UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

SECOND SUPPLEMENTAL DECLARATION OF DR. ROBERT E. MORAN

I, Dr. Robert E. Moran, do hereby swear that the following is true to the best of my knowledge:

1. **Professional Qualifications and Introduction**

Robert E. Moran, Ph.D.
Michael-Moran Assoc., LLC
Water Quality/Hydrogeology/Geochemistry
Golden, Colorado, U.S.A.
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I am a hydrogeologist and geochemist with more than 42 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, NGO's, law firms, and governmental agencies at all levels. Much of his technical expertise involves the quality and geochemistry of natural and contaminated waters and sediments as related to mining, nuclear fuel cycle sites, industrial development, geothermal resources, hazardous wastes, and water supply development. In addition, I have significant experience in the application of remote sensing to natural resource issues, development of resource policy, and litigation support. I have often taught courses to technical and general audiences, and has given expert testimony on numerous occasions. Countries worked in include: Australia, Greece, Bulgaria, Mali, Senegal, Guinea, Gambia, Ghana, South Africa, Iraqi Kurdistan, Oman, Pakistan, Kazakhstan, Kyrgyzstan, Mongolia, Romania, Russia (Buryatia), Papua New Guinea, Argentina, Bolivia, Chile, Colombia, Guatemala, Honduras, Mexico, Peru, El Salvador, Belgium, France, Canada, Great Britain, United States. My curricula vitae is attached.

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2. **Literature Reviewed**

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NRC Responses to Comments do not Address or Change Previous Opinions.

3. The Final SEIS contains almost no technically-substantive responses to my past comments (attached). They frequently avoid discussing technical details by stating that the approach taken in this SEIS complies with appropriate regulations---disregarding the real-world experiences from previously-operated sites. Furthermore, the Final SEIS contains no new data, either from Powertech sources, but more importantly from any independent sources. The conclusions presented in this Final SEIS are based almost entirely on data collected by Powertech or their consultants, and on summaries and interpretations presented by Powertech to the NRC. The responses provided in the FSEIS do not substantively change the assertions or conclusions put forward in my previous declarations.

Water Resources and Related Impacts.

4. These opinions focus predominantly on the water resources and related impacts within the proposed Dewey-Burdock (D-B) area. The D-B waters are natural resources presently used collectively by numerous parties (ranchers, municipalities, tribal groups, fish and wildlife, mineral and oil and gas developers, etc.). The actions proposed in the SEIS will result in negative impacts on water and additional costs for the general public that are clearly not renewable. These include:
   -allowing Powertech to use tremendous volumes of water, which will increase competition for this water with other users;
   -removal of ground waters from public use (exempted aquifer);
   -contaminate and degrade the quality of much of this water;
   -divert much of the water to deep aquifers where it will be unusable;
   -evaporate much local ground water into the air where it will not be usable locally;
   -these short-term actions are likely to render these ground waters unusable for future, long-term uses, many of which may not be anticipated until many years in the future.

5. The Final SEIS must, but does not, realistically anticipate what will be the true *long-term* uses of these waters---especially when many generations must be

considered. Thus, *truly conservative assumptions* should be employed—which is not the case in this Final SEIS.

SEIS Water-related Sections Predominantly Based on Information from Biased Parties.

6. It is my experience that the agency preparing the NEPA document is responsible for ensuring accurate data, , but almost all of the data and fundamental, technical opinions in the SEIS were taken directly from reports generated by the applicant or their consultants. Even where the applicant has presented controversial flow pathway interpretations (for example, that the D-B site contains no faults, fractures, collapse structures), the NRC has repeated these interpretations in the SEIS as accepted conclusions. The presence of such geologic structures has been described in other historical documents (i.e. TVA, 1979; Butz, et. al. 1980), yet the NRC chose not to address these well-respected scientific opinions in the SEIS.

The SEIS quotes *generic* sections from the GEIS, but the NRC staff then fail to provide independent interpretations of the site-specific (D-B) data and information.

7. For example, on SEIS p.4-60: "Consumptive water use during ISR operations could impact those who use local water from the production aquifer outside the exempted zone. This potential impact will lower water levels in nearby wells and reduce the yield of these wells. In addition, if the production zone is hydraulically connected to other aquifers above and/or below the production zone, consumptive use may impact the water levels in these overlying and underlying aquifers and reduce the yield in any nearby wells withdrawing water from these aquifers. (NRC, 2009a)".

