were somehow contaminated (which has never occurred at an NRC-licensed ISR facility according to the GEIS), it would take some 9,000 to 11,000 years for the contamination to reach Edgemont traveling through the Fall River or Chilson aquifers.

### 3.9 The Average Groundwater Flow Velocities in the Fall River and Chilson Are on the Order of 6 to 7 Feet per Year

Q.76. How do you respond to the allegation that there will be an inability to contain fluid migration due to high horizontal flow velocity (CI 2010 at 38, LaGarry 2010 at 4)?
A.76. This allegation is based on faulty conclusions drawn from the data presented in Powertech's license application. LaGarry alleges that Sec. 3.3.2.2 in the ER states that the

horizontal flow [velocity] in the Chilson aquifer is up to 35.5 meters per day. Such a velocity is not reported in the ER; instead ER Sec. 3.3.2.2 lists the horizontal permeability ranging from $2.6 \times 10^{-3}$ to $4.1 \times 10^{-3}$ cm/sec based on core sample analyses (Exhibit APP-040-A at 3-13).

LaGarry also attempts to compare the reported regional transmissivity values for the Inyan Kara (up to 6,000 $ft^2$/day in ER Sec. 3.4.3.1.2) with the alleged 35.5 m/day velocity. This relies on an incorrect assumption – that transmissivity can be converted directly to velocity. LaGarry uses the inaccurate velocity value to estimate that groundwater will reach "the major, mapped faults north of the Pine Ridge in Nebraska in less than 5 years (using the smaller value)." In contrast, the USGS estimated that will take 10,000 years for groundwater to reach Edgemont, which is about 13 miles away (Exhibit APP-023 at 17).

Powertech calculated the average groundwater velocity in the Fall River and Chilson aquifers to be approximately 6 to 7 feet per year (Exhibit APP-025 at 6).

Q.77. Please describe how Powertech calculated the average groundwater velocity in the Fall River and Chilson.

A.77. As explained in the February 2012 numerical modeling report (Exhibit APP-025 at 6), the horizontal velocity may be calculated using Darcy's Law. Darcy's Law is used for calculating groundwater velocity between two points in porous media in the same hydrostratigraphic unit and can be expressed as the hydraulic conductivity of that unit multiplied by the hydraulic gradient between those points, divided by the effective porosity. Based on site-specific measurements of hydraulic conductivity and hydraulic gradient and an estimate of effective porosity, the estimated flow velocities in the Fall River and Chilson are approximately 6 to 7 feet per year.

Q.78. Are these typical groundwater flow velocities for ISR facilities?

A.78. Based on my experience working with over a dozen permitted ISR facilities, groundwater flow velocities on the order of 10 feet per year are typical for ISR facilities. Further, the USGS independently estimated the horizontal flow velocity in the Chilson aquifer to be 4.34 meters per year (Exhibit APP-041 at 36), which equates to about 14 feet per year. Although somewhat higher than the estimates in the February 2012 numerical modeling report described above, this value is consistent with Powertech's estimate and consistent with typical natural flow velocities at uranium ISR facilities. In contrast the value alleged by LaGarry of 35.5 meters **per day** is some 6,000 times higher than Powertech's estimate and is not supported by the hydrologic data presented in the application.

Q.79. Please comment on how horizontal migration of ISR solutions will be controlled.

A.79. Horizontal fluid migration will be limited by operational controls (especially maintaining hydraulic wellfield control through bleed and wellfield balancing) and verified through monitoring. This is summarized in the FSEIS at 4-73 through 4-74:

> "Impacts from horizontal excursions will be SMALL because (i) uranium-bearing production aquifers will be exempted as USDWs through the EPA-issued aquifer exemption in accordance with the criteria under 40 CFR 146.4, (ii) the applicant will be required to submit wellfield operational plans for NRC and EPA approval, (iii) inward hydraulic gradients will be maintained to ensure groundwater flow is toward the production zone, and (iv) the applicant's NRC-mandated groundwater monitoring plan will ensure that excursions are detected and corrected."

