From: James A Davis <jadavis@usgs.gov>
To: <WRO1@nrc.gov>, <ALS2.twf5_po.TWFN_DO@nrc.gov>, <jdr@nrc.gov>
Date: 2/22/06 5:17PM
Subject: Fw: Comments on NUREG/CR-6870

5/2/05
70 FR 22728
4

These comments would take quite some time and effort to respond to. I agree that the report needed to have more data to evaluate. It's not correct, however, that I did not contact these people (LQD) or other operators. I did, though perhaps my efforts were not forceful enough. Hardly any responded with useful information. Now that the draft report is out they see it as something important. But the people at LQD I contacted some time ago were probably lower level people who didn't think my request was important, and kind of brushed me off. Others said they would send data and then didn't. Some gave me the run around.

If the NRC wants the report to be revised to consider more data, scenarios, and simulations, then the NRC needs to get involved in getting these people to actually provide some data instead of just talking about it.

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----- Forwarded by James A Davis/WRD/USGS/DOI on 02/22/2006 02:07 PM -----

"John Randall" <jdr@nrc.gov>
09/16/2005 04:31 AM

To
<gpcurtis@usgs.gov>, <JADAVIS@USGS.GOV>
cc

Subject
Fwd: Comments on NUREG/CR-6870

----- Message from "Roberta Hoy" <RHOY@state.wy.us> on Wed, 31 Aug 2005 13:08:08 -0600 -----
To:
jdr@nrc.gov
Subject:
Comments on NUREG/CR-6870
Please see attached. If you received an earlier e-mail with a similar attachment, please disregard it. The earlier attachment was a draft without the comment numbers in order. Thank you for the opportunity to

SISP Review Complete
Template = ADM-013

E-RIDS = ADM-03
Add = A. Schwartzman (ALS2)

comment.

CC: Gary P Curtis <gpcurtis@usgs.gov>

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Subject: Fw: Comments on NUREG/CR-6870
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August 31, 2005
(via e-mail followed by U.S. Mail)

Mr. John D. Randall
MS T9C34
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

Re: Review of June 2005 Draft Report for Comment - "Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities" NUREG/CR-6870

Mr. Randall:

The Land Quality Division (LQD) of the Wyoming Department of Environmental Quality has reviewed the above-referenced report, and the following text-specific comments are listed in order of the report sections. Based on LQD's experience with in situ mining and restoration activities since the 1970s, the LQD also has several overall concerns with this report, and these concerns are listed in last portion of this review.

1 Background

1. Page 1, Column 1, 1st ¶, last sentence - The text states in situ leach (ISL) mining "must" be conducted in confined aquifers. From a hydrologic standpoint, an ore zone in a water-table aquifer could be mined by ISL processes, although the practical and geochemical considerations would make it more difficult.

2 Page 1, Column 2, 1st full ¶, last sentence - The text implies no wellfield bleed (i.e., larger overall production rate than injection rate) in balancing a wellfield. It has been Wyoming's experience that a wellfield bleed is necessary (and commonly used) to minimize fluid flow away from a wellfield.

3. Page 1, Column 2, last ¶, 1st sentence - The water quality effects that result from ISL mining include the effects of the mining process on ground water in the wellfield *as well as* the effects of excursions and natural migration on adjacent ground water.

4. Page 1, Column 2, last ¶, carryover sentence to Page 2 - Iron and manganese are also mobilized and have proven difficult to restore to baseline or class-of-use values.

5. Page 2, Column 1, carryover ¶ to Column 2 - It is not clear that the groundwater sweep phase is separate from the recirculation phase. Separate paragraphs for discussion of the two phases or mention that the recirculation phase is generally the next phase after the initial ground water sweep phase would help clarify the description.

6. Page 2, Column 2, carryover ¶ to Page 3 - The "appropriate regulatory authority" is mentioned in the 1st sentence on Column 1 on Page 2, and NRC is mentioned in Column 2 on Page 2. However, it should be noted that NRC's involvement in the subsurface aspects of ISL mining is recent (2000). ISL facilities have been regulated under the auspices of the Wyoming Environmental Quality Act and the U.S. EPA's Underground Injection Control Program since the late 1970s/early 1980s.