8. Such generic statements are made throughout the SEIS, yet the NRC then proceeds to use the data and assumptions from Powertech to explain why such impacts are not likely to occur. This is a disingenuous use of GEIS language to imply future site-specific safety and minimal impacts at D-B. In my experience, independent verification of an applicant's site-specific data and analysis is conducted by the reviewing agency.

Many Unknowns.

9. The SEIS fails to provide verifiable, detailed information on quantities of water available in aquifers to be impacted, or on the interactions (hydraulic and chemical) between these aquifers when pumped long-term. The NRC has allowed the applicant to delay collection of such detailed data until after permit approval. As such, there is no reason to accept Powertech's optimistic claims about the volumes of water to be used, or the impacts to be generated. They simply have not performed adequate testing to provide detailed answers to these questions.

10. Additional fundamental water "unknowns" that are not answered in the SEIS, but which are delayed until after permit approval include:

-Pre-mining "Baseline" will be determined after permit approval. [SEIS, V.1, p. 2-37 (131). Throughout the SEIS it is confusingly and inconsistently called "**background".**
- **Aquifer clean-up criteria** will not be determined until after permit approval and could change (be weakened) depending on the applicant's ability to remediate the aquifer(s). [SEIS, V.1, p. 2-35 & 2-37(129-131)].
-**Detailed hydrogeologic characteristic** of aquifers and inter-beds, surface water-ground / water interactions, including long-term pump tests; to be performed and determined after permit approval (SEIS Section 2.1.1.1.2.3).
-**Long-term water level declines** during and after long-term pumping and operation. For example, what will be long-term water level declines in the Madison aquifer at Edgemont where Madison wells supply municipal water? No detailed testing data have been supplied in the SEIS. To be determined after permit approval.
-**Specific lithologic details** of site sediments. These details to be determined after permit approval (SEIS Section 2.1.1.1.2.3).
-**Detailed Operating Procedures**, such as whether the applicant will mine in partially-saturated, eastern zones of the Chilson; to be determined after receipt of permits.
-**Detailed Water Rights** / hydrogeologic studies necessary to determine that adequate **unappropriated** ground waters exist in the Madison or Inyan Kara. Such detailed studies have been conducted and **relevant South Dakota Water Rights permits have not been received.** To be done after receipt of NRC permits.
-**Methods of liquid waste disposal** to be employed. Will deep-well injection or land application methods, or some combination be employed, and what are the technical details. To be determined after permit approval.
-D**eep-well, underground injection (UIC) permits.** These issued by US EPA, but EPA has not commented on these issues or awarded the permits. To be determined after NRC permit approval. In order for EPA to reliably evaluate the UIC options, they must have access to the detailed hydrogeologic data and information mentioned above, but which will not be available until after NRC permit award.
-Aquifer Exemption (Inyan Kara). Must be approved by US EPA, but will not done before NRC permits are issued.
-Detailed chemical compositions of pregnant leach solutions, liquid waste solutions (to be disposed by deep-well injection or land application), solid wastes accumulating in land application facilities, etc. are unknown and not reported in the SEIS. Powertech has publicly-stated that they have completed at least one Feasibility Study, so all such detailed information must already be known.
-Financial Assurance details and amounts. All such details are unknown and should be public before the NRC license is approved. Financial Assurance calculations are presently handled by three separate federal and state agencies.

Since NRC predicts that water-related impacts will be SMALL, then the Financial Assurance dollar amounts are likely to be relatively SMALL. Thus, there will be little protection for the taxpayers in the event of unforeseen impacts or unexpected project closure.

-**Detailed Water-related Impacts**. Because *detailed*, site-specific geologic, hydrogeologic, and geochemical data are not presently available, it has not been possible to reliably evaluate future water-related impacts (i.e. specific volumes of water available from the Inyan Kara aquifers). Thus, the estimates of impacts [SMALL, MODERATE, LARGE] presented by the NRC in the SEIS are based on inadequate data. Clearly such impacts will only be determined after permit approval.

-Historical Data on Aquifer Restoration at Other ISL Sites. The NRC, both in the SEIS and in their responses to public comments, repeatedly cites the results they have compiled from three NRC-licensed ISL facilities (COGEMA's Irigary/Christensen Ranch facility, PRI's Smith Ranch/Highland Uranium Project facility, and Crow Butte Resources' Crow Butte facility) (NRC, 2009b). However, it is misleading to selectively cite the results from only three ISL operations when data from at least 30+ such ISL operations should have been compiled for comparison. All such data / information I have reviewed—in addition to the three cited by NRC-- also indicate an inability to return the ground water quality to preoperational baseline. While the NRC did not directly regulate many of these operations, surely the NRC could have obtained these data if they truly wanted to evaluate the success or failure of aquifer water quality restoration over numerous decades. As such, it is clear that no one has conducted a reliable, representative study to evaluate long-term effectiveness of aquifer restoration (of preoperational water quality) at the vast majority of operating and closed ISL sites—at least not one that is publicly-available.