Further, the FSEIS at E-94, citing GEIS Sec. 2.11.4, describes how horizontal excursions generally are recovered quickly (weeks to months) by adjusting pumping rates in the vicinity of the excursion. Similarly, the NRC Staff Assessment of Groundwater Impacts from Previously Licensed ISR Facilities describes how "[m]ost excursions were short-lived," "[f]or most of those events, the licensees were able to control and reverse them through pumping and extraction at nearby wells" and "[n]one had resulted in environmental impacts" (Exhibit NRC-0075 at 1-2).

### 3.10 Leakage between the Fall River and Chilson in Localized Areas Is Attributed to an Improperly Completed Well and the Presence of One or More Open Boreholes in a Limited Area

Q.80. Please respond to the allegation that the 1979 and 2008 pumping tests reveal leakage between the ore zones and the surrounding formations (CI 2010 at 16-17, CI 2013 at 24, Moran 2010 at 21, OST 2010 at 23-24).

A.80. This allegation concerns the results of previous pumping tests conducted in and near the project area, which are described in TR Section 2.7.2.3 (Exhibit APP-015-B at 2-167 through 2-178). These included TVA pumping tests conducted from 1977 through 1982 and Powertech pumping tests conducted in 2008. Figure 2.7-28 in the revised TR (Exhibit APP-015-B at 2-169) depicts the locations of three TVA pumping tests conducted in 1979 and 1982 and two Powertech pumping tests conducted in 2008.

TVA pumping tests evaluated in Powertech's license application include two tests conducted in the Burdock area (one each on the Fall River and Chilson aquifers) and one in the Dewey area (Fall River aquifer). The results of the TVA tests are summarized in two reports provided in Powertech's license application: Boggs and Jenkins, 1980 and Boggs, 1983 (Exhibit APP-016-R). During the 1979 TVA tests in the Burdock area, hydraulic communication was observed between the Fall River and Chilson aquifers. In the summary and conclusions section of Boggs and Jenkins, 1980, they note (APP-016-R at PDF page 42):

> "The aquifer test results indicate that the Fuson member of the Lakota formation is a leaky aquitard separating the Fall River and Lakota aquifers. The Hydraulic communication between the two aquifers observed during the tests is believed to be the result of (1) general leakage through the primary pore space and naturally occurring joints and fractures of the Fuson shale, and (2) direct connection of aquifers via numerous old unplugged exploratory boreholes."

Upon closer inspection of the text, Boggs and Jenkins specifically state that the response in the overlying Fall River to pumping in the Chilson must be indicative of direct flow from one to another (i.e., such as would occur through unplugged exploration holes or a well completed in both formations, Exhibit APP-016-R at PDF page 26):

> "The fact that a greater pumping response is observed in [the] Fall River formation than in the Fuson during the early part of the test indicates that direct (though restricted) avenues through the Fuson must exist. This condition was suspected before the test, and is believed to be the result of numerous old, unplugged uranium exploration boreholes in the test vicinity."

Q.81. What is your conclusion regarding the cause of communication between the Fall River and Chilson during the 1979 pumping test?

A.81. Based on evaluation of historical TVA pump test data presented in Boggs and Jenkins (1980), the reported "leaky aquifer" response is likely related to: (1) a nearby well that has since been confirmed to have been completed in both the Chilson and Fall River aquifers and therefore can provide a direct communication pathway, and/or (2) the presence of one or more open boreholes in a limited area near the Burdock test. The test results do not support general leakage through the Fuson Shale. In fact, further evaluation of the data suggests the response was caused by an improperly constructed well, as discussed below.

Q.82. Please describe whether the 2008 pumping test showed communication between the Fall River and Chilson.

A.82. The 2008 Powertech pumping test in the Burdock area similarly resulted in a small response in the overlying Fall River aquifer when a well was pumped in the Chilson aquifer. More specifically, drawdown in the Chilson at the pumping well was approximately 91 feet, and approximately 1 foot of drawdown was observed in the Fall River. Powertech's previous conclusions and interpretations from this pump test submitted with the original license application indicated that the Chilson behaved as a leaky aquifer system. Further review of the site geology and hydrology suggests that interpretation was not representative of site conditions. Rather, based on the thickness and continuity of the Fuson Shale throughout the project area and permeability measurements from core samples, the response in the Fall River aquifer during the 2008 pumping test in the Chilson aquifer is attributed to the same causes as the 1979 TVA test: (1) a nearby well completed in both the Fall River and Chilson and/or (2) unplugged or improperly plugged boreholes in a limited area near the test.