7. Page 3, Table 1 -

   a. The table lists overall ground water restoration costs, but a unit measurement, such as costs per 1,000 gallons of treated water, would allow for easier comparison of costs among the various operations.

   b. The use of the term "Nonconventional" in the table title is not consistent with the report text. Presumably this was the term used in the referenced U.S. Department of Energy report, but not all "nonconvenational" operations are ISL operations.

   c. Much more recent costs are available than the 1994 costs, and data is also available for facilities not listed in the (e.g., the Smith Ranch and Gas Hills facilities).

2 Geochemical Characteristics of Uranium Roll Front Deposits and Associated Groundwater Systems

8. Page 5, Column 2, 1st full ¶ - Addition of reductant is not necessary to regenerate reducing conditions. Removal of oxygen due to chemical reactions, such as iron oxidation will also regenerate reducing conditions.

3 Aqueous Geochemical Reactions during In-Situ Uranium Mining

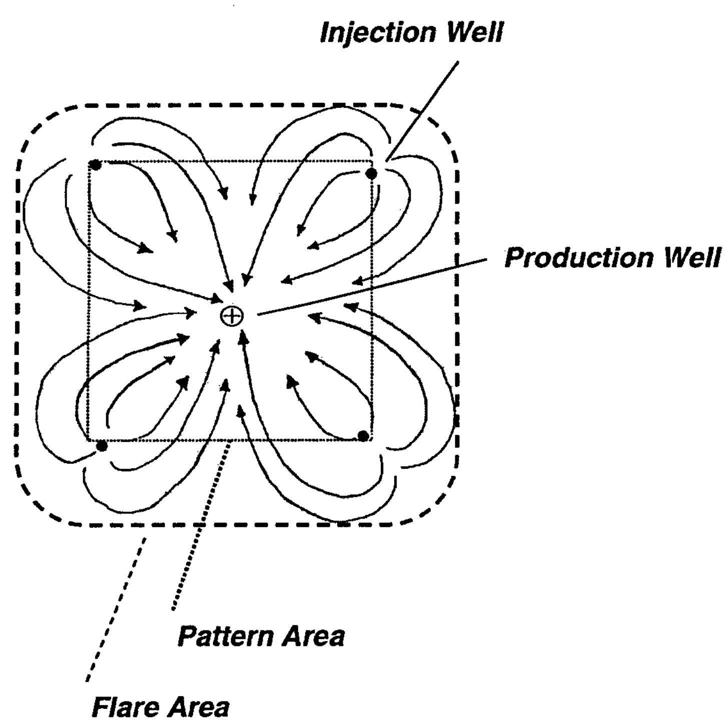
9. Page 13, Column 1, carryover ¶ to Column 2 - Sodium bicarbonate is not used that commonly in Wyoming because the sodium adsorbs onto the clays in the ore zone, affecting

production and injection rates (although it may be used in some areas to improve uranium recovery). An oxygen-fortified carbonate solution is more commonly used.

10. Page 13, Column 2, 1st full ¶ - As discussed in Comment 14, more data is available on the various aspects of in situ mining from sources other than published reports, Although some of the data on mining efficiency might be considered proprietary, the operators might be willing to share some information.

4 Groundwater Restoration

11. Page 15, Column 1, 2nd ¶ - The description of a "pore volume" is contradictory. In the 3rd sentence in the ¶, the term is defined as the "volume [of water] required to replace the water in the *volume of aquifer that was mined.*" However, in the 6th sentence, the dimensions of the "ore zone region is based on the *area of the well field patterns....*" (emphasis added) In general, the areal extent of mining extends beyond the wellfield patterns because of the 'flare' from the injection wells, as noted in the following diagram. To LQD, the term "pore volume" encompasses the flare area, as well as the pattern area. A similar concept is used by NRC, although the reference in the 5th sentence of the 2nd ¶ should be to the 2003 NRC publication (NUREG 1569) rather than the 2001 publication (NUREG/CR-6733).



12. Page 16, Column 2, 1st full ¶ - The presence of low permeability zones, and residual lixiviant in those zones, is mentioned as a possible reason ground water restoration may take more time than anticipated. However, in LQD's experience, the presence of low permeability zones in the ore sand and in the area affected by the 'flare' from the production and injection wells has not been particularly problematic. Rather, low permeability zones have proven problematic during excursions, but not in wellfields where the wellfield balance has been maintained. For example, at one in situ mine, the presence of improperly abandoned drill holes allowed migration of mining fluids from the ore zone to an overlying aquifer with very low permeability.

13. Page 16, Column 2, carryover ¶ from Column 1 - The use of deep disposal wells for disposal of the reverse osmosis (RO) waste stream is not mentioned, even though this disposal method is becoming more common.