11. Clearly, the post-restoration water quality within the exempted aquifers, for many chemical constituents at the three sites cited by the NRC, was not returned to preoperational conditions / concentrations. Thus, these exempted waters are lost to the public for numerous future uses without some form of additional, costly treatment.

<u>D-B Uranium ore zones are NOT hydraulically-isolated from other geologic units, other aquifers, or zones outside the project area.</u>

12. The NRC has disregarded the conclusions of numerous hydrogeologic experts (both Powertech-funded and independent experts) in stating the following (Final SEIS, Exec. Summary, p. xxxvi): "Alluvial aquifers are separated from production zone and surrounding aquifers by thick aquitards (confining units) and, therefore, are not hydraulically connected to production zone and surrounding aquifers."

13. This incorrect and overly-simplistic statement clearly contradicts expert opinions which state or infer that, long-term, all of the relevant D-B water-bearing zones are hydrogeologically-interconnected (i.e. Keene 1973; Gott, et. al., 1974; TVA,

1979; Butz, et. al., 1980; Smith, 2005; Boggs & Jenkins, 1980, Boggs, 1983, Bredehoeft et. al., 1983; Knight Piesold, 2008.

14. After reviewing the relevant data, reports and various combinations of satellite imagery, I also conclude that these relevant D-B water-bearing zones are hydrogeologically-interconnected, especially when subjected to long-term pumping.

15. Powertech's management and ground water experts have made inconsistent statements about whether the D-B confining units are leaky or not, varying between individual reports, deposition opinions and public hearing testimony. In this Final SEIS, Powertech (through the NRC authors) states that all of the relevant pumping tests indicated that the D-B sandstones behaved as leaky-confined aquifers (SEIS, p. 3-34). The consultants who conducted these pumping tests reported the same conclusions. Nevertheless, on SEIS, p. 3-36, it states:

    "Based on results of the numerical model, the applicant concluded that vertical leakage through the Fuson Shale is caused by *improperly installed wells or improperly abandoned boreholes."*

16. These inconsistencies make clear that Powertech has failed to define the detailed, long-term hydrogeologic characteristics and behavior of the relevant D-B aquifers and adjacent sediments.

17. It is not unusual for the inter-fingering sands, shales, etc. of sedimentary uranium deposits to be hydrogeologically interconnected, when pumped, long-term. In fact, it is the norm.

<u>Potential Groundwater-Flow Pathways at D-B.</u>

18. D-B sediments are hydrogeologically-interconnected by several potential pathways, which include:
    - -inter-fingering sediments;
    - -fractures and faults;
    - -breccia pipes and / or collapse structures;
    - -4000 to 6000 exploration boreholes (Bush, 2010, Update Technical Report, prepared for Powertech, states approximately 6000 drill holes are present at D-B);
    - -oil test wells.

19. **Drilling of hundreds and thousands of wells since the 1880s has caused drop in artesian pressure of the various sedimentary aquifers in the southern Black Hills areas** (Keene, 1968; Darton, 1909; Davis, Dyer &Powell, 1961). Therefore, many wells and boreholes that formerly flowed to the land surface no longer do so, but still contained water under pressure. Thus, contrary to the NRC and applicant comments in the SEIS, upward flowing waters in these

wells and boreholes can interconnect and mix between the various vertical water-bearing zones without showing any expression at the land surface.

[Keene (1968) p.24: Re. Fall River Fm: " Interview reports indicate that the yields from the Fall River sands have dropped within recent years. Part of this problem is probably due to incrustation ..However, some of this loss of head may result from the recent uranium exploration program. The author personally saw uranium test holes that were uncased, unplugged, and flowing at the surface. This practice is not only wasteful of water, but will ultimately lead to loss of pressure in the aquifer and possible contamination of the Fall River and Lakota aquifers."]

20. Powertech has repeatedly claimed, and apparently the NRC accepts, that no significant geologic structures are present at the D-B site, structures which could allow migration of water vertically or horizonally. Again, this claim is contradicted by numerous published reports, such as: Braddock,1963; Butz, et. al.,1980; Gott, et. al., 1974; Smith, 2005; TVA, 1979. In addition, review of several forms of D-B-area satellite imagery by myself and senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, shows clearly that this area is intersected by numerous faults and fractures. The imagery also shows evidence of circular geologic features at the land surface, indicating the presence of collapse structures.