Q.83. Please describe the well that was completed in both the Fall River and Chilson aquifers.

A.83. Powertech confirmed that well 668, which was installed by TVA for the purposes of pumping tests, is screened across the Chilson and Fall River (Exhibit APP-015-C at 5-21d). Further, when Powertech placed a temporary plug between the Fall River and Chilson completion intervals in this well, a difference in potentiometric head was observed. This

demonstrates that the Fuson Shale is an effective confining unit except in limited areas where direct communication through the Fuson is caused by improperly screened wells or unplugged boreholes.

Q.84. Please describe the measures that Powertech will take to ensure that communication between the Fall River and Chilson does not result in lack of containment of ISR solutions.
A.84. Prior to operating each wellfield, Powertech will be required to demonstrate that the production zone is hydraulically isolated from underlying and overlying aquifers. This will be done through wellfield-scale pumping tests as described in A.51 of this written testimony. If leakage through a confining unit such as the Fuson Shale is observed during the pumping test, Powertech will be required to identify and correct the source of leakage and repeat the pumping test until confinement is demonstrated to the satisfaction of NRC and EPA staff.

### 3.11 The Pumping Test Durations Are Adequate for Their Intended Purpose

Q.85. Please respond to the allegation that there is a lack of long-term pump testing data (CI 2013 at 25, Moran 2013 at 7, 13, Moran 2014 at 26).
A.85. TR Figure 2.7-28 (Exhibit APP-015-B at 2-169) shows the location and duration of five pumping tests that were evaluated in the license application. The duration of these tests ranged from 2 to 11 days. These durations are consistent with those of more than 40 wellfield pump tests that Petrotek Engineering Corporation has designed and conducted at uranium ISR facilities in Texas, Wyoming and Nebraska. The durations were sufficient to calculate the hydraulic properties of the production-zone aquifer (Fall River or Chilson) and confining unit (Fuson) for each test. Further, the tests were designed to evaluate communication between the pumping well(s) and monitor wells that clearly was a cause and effect response (i.e., a response that could be clearly differentiated from background fluctuations and changes due to barometric pressure).

Q.86. Please compare the duration of the Dewey-Burdock Project pumping tests with those at other ISR facilities.
A.86. The pump testing durations at the Dewey-Burdock Project are consistent with the durations of pump testing at recently and historically licensed ISR facilities, including:

- Moore Ranch Project (SUA-1596), historical pumping tests conducted by Conoco between 1977 and 1980 ranged in duration from less than 1 day to about 2 days, and 2007 pumping tests conducted by Energy Metals Corporation ranged in duration from 1 to 10 days (Energy Metals, 2007).
- Nichols Ranch ISR Project (SUA-1597), pumping tests ranged in duration from several hours to about 3 days (Uranerz Energy Corporation, 2007).
- Lost Creek ISR Project (SUA-1599), pumping tests ranged in duration from 30 minutes to approximately 3 days, except that one test was conducted for nearly 6 days specifically to evaluate the impacts of a fault that is present within the project area (Lost Creek ISR Project, 2010).

- Ross ISR Project (SUA-1601), pumping tests conducted by Strata Energy, Inc. ranged from 1 to 3 days (Strata Energy, 2010).
- Crow Butte Project (SUA-1534), pumping tests conducted in 1982 and 1987 in support of the NRC license application ranged from 2 to 3 days (Ferret Exploration, 1987).

The 11-day pumping test conducted by TVA in the Chilson aquifer actually is significantly longer and at a much higher flow rate (495 gpm) than what typically would be conducted for a uranium ISR facility. The reason is that this test was done as part of an evaluation for a potential underground mine that would have required the production-zone aquifer to be dewatered.

The 200-gpm TVA pumping test conducted for 3 days in the Burdock area also is a much higher flow rate than what would typically be conducted for a uranium ISR facility. This is approximately 10 times that anticipated typical bleed rate from a planned ISR wellfield at the Dewey-Burdock Project.

Q.87. Please describe NRC staff's review of Powertech's evaluation of recent and historical pumping test results.

A.87. NRC staff reviewed Powertech's pumping test results and Powertech's evaluation of previous pumping tests conducted by TVA in Sec. 2.4.4 of the SER. The results of the review are summarized as follows (Exhibit NRC-00134 at 54):

> "Based upon the review conducted by the staff, and based on information provided by the applicant, the staff determines that the applicant's description of surface water hydrology and hydrogeology is consistent with Section 2.7.3 of the standard review plan and complies with 10 CFR 40.31(c)."

### 3.12 The 2012 Numerical Groundwater Model Provides a Reasonable Representation of Site Hydrologic Conditions without Introducing Unsubstantiated Features Such as Faults or Breccia Pipes

Q.88. Please describe your role in the preparation of the February 2012 numerical groundwater model.

A.88. I developed the groundwater model that is provided in Exhibit APP-025.

Q.89. Please describe your prior experience in developing groundwater models for uranium ISR facilities.

A.89. I developed the groundwater models used in licensing of the UR Energy Lost Creek ISR project and the Uranium One Moore Ranch ISR project, both in Wyoming. NRC staff reviewed and accepted both models and issued source material licenses for each site. I have provided oversight for modeling developed for the AUC Reno Creek license application that is currently under review by NRC. I developed a model for the Cogema Irigaray site, also in Wyoming, that was used to support a demonstration of aquifer restoration at that facility. That model was accepted by the NRC and groundwater was deemed restored. I have developed numerous

wellfield-scale models for the Uranium One Willow Creek Project (formerly the Christensen Ranch Project) in Wyoming, to support production and restoration at those sites. Outside of the United States, I have developed models to support feasibility studies and due diligence reviews for ISR projects in Turkey and Kazakhstan.

Q.90. Please describe the primary purpose of the February 2012 numerical groundwater model.
A.90. The primary purpose of the model was to evaluate hydraulic responses of the Fall River and Chilson aquifers to ISR production and restoration operations at the site and to better understand the regional and local Fall River and Chilson aquifer systems.

Q.91. Please respond to the allegation that the Petrotek (2012) hydrogeologic model does not consider the presence of faults, fractures, breccia pipes, or open boreholes (Moran 2014 at 29).
A.91. Refer to A.47 through A.51 of this written testimony, which describe how there is extensive evidence against the presence of faults or fractures in the project area that would substantially impact groundwater flow. Also refer to A.52 through A.55, which describe evidence that strongly supports the conclusion that there are no breccia pipes within several miles of the project area. Also refer to A.56 through A.61, which describe how historical exploration holes were plugged in accordance with State standards at the time of drilling and there is only one isolated area where unplugged or improperly plugged boreholes are suspected to occur. Further, Powertech will be required to demonstrate adequate confinement of each production zone to NRC and EPA staff prior to operating each wellfield. Since features such as faults, fractures, breccia pipes and open boreholes are not present or only present in very limited instances across the site, they were not included in the development of the February 2012 numerical groundwater model (Exhibit APP-025), which provides a reasonable representation of site hydrologic conditions without introducing such unsubstantiated features.

Q.92. Please describe the model calibration and verification procedures.
A.92. The groundwater model was calibrated to potentiometric surfaces determined from multiple water level measurements of monitor wells located within the project area. Additional information is found in Exhibit APP-025 at 12-14.

The groundwater model also was verified to the response of the Fall River and Chilson aquifers to pumping tests within and near the project area. This is described in Exhibit APP-025 at 14-15.

Q.93. Please describe NRC staff's review of the groundwater model.
A.93. As described in A.42 of this written testimony, NRC staff's detailed review of the groundwater model is provided in the SER. A summary of their review is found in the FSEIS at 4-64:

> "NRC staff reviewed the applicant's numerical groundwater model and calibration, and it determined that the model was appropriately developed and sufficiently calibrated."

Q.94. Did the modeling include evaluation of a hypothetical breccia pipe in the project area?
A.94. Yes. Although there is no evidence for breccia pipes in the project area, a hypothetical breccia pipe was simulated to assess the potential hydraulic impacts of a breccia pipe. No such features have been indicated in potentiometric data collected from the groundwater monitoring network; thus, the model could not be calibrated with the hypothetical breccia pipe in place. The results of the breccia-pipe simulation show that if significant amounts of groundwater were transmitted upward from deeper aquifers such as the Minnelusa there would be notable mounding (rise) to the potentiometric surface that would be detected with the current and proposed monitoring network.