Breccia Pipes / Solution or Collapse Features.

21. Numerous authors state that breccia pipes / collapse structures allow upward flow of ground waters from the Paleozoic formations to the Inyan Kara rocks at the southern margins of the Black Hills [Bowles, 1968; Braddock, 1963; Keene, 1973; Gott, et. al., 1974; TVA, 1979; Butz, et. al., 1980. Carter, et. al., 2003 state such recharge to the Inyan Kara may occur via such pathways.]

22. However, several Powertech reports and the Final SEIS argue that there is no evidence that breccia pipes or related collapse structures exist within the D-B property [i.e. NRC, 2014(Final SEIS); NRC, 2013 (March), Safety Evaluation Report, p.40; Clarification of Breccia Pipes, LSMPA, Append. 3.2-C. [Sept. 2012].

23. In Appendix 3.2-C of the Large Scale Mine Permit Application [Powertech 2012 (Sept.)] Powertech presents a map, Plate 2, which shows a red line that supposedly represents the area in which evidence of breccia pipes and collapse structures have been reported. This Plate was modified by Powertech from an original map in Gott, et. al., 1974, [U.S.G.S. Professional Paper 763], Plate 4. However, Powertech has misrepresented the data on the original U.S.G.S. map, neglecting to include several locations within the outcrop areas of the Inyan Kara rocks that were originally described as being "topographic depressions" or "structures of possible solution origin". Clearly the original U.S.G.S. authors mapped these areas within the Inyan Kara rocks—near the D-B project-- as probable locations of solution features, such as breccia pipes.

24. Similar circular, topographic features can be seen on modern, satellite imagery of the D-B site and surrounding areas. It is my opinion and that of senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, that these features likely represent solution / collapse structures.

25. Neither Powertech nor the NRC have presented any detailed interpretations of the D-B structural geology using high-quality satellite imagery. Until such studies have been performed, it is reasonable to assume that these circular features are potential pathways for upward migration of ground waters into the Inyan Kara sediments.

26. Instead of meaningfully addressing my opinions, or the cited literature confirming the complex hydrology of the project area, this SEIS continues to allow Powertech to delay conducting detailed hydrogeologic testing and determination of detailed aquifer cleanup standards until after the NRC has given project approval. Detailed hydrogeologic and water quality studies must be conducted **prior to** issuance of NRC / State permits. Otherwise, it is not possible for regulators or the public to reliably evaluate potential impacts and consequences to natural resources and the environment.

<u>The applicant will use and contaminate tremendous quantities of ground water.</u>

27. Because differing water use volumes are presented in different sections of the SEIS, and because of the numerous operational uncertainties, reliable estimates of D-B water use volumes are unclear. The SEIS confirms that there are known volumes of water the applicant has applied for from the State of South Dakota [SEIS, p. 4-54 & 4-55 (360-361)]:

28. Powertech has applied for water from the Inyan Kara: 274.2 ac-ft of water **annually** at a rate of 8500 gpm = 12,240,000 gpd (gallons per day) = **4.5 Billion gallons per year = 89.4 Billion gallons over 20 years.**

    Powertech has applied for water from the Madison: 888.8 ac-ft water annually at a maximum rate of 551 gpm = 793,440 gpd = 289,605,600 gallons per year **(289.6 Million gallons per year)** = **5.8 Billion gallons over 20 years**.

    If deep disposal wells prove feasible, up to about 160 gpm will be required from the Madison. At 160 gpm = 84 Million gallons per year
    20 years = 1.7 Billion gallons over 20 years.

29. Referring to the Inyan Kara waters, the SEIS states that consumptive use will be relatively small as only 2 percent of the water will be disposed of as liquid waste (assuming UIC option is accepted). However, this estimate clearly neglects the fact that much of the water from either aquifer will have been contaminated, and that the water undergoing land application will be lost via evaporation /

evapotranspiration. In either case, this water is no longer available for present or future uses within the exempted aquifer zone. Clearly, the SEIS under-estimates the volumes of water that are lost or contaminated through these processes.