Figure 7-1 from the 2012 numerical groundwater model report (Exhibit APP-025 at PDF page 111) shows the results of the simulated hypothetical breccia pipe discharging 200 gpm of groundwater into the Fall River aquifer. It shows a large mound in the Fall River potentiometric surface resulting from the hypothetical breccia pipe. Figure 7-3 (Exhibit APP-025 at PDF page 113) shows a similar simulation for the Chilson aquifer. Because of the large change in the potentiometric surface, the occurrence of discharge from a breccia pipe into either the Fall River or Chilson should be observable with the existing monitor well network and would definitely be noticed once a monitor ring has been installed around a proposed production unit. No such recharge mound has been observed to date.

NRC staff assumed the opposite in the SER – that flow would be from the Inyan Kara into deep aquifers if breccia pipes were to exist, based on the hypothesis that the potentiometric surface of the Minnelusa may be lower than that of the Inyan Kara (Fall River and Chilson). Regardless of the direction of flow, NRC staff determined that Powertech will have the procedures in place to identify the presence of a breccia pipe if it were present. This is summarized in the SER (Exhibit NRC-00134 at 101, emphasis added):

> "[T]he staff's independent review of published reports indicates the opposite; water would flow out of the Chilson and Fall River Aquifers because the hydraulic heads in these aquifers are higher than those of underlying aquifers. This difference does not change the staff's determinations that breccia pipes are not located in the license area. **The staff also finds that the applicant will be able to identify any hydrogeologic conditions indicative of breccia pipes during the installation and analysis of individual wellfields**."

### 3.13 The 2012 Numerical Groundwater Model Adequately Addresses Heterogeneity in the Fall River and Chilson Aquifers

Q.95. Please respond to the allegation that the Petrotek (2012) hydrogeologic model does not consider the complex inter-fingering of Inyan Kara sediments but instead assumes they are homogeneous (Moran 2014 at 29).
A.95. This allegation is incorrect and reflects a lack of understanding of the purpose and utility of a site-wide model. Although "complex interfingering of Inyan Kara sediments" was not built into the model on a micro scale, the effects of all such features are included on a site-wide basis. If any such features had significant effects on the site-wide hydrogeology it would not have been

possible to calibrate and verify the model as was done in this case. The model addressed site-wide heterogeneity in the Fall River and Chilson aquifers by using zones of varying hydraulic conductivity to facilitate model calibration.

The 2012 numerical groundwater model was designed to serve as a site-wide, predictive model to estimate cumulative drawdown impacts, etc. from the entire ISR project. The objectives of the model, as stated in Exhibit APP-025 at 1-2, were to:

- Enhance understanding of the Fall River and Chilson aquifer systems with respect to regional and local flow patterns, recharge and discharge boundaries, and overall water budget (available and sustainable resources)
- Evaluate potential hydraulic impacts (e.g., drawdown and potential dewatering) from production and restoration operations on both the local and regional scale
- Assess any potential communication (if any) between the Fall River and Chilson aquifers during production and restoration activities
- Compare hydraulic impacts of variable bleed rates and production rates on the Fall River and Chilson aquifers
- Determine the level of interference between wellfields that could occur with simultaneous production and restoration operations
- Evaluate the potential impacts of ISR operations to an open-pit mine located within the project area that intercepts Fall River groundwater
- Assess the potential hydraulic impacts that would result from a hypothetical breccia pipe

Q.96. Please describe the extents of the model.

A.96. The model domain encompasses an area of nearly 360 square miles with north-south and east-west dimensions of 100,000 feet (18.9 miles). North and east of the project area the Fall River Formation and the Chilson Member have been eroded away. The northern and eastern extent of the model domain represents the natural updip termination of saturated conditions within the Inyan Kara aquifer system in the vicinity of the project area due to this absence of the Fall River and Chilson hydrologic units. The south and west boundaries of the model extend at least 10 miles beyond the project area. The model domain is depicted on Figure 4-1 in the model report (Exhibit APP-025 at PDF page 39).

The model grid was designed to provide adequate spatial resolution within the project area to simulate response of the aquifer to extraction and injection rates anticipated for the Dewey-Burdock Project. The model domain was extended a considerable distance from the wellfield boundaries to minimize impacts of exterior boundary conditions on the model solution.