30. Because disclosure and analysis of detailed hydrogeologic evaluations have been delayed until after NRC permit approval, it seems untenable to state that approval of the application "will not result in average annual withdrawals from the Inyan Kara aquifer that exceed the average annual recharge to the aquifer." Likewise, using such limited testing data and modeling results, any estimates of long-term water level drawdown in either the Madison or Inyan Kara are semi-quantitative, at best.

No Adequate, Detailed Water Balance Presented in SEIS.

31. In order to evaluate the adequacy of mine water-related data and water management practices, it is standard practice for EISs and similar mine environmental reports to include a detailed water balance. Such a balance includes measured data for all water inputs and outputs related to all mine operations and all sources of water that might influence these operations. Essentially any detailed ground water textbook describes the workings of such water balances (e.g. Freeze & Cherry,1979) and ICMM (2012) and Golder Assoc. (2011) represent two industry-sponsored studies that describe how water balances should be applied at mine operations.

32. On page 2-36 the SEIS (see Fig. 2.1-14) contains what the authors claim is a water balance, but it clearly is not. In fact, it is actually labeled as "Typical Project-Wide Flow Rates". This is not a water balance for the D-B site or D-B operations. It lacks basic components of a water balance, including detailed, measured data for volumes of water entering the system and losses (e.g. volumes of ground water available in the various aquifers, evaporation from land-application facilities, volumes under-going UIC injection, etc.), and *fails to calculate an actual balance.* Clearly a reliable water balance was not prepared and moreover, could not be prepared until the detailed testing has been completed.

33. Apparently this misleading figure was added to the SEIS because of past criticisms of the lack of water balance in the Draft SEIS. However, NRC has not cured the deficiency by including a flow rate figure, which lacks the basic components of a water balance.

Tens of Thousands of Pages.

34. As of the end of 2013, one of the South Dakota law firms representing various citizen's groups against Powertech stated they had already received roughly 70,000 pages of documents related to D-B issues. The two volumes of the Final SEIS add another 1310 pages. **Nevertheless, the Final SEIS authored by**

Powertech and the NRC still fails to provide some of the most basic information necessary to answer fundamental questions relating to the D-B water resources and possible impacts to these resources.

35. The original Draft Environmental Statement for the Edgemont Uranium Mine, prepared by the Tennessee Valley Authority (TVA, 1979) was only 208 pages in total.

Short-term versus Long-term Impacts.

36. The SEIS fails to consider true, long-term impacts from either the proposed D-B operations or regional CUMULATIVE impacts. On pg. 5-28 (596) of the SEIS it states: "The timeframe for the analysis is 2009 to 2030 (see Section 5.1.2 for the estimated operating life of the facility)." Clearly the SEIS fails to consider long-term impacts that are likely to occur, such as changes and increases in water demand.

Past Uranium Mining and Other Contamination.

37. The D-B region has been impacted by past mining and related activities, which were permitted by the AEC / NRC, and which have resulted in negative impacts to the local water resources and environment. Activities at the Black Hills Ordinance Depot (operational from 1942 through1967) have also impacted waters in this region. While limited remediation of surface facilities at portions of these two areas has occurred, no remediation of the historic water contamination has occurred at either site.

Inadequate Baseline Concept and Baseline Data.

38. Throughout the Final SEIS, the NRC fails to consider that past uranium exploration and mining activities have degraded the quality of much of the D-B-area ground and surface waters. The SEIS presents no baseline water quality data from prior to such activities, or as a minimum, from samples collected in the early periods of these mining activities. Instead, the NRC assumes that the degraded water quality represents "baseline", against which all proposed activities are to be judged. This regulatory approach is an indirect path towards approving increased degradation of the original D-B area water quality.

Fundamental Hydrogeologic Information Lacking.

39. In addition to using a "degraded" concept of baseline water quality, the NRC has failed to require Powertech to provide *detailed water-related* data and information ***prior to approval*** of this Final SEIS. Such detailed information is necessary to develop reliable conclusions about future impacts, and includes publication of the following categories of information:

-detailed hydrogeologic testing, including long-term aquifer testing, coupled with simultaneous water-quality sampling;
-*detailed* chemical compositions and volumes of all solid and liquid wastes and operating fluids, such as pregnant lixiviant solutions;
-specific aquifer restoration "clean-up standards / criteria (including ACLs—see Append. B);
-risk assessment studies of chemical constituents that will require an ACL;
-final selection of actual waste disposal methods to be employed;
-EPA aquifer exemption;
-detailed analyses and data relating to the specific Underground Injection Control (UIC) Well studies required by the US EPA. EPA approval of the UIC well permits should precede approval of the NRC license.
-specific details concerning the Financial Assurance measures that will be required of Powertech if the NRC permit is approved.