The cell dimensions within the vicinity of the Project Area are 100 feet by 100 feet. Cell dimensions are gradually increased to a maximum size of 400 feet by 400 feet near the edges of the model. The model consists of 525 rows and 523 columns with 4 layers and contains 1,098,300 cells.

Q.97. Please describe how the various geologic formations were incorporated into the model.
A.97. The four layers of the model represent, from shallowest to deepest, the Graneros Group, the Fall River Formation, the Fuson Shale and the Chilson Member of the Lakota Formation. The Morrison Formation beneath the Chilson is considered a regional confining unit and is represented as a no-flow boundary in the model. The Graneros Group is also considered a regional confining unit but was included in the model to provide a reference point for water level elevations within the Fall River and Chilson aquifers relative to ground surface.

Ground surface elevation corresponds to the top of the model, and the bottom of the Chilson corresponds to the base of the model. Structure contour data within the project area are based on site borings. Outside of the project area, formation tops and bottoms are largely based on oil and gas well logs. The geologic dips of the surfaces are projected out to the model limits.

Q.98. Please describe how the model was calibrated to site conditions.
A.98. The initial potentiometric surfaces of the Fall River and Chilson were estimated from average water level measurements collected from baseline monitor wells in 2010 and 2011. The model was calibrated to potentiometric surfaces built from these monitor wells across the entire project area, and the calibrated model was verified to regional pump tests within and adjacent to the project area.

Hydraulic conductivity determined from recently conducted site pumping tests were used to establish initial values in the model. Zones of hydraulic conductivity were set up to facilitate calibration of the model. During calibration, parameter values were maintained within the general range exhibited in the pumping tests.

The modeling was done on a regional/site characterization level consistent with the information required under NUREG-1569 Sec. 2.7, and in fact numerical modeling is above and beyond the minimum requirements for license applications. As described in A.40 through A.43 of this written testimony, NUREG-1569 Section 2.7.2 review criteria require a conceptual model of site hydrologic conditions, not a numerical model.

As stated above, NRC staff reviewed the numerical model and calibration, and they determined that the model was appropriately developed and sufficiently calibrated.

### 3.14 The 2012 Numerical Groundwater Model Adequately and Conservatively Addresses the Dewey Fault

Q.99. Please respond to the allegation that the Petrotek (2012) hydrogeologic model assumes the Dewey Fault is a no-flow boundary, despite the fact that Boggs (1983) presents conflicting statements about the fault. (Moran 2014 at 29).
A.99. The Dewey Fault is a steeply dipping to vertical normal fault with the north side uplifted several hundred feet by a combination of vertical and horizontal displacement. The Dewey Fault system has sufficient offset such that there is a break in the continuity of the Fall River and Chilson units. Therefore, the assumption used in the development of the numerical groundwater flow model is that there is no flow across the fault in either the Fall River or Chilson aquifers.

The model domain north of the Dewey Fault system is simulated using the no-flow boundary condition.

See also FSEIS quotation under A.49 of this written testimony, which describes how the Dewey Fault has a combined displacement and drag of approximately 500 feet and is not anticipated to have any effect on proposed site activities.

A primary purpose of the model was to assess water availability. Assuming the Dewey Fault is a no-flow boundary limits the amount of water that is available as recharge from the north and therefore represents a conservative approach regarding the assessment of water availability.

If, in fact, the Dewey Fault acts to merely restrict, rather than prevent, the flow of water (i.e., partial offset), the actual drawdown impacts within the project area will be less (although they could spread further north of the fault). Since drawdowns were shown to be minimal in both the Fall River and Chilson units (about 12 feet and 10 feet, respectively at the license boundary), a small drawdown toward the north would not be a serious impact.

### 3.15 The 2012 Numerical Groundwater Model Adequately Assesses Potential Drawdown Impacts

Q.100. Please respond to the allegation that computer simulations only provide rough approximations of quantitative results; often the results may be in error by hundreds of percent (Moran 2014 at 30).