40. The Final SEIS states repeatedly, that the NRC will require Powertech to collect such detailed data / information **after** NRC license approval. Such information is needed to reliably evaluate risks, impacts, costs / benefits, etc. In my opinion, the delayed production of information until after licensing prevents disclosure and analysis of the environmental impacts, alternatives, and mitigation measures involved with the D-B project.

Price of Water.

41. The SEIS makes no mention of the price that the applicant will pay for the water used in the sum total of all operations, either consumptively or otherwise. Because all other users must pay some price for the water they use, the SEIS should include a table of comparative unit costs paid by various users (e.g. domestic, municipal, agricultural, industrial, etc.). Likewise, no price for water seems to have been included in the cost-benefit analyses presented in the SEIS, even for situations where water quality has been degraded.

Data all provided by the applicant.

42. Almost none of the relevant Application data were collected by financially-independent parties. Preparation of most of the documents was directed and paid for by the applicant. The "independent" federal agency with the most, long-term hydrogeologic experience in this region, the Rapid City USGS staff, have not been included as cooperating agencies in the preparation of the SEIS.

43. Some of the recent documents are largely authored by the applicant, not their consultants. In my experience, this is a signal of significant conflict of interest and the possibility that the consultants were unwilling and unable to give the applicant the desired answer. Many of the significant conclusions disregard unfavorable details and lack the analytical methods and rigor used by professional hydrogeologists and other water experts.

Historic ISL Water Data from U.S. Operations.

44. Review of actual, detailed, historical data from operating and closed ISL sites is the best method for anticipating future problems and impacts. Such actual long-term, data provide much more reliable information on future impacts than do the typical, overly-optimistic computer simulations often presented in EISs. Some of these sites have operated since at least the early 1970s. Thus, considerable information / data must exist for all these sites. Despite the fact that the NRC has had a role in permitting such ISL operations for more than 40 years, no publicly-available, *detailed database* on aquifer restoration water quality (and quantity) data has been compiled, summarizing data from all, or the majority of such ISL sites. Some limited data summaries have been released [i.e. the present GEIS (US NRC, 2014); US EPA, 2011; Davis & Curtis, 2007; Hall, 2009; Darling, 2008; Sass, 2011]. Dr. Susan Hall, U.S.G.S., Lakewood, CO stated (Feb. 2014) that she expects to release a summary of the publicly-available ISL water quality data (pre-and post-remediation) sometime later in 2014. She also stated that long-term, historic ISL data are very limited.

45. Most importantly, the limited aquifer restoration data that are available provide ample evidence to show that the leached aquifers at most, if not all ISL operations, have never truly been restored to their pre-operational, baseline water quality.

Otton, J.K., & S. Hall, 2009, In-situ recovery uranium mining in the United States: Overview of production and remediation issues. IAEA-CN-175/87
www-pub.iaea.org/mtcd/meetings/PDFplus/2009/.../08_56_Otton_USA.pdf

"To date, no remediation of an ISR operation in the United States has successfully returned the aquifer
to baseline conditions."

US EPA, 2007, TENORM, V.2, Append. III, P. AIII-10 last paragraph of section. "Finally, in situ leaching poses a problem from a restoration standpoint. Although there are multiple techniques to restore the mined aquifer to its preoperational state, in many cases the lixiviant can never be completely purged from the site. Attempts to bring the aquifer to a chemically reduced state cannot account for all types of contaminants, and the entire rehabilitation process is both expensive and time consuming."

46. Hence, summaries of water quality and hydrogeologic data from all operating or closed ISL sites within the U.S., together with interpretation of the impacts from these operations should be made publicly-available, prior to approval of the DB NRC license. Clearly some of these sites operated under State regulation, but it appears that the US NRC did not obtain and summarize the available information regarding actual performance of past and present ISL operations at similar sites, relying instead on generic information or no information at all.

Injection of wastes into major aquifers like Deadwood & Minnelusa.

47. Carter, et. al. (2003) p.11(electronic)
"The major bedrock aquifers are the Deadwood, Madison, Minnelusa, Minnekahta, and Inyan Kara aquifers."

GDP, P. 99: The Fall River Formation, along with the Chilson Member of the Lakota Formation, are the principal sources of water in the vicinity of the project area for domestic, livestock, and agricultural uses. These same formations are the host rocks for uranium mineralization within the project area.