A.100. The magnitude of potential error claimed in this allegation probably reflects the commenter's inexperience with groundwater modeling, development of a hydrogeologic conceptual model, use of field data for model calibration, or unfamiliarity with the hydrogeology of the Dewey-Burdock project area. Also, this allegation does not state which "results may be in error by hundreds of percent." The maximum modeled drawdown in the Fall River and Chilson aquifers are about 12 feet and 10 feet, respectively at the license boundary (Exhibit APP-025 at 26). An error of hundreds of percent (i.e., 2 times or more) in these values would be highly unlikely based on the model calibration and verification described previously. Even the drawdown were greater than predicted, it is unlikely that nearby water supply wells would be impacted, since the potentiometric water level elevation in these wells is typically hundreds of feet above the top of the aquifer.

The objectives of the numerical groundwater flow model are listed in A.95 of this written testimony. In summary, the model was used to evaluate several issues that had been raised as concerns by NRC staff such as water availability, water withdrawal impacts of operating and restoring groundwater in multiple wellfields, and impacts on area water supply wells.

The model is used to assist the user as a decision-making tool, allowing the user to adjust the input parameters such as which wellfields(s) are in production and restoration at a given time and at what net flow rate and to evaluate the probable outcome. While there is no expectation of 100% accuracy, the model is the best tool available at the time it was developed to do predictive analysis of probable and reasonable outcomes.

The model inputs and calibration were based on site-specific data including hydraulic properties obtained from pumping test results and core samples, potentiometric data, observed drawdown during pumping tests, etc. Certain parameters were adjusted as necessary to improve calibration, but they remained within the general range of values determined from pump tests conducted in the project area. With this calibration it is very difficult to imagine how the model could be off by "hundreds of percent."

Calibration to steady-state potentiometric surfaces based on monitor well data and verification of the model to transient pump testing results provided confidence in the model's ability to predict site-wide impacts.

Q.101. Please describe any other evidence that adequate water is available in the Fall River and Chilson aquifers for uranium ISR.
A.101. Water availability is supported by SDDENR staff's report to the Chief Engineer on the Inyan Kara water right application (Exhibit APP-048). Specifically, that report contains the following findings:

- "Approval of this application will not result in average annual withdrawals from the Inyan Kara aquifer to exceed the average annual recharge to the aquifer" (Exhibit APP-048 at 13).
- "The Inyan Kara aquifer is an extensive aquifer and there is a reasonable probability that there is at least 274.2 acre-feet per year [the requested appropriation amount] of unappropriated water available from the aquifer" (Exhibit APP-048 at 13).
- "SD DENR-Water Rights Program observation well data indicates that unappropriated water is available from the Inyan Kara aquifer" (Exhibit APP-048 at 13).
- "There is a reasonable probability that the diversion proposed by this appropriation can be made without unlawful impairment of existing appropriative rights or domestic wells" (Exhibit APP-048 at 13).
- "The quantities of both the average annual recharge and the average annual use for the Inyan Kara aquifer are both small percentages of the amount of water stored in the Inyan Kara aquifer so the aquifer can actually withstand several years of drought conditions with only minimal impact to wells" (Exhibit APP-048 at 5).

Q.102. Please describe what will happen if the model results are inaccurate by hundreds of percent as alleged.
A.102. Regarding any potential impacts on area water supply wells above those predicted by the model, such impacts will be protected by the Inyan Kara water right permit, which will protect existing water right holders and nearby domestic wells, which do not require water rights under South Dakota law.

Regarding the other model objectives such as controlling production fluids, this will be further demonstrated through wellfield-scale evaluations and pumping tests, and the results will be provided to NRC and EPA staff in wellfield packages prior to operating each wellfield.

### 3.16 The License Application Adequately Addresses Limited Areas Where the Fall River is Partially Saturated

Q.103. Please respond to the allegation that in areas of the Fall River Formation that are not hydrologically confined, hydrogeologic investigations to determine the potential impacts of mining will not be done prior to license issuance but after issuance (CI 2013 at 22, OST 2013 at 17).

A.103. This allegation mischaracterizes the purpose of the additional hydrogeological investigations that Powertech has committed to perform should it decide to develop ISR wellfields in the Chilson aquifer in the eastern portion of the license area where the Chilson aquifer is confined geologically, but hydraulically is only partially saturated. This is commonly referred to as a "hydraulically unconfined aquifer," meaning simply that the potentiometric water level is not above the base of the overlying confining unit (Fuson Shale). It is important to stress that the Chilson is confined geologically by the overlying Fuson Shale, which averages 50 feet thick in this area (refer to A.69). Moreover, locally occurring shale units in the Chilson are expected to provide additional geologic confinement of the production zones in these areas such that the portion of the aquifer targeted for ISR will be fully saturated and geologically confined or, at a minimum, will contain sufficient head to perform normal ISR operations.