Disposal capacities for these aquifers are not disclosed. No justification given to allow contamination of Madison waters via mixing / dilution by contaminated ISL process waters. [Madison Application, p. 6-7(electr.)]

Applicant's Performance in the Application process is flawed.

48. Despite the fact that the applicant has collected no new aquifer-testing or hydrogeologic information since their original Application, the applicant's "story" keeps changing with each new document and new deposition or hearing testimony. The applicant has presented a moving target of opinions [i.e. in early reports no leakage occurred between the Inyan Kara aquifers and the finer-grained, bounding sediments. Now, the applicant admits that leakage occurs between these units, but according to the applicant, this has no significant influence on operational details or project impacts]. Frequently the applicant's managers have been authors of the technical language which appears to "soften" the unfavorable conclusions of the original technical authors.

49. These sequential changes in the applicant's opinions based on the same, original test data came about only because of significant, costly opposition from the public and their experts (and not from changes required by the NRC or State). This pattern clearly demonstrates that the NRC should have required the applicant (or preferably, independent experts) to conduct the necessary *detailed,* long-term hydrogeologic testing and baseline sampling prior to issuance of the SEIS.

50. This raises the question as to whether other relevant applicant-generated or contracted water / hydrogeology-related reports exist, besides those listed in the various Applications and the SEIS. I would expect that other reports exist, as the reports listed in the Application and SEIS do not include the critical analysis and information I would expect to find in an unbiased inquiry.

Petrotek (2012) hydrogeologic model does not consider presence of faults, fractures, breccia pipes, or open boreholes, etc.

51. The predictions from such flow models are all based on the **simplifications and assumptions entered into the model.** At D-B, detailed, long-term testing has not been performed, so Petrotek lacked the detailed information necessary to reliably define many of the hydrogeologic processes. For example, many of the historic pump test data on hydraulic conductivity (vertical and horizontal) differ greatly from the data generated by lab testing of core. Thus the hydraulic conductivity inputs into this model are questionable, and any conclusions about leakage from one water-bearing unit to another are quite speculative. Also, the model assumes that no water flows vertically through some of the bounding geologic units (e.g. the underlying Morrison), but inadequate testing has been conducted to prove this. Likewise, several independent authors have argued that vertical flow does occur through the Morrison into the Inyan Kara. Inadequate data exist to reliably demonstrate the rates of recharge from the Graneros Group and surficial alluvium into the Inyan Kara, or the extent of other surface water-ground water relationships.

52. The simulations presented in Petrotek (2012) report are unable to reflect the complex inter-fingering of these sediments (facies changes, laterally and vertically), and assume that the Inyan Kara sediments are homogeneous sediments.

    Site boring data were used to calculate the tops and bottoms of formations---which were often inconsistent—but these borehole data failed to indicate whether the holes were functionally plugged or acted as conduits for vertical leakage. The statements (by the applicant and Petrotek) that some of the anomalous results are likely the result of leaking boreholes is simply a supposition, not based on actual data obtained from these wells and boreholes. Also, this explanation fails to explain the percentage of error that might be the result of cross-facies leakage, rather than communication through unplugged boreholes and wells.

    It is not reasonable to assume that where historic boreholes and wells have been functionally-plugged in the past, that these plugs remain stable forever. Numerous studies show this is simply untrue, and the various seals, surface casings, plugs, etc, begin to deteriorate after several years, leading to cross-communication between the water-bearing zones.

53. This flow model assumes that all ground water flow is via porous media and that no permeable faults, fractures or collapse structures act as flow pathways within the D-B property. In this model, even the Dewey Fault is considered a no-flow boundary (see below), despite the fact that Boggs (1983) presents conflicting statements about the Dewey Fault zone (p.12-13). Boggs states it is a barrier to flow, but also that upward recharge may occur at relatively low rates. Obviously detailed testing is needed to answer this question. More importantly, numerous

independent investigators have reported the presence of faults within the D-B area, contrary to the claims of the applicant. Additionally, significant information from independent remote-sensing indicate that faults do exist, and that surficial evidence of multiple, circular collapse structures are visible at the D-B site. Likewise, structural interpretations and production data from Cretaceous oil fields indicate that oil and gas have been generated from fractures within shales in these formations. These same Cretaceous formations exist within the D-B region, and it seems obvious that the entire package of D-B area Cretaceous sediments are fractured. **The Petrotek model assumes that none of these secondary geologic features transmit water, thus the flow rates are questionable, as would be the changes to water quality resulting from long-term dewatering of the various sand and shale formations.**

54. The model does include one simulation assuming the presence of **one** collapse structure at the D-B site, and assuming it transmits water vertically at 200 gpm. Evidence exists that several other vertical collapse structure pathways may exist, thus upward flows may be much greater than 200gpm. However, throughout the SEIS, the applicant and the NRC state that no evidence exists for and such collapse structures. Despite all of the evidence to the contrary, p. 4-61 of the SEIS P.4-61 states: "Because there is **no evidence for fast flow paths, such as fractures, in the ore-bearing aquifers,** NRC staff conclude that the cone of depression will be maintained during ISR operations."

55. Computer simulations only provide rough approximations of quantitative results---(flow volumes, not chemistry) even in simple, homogeneous, porous media. Often, when predicted results are compared to future, actual data, the results may be in error by hundreds of percent. One of the main goals of such model exercises is to promote a belief that someone can predict future impacts with real quantitative accuracy (Pilkey, 2007; Sarewitz, et. al. 2000)—which is often untrue. Where unreasonable assumptions and faulty evidence is used, the model cannot be relied upon to disclose impacts or to design monitoring and mitigation measures

56. Several examples of sections within Petrotek (2012) that support my analysis of the unreasonable assumptions and unreliable conclusions in the hydrogeologic modeling are provided below:

    -8: "The Morrison Formation beneath the Chilson is considered an aquitard for the region and is represented as a **no flow boundary in the model**. The Graneros Group is also considered an aquitard in the region 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."

    -8: "The data within the Project Area are based on site borings. Outside of the Project area, geologic picks are largely based on available oil and gas well logs. The geologic dips of the surfaces are projected out to the model limits."

- 8: "Therefore, the assumption used in the development of the model is that there is no flow across the (Dewey) fault in either the Fall River or Chilson aquifers. The model domain north of the Dewey Fault system is simulated using the NFB condition."

-11: "During model construction, there was difficulty in maintaining integrity between the various layers of the model. Based on projection of the available data, some of the layers intersected each other in space. This occurred primarily because the data sets were not entirely consistent, ."

-11: As previously noted, the Fuson ranges from 20 to 80 feet thick across the Project Area (Dewey- Burdock TR), therefore, **a simulated thickness of 45 feet** is a reasonable approximation for purposes of the model.

-12: "Because of the uncertainty in the discharge rates from the pumping and artesian wells, the calibration is considered to be more of a representative steady state than a true steady state calibration."

-14: "The model was **unable to replicate drawdown in the Fall River** on the scale of what was observed during the test despite extensive efforts to do so. It is possible that the drawdown observed in the Fall River during the 495 gpm pumping test in the Chilson was the **result of improperly completed wells or exploration boreholes that provided a hydraulic connection between the two units."**

-17: "In summary, changes to the conductance and head of the GHBs in the vicinity of Pass Creek do not appreciably alter the flux of the Fall River and Chilson aquifers across the Project Area, but do result in significant increases to the RSS, indicating a **generally poorer calibration**. **Increasing the recharge rate also changes the calibration substantially and causes large increases in the flux of both the Fall River and Chilson.** Decreasing the recharge has negligible effect on either flux or calibration."

-18: "For purposes of this modeling effort, the Fall River and Chilson are not subdivided and are each simulated as a single layer within the model."

-22: "Use of a numerical model can assist in this effort. However, real time monitoring of water levels during operations and adjustment of flow rates in response to water level changes provides the best engineering control to minimize wellfield interference."

-26: "The calibrated numerical model developed for the Dewey-Burdock ISR Project was used to assess the potential hydraulic impacts of a hypothetical

breccia pipe release. **A breccia pipe release into the Fall River and or Chilson was simulated by placing an injection well into the model layers** representing those hydrostratigraphic units and running a steady state simulation. **A value of 200 gpm was selected for the simulations. Much higher flow rates have been documented at known breccia pipe locations.** Discharge rates much lower than 200 gpm would probably have minimal impact on ISR operations and could be controlled using engineering practices."

-26: "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.**"

Surface Water Predictions of 100-year floodplains are likely merely semi-quantitative representations.

57. The September 2013 flood events in the Colorado Front Range and Blizzard in the Black Hills of South Dakota demonstrate the degree of error routinely encountered in such hydrologic predictive models. In both areas, actual flooding and snowfall exceeded not simply 100-year, but 500-year predictions for many of the affected areas.

Pursuant to 10 C.R.F. § 2.304(d) and 28 U.S.C. § 1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed on the 17th day of March, 2014,

Robert E. Moran, PhD.