Following license issuance, Powertech will be required to design and install monitoring networks for each wellfield, including the three Burdock-area wellfields where the Chilson is not fully saturated but is geologically confined by the overlying Fuson Shale. In these cases, it is anticipated that local confining units within the Chilson aquifer will have sufficient thickness and continuity to provide hydraulic isolation of the production zone. Powertech will be required to demonstrate production zone isolation through pump testing prior to operating these and all other wellfields. The purpose of the additional investigations is not to determine the potential impacts of ISR, but to demonstrate production zone isolation and to ensure that sufficient potentiometric head is available to perform normal ISR operations.

Q.104. Please describe the procedures by which NRC staff will review the pump testing results for each wellfield in this area.

A.104. Powertech also will be required to submit, for NRC review and formal approval (i.e., requiring a license amendment), the hydrologic test packages for the three wellfields to which this applies (B-WF6, B-WF7 and B-WF8). Included in the hydrologic test package will be justification for well spacing in the monitor well ring and overlying and underlying aquifers.

Again, Powertech is not allowed by federal regulations to construct the entire wellfield monitor well network or conduct the wellfield pump testing and prepare the hydrologic test packages until after license issuance; thus, they could not be included in the FSEIS.

## 4. CONTENTION 4

Q.105. What is the nature of your testimony on this contention?
A.105. My testimony addresses a specific allegation regarding the estimate of the sustainable pumping rate in the production zone aquifer.

### 4.1 The Previous Estimate of the Sustainable Inyan Kara Pumping Rate Was Updated in the 2012 Numerical Groundwater Model

Q.106. Please respond to the allegation that the DSEIS reports that Powertech has calculated that the sustainable pumping rate from the Inyan Kara aquifer is 40 gpm, yet the DSEIS and Powertech indicate that the operational requirements for the CPP alone would be 65 gpm (CI 2013 at 27-28, Moran 2013 at 12).
A.106. As described in the FSEIS at 4-68, "the estimated sustainable net extraction rate from the Inyan Kara aquifer … is estimated to be at least … 147 gpm … for 2 years and …96 gpm for 8 years …"

In fact the Inyan Kara aquifer probably could sustain a much larger withdrawal rate – a larger rate was not modeled because there wasn't a need. The fact that drawdowns from the operation are minimal and water levels recover within about one year after operations cease is indicative that the aquifer could sustain much larger pumping rates than are proposed at the Dewey-Burdock Project. ISR actually does not require much water relative to many other types of uses (including irrigation), and there are many incentives for Powertech to minimize water withdrawal, not the least of which is to minimize the amount of water that must be disposed by land application or deep well injection, both of which are relatively expensive.

The previous estimate of 65 gpm water usage for the central processing plant (CPP), as presented in Powertech's 2009 ER and TR, has been replaced by Powertech's current estimate of 12 gpm, which is consistently used throughout the June 2011 TR RAI responses (Exhibit APP-016-B at 69, 84-85), revised TR (Exhibit APP-015-B at 2-181 and Exhibit APP-015-C at 3-21f and 4-27c), FSEIS at 2-36 and SER (Exhibit NRC-00134) at 86.

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**UNITED STATES OF AMERICA**
**NUCLEAR REGULATORY COMMISSION**

**BEFORE THE ATOMIC SAFETY AND LICENSING BOARD**

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| In the Matter of: | ) | |
| | ) | |
| POWERTECH USA, Inc. | ) | Docket No. 40-9075-MLA |
| | ) | ASLBP No. 10-898-02-MLA-BD01 |
| | ) | |
| (Dewey-Burdock Project | ) | |
| In Situ Uranium Recovery Facility) | ) | |

**AFFIDAVIT OF ERROL LAWRENCE**

I declare under penalty of perjury that my statements in prefiled Exhibits APP-037 (Errol Lawrence Initial Testimony) and APP-038 (Errol Lawrence CV) are true and correct to the best of my knowledge and belief.

Errol Lawrence

Executed in Littleton, CO
this 20th day of June, 2014