14. Page 17, Column 1, last ¶ - The text notes that there are "few published studies of evolving ground water quality during groundwater restoration." However, there is a wealth of data available from files maintained by State regulators, and the operators may have been willing to share data as well. It is not clear why this study relied solely on published data.

5 Modeling of the Groundwater Restoration Process

15. Page 19, §5.1, 1st sentence - As noted in Comment 11, the definition of "pore volume" needs to be specified, particularly given that this volume is generally used as the basis for estimating ground water restoration costs. Also, the reference should be to the 2003 NRC publication.

16. Page 19, §5.1, 2nd ¶, 1st sentence - The term "minor excursions" is not clear. Presumably, the term applies to movement of lixiviant out of the 'flare area' but not as far as the monitor well ring. However, the term "excursion" generally implies movement of the lixiviant to the monitor well ring.

17. Page 19, §5.1, Column 2, 1st full ¶, 2nd sentence - The text should probably read 'mobile flow' rather than "mobile flowing".

18. Page 19, Section 5.2, 3rd sentence, Page 20, Column 1, 1st full ¶, 1st sentence, and Page 26, Column 2, 1st sentence. The use of the term "re-injection" and the discussion about sources of water for reinjection during RO need to be clarified:

    a. On Page 19, the text states that "an equal volume of water was *re-injected* using the same well field as was used during mining." (emphasis added) On Page 20, the term "*re-injected water*" is used again, with the additional information that this re-injected water is a mix of 25% "untreated groundwater" and 75% pure water. (emphasis added) For LQD, the term 're-injection' implies a specific wellfield practice, i.e., physically reintroducing water into wells. In the wellfield, the reinjection rate is often not 100% of the withdrawal rate, and maybe as little as 75% of the withdrawal rate, depending on the volume of brine generated during RO operation. The 25% 'bleed rate', which is much higher than the bleed rates during production, helps increase the hydraulic gradient toward the wellfield. However, based on the usage of the term 're-injection' on Pages 20 and 26, the term 're-injection' is being used to describe the *model* influent from both well injection *and* from ground water inflow. Because the term 're-injection' relates to a specific wellfield practice, it would be helpful if a different term were used in the discussions of the model influent.

b. Assuming the "pure water" portion is the treated water from the RO, what is the percentage of constituents left in this water? The reject rate can be predetermined for the RO unit. If the reject rate is 80%, the RO water retains 20% of the dissolved constituents from the input stream. Please clarify if there were any constituents in the "pure water".

19. Page 19, Section 5.2 or Page 27, Section 5.2.1 - The results of Simulation 1 (Figure 12) are compared with the Ruth data (Figure 11). For illustrative purposes, it might be helpful to have another figure with the both the simulation results and the field data. Also, it would be helpful if the differences between the Ruth test and Simulation 1 were noted. For example, how many pore volumes were removed during ground water sweep during the Ruth test (and how was 'pore volume' defined for the Ruth test)?

20. Page 20, Column 2, 3rd full sentence - The potential for impacts from residual minerals, due to their presence in areas of low permeability, are mentioned. However, the residual minerals may be present for other reasons. In particular, a company may have reached an economically recoverable limit.

21. Page 20, Column 2, 3rd and 4th sentences - While a reason for residual uraninite is mentioned (however see Comment 20), the reason for the residual pyrite is not mentioned.

22. Page 20, Column 1, 1st full ¶, 2nd sentence - It should be clarified that RO was not simulated for 100 pore volumes, rather groundwater sweep and RO were simulated for about 5 pore volumes (Section 5.2) and then groundwater stabilization was simulated for the remaining pore volumes up to 100 pore volumes (Section 5.3).

23. Pages 22 and 23, Table 2 - It would be helpful if column headings were repeated on the 2nd page of the table.

24. Page 25, Column 1 - How do the assumed concentrations of selenium, pyrite, and uraninite in the cells with "immobile water" compare with field conditions in the aquifer matrix. For example, the presence of 500 parts per million (ppm) of elemental selenium seems high.

25. Page 26, 1st sentence - Are the "pre-operational baseline chemical conditions" the conditions inside or outside the ore zone? Given the substantial difference in concentrations of some parameters (e.g., uranium) inside and outside the ore zone, and the fact that most operators remove more than one pore volume during ground water sweep, the changes in influent concentrations as sweep progresses (and more water from outside the ore zone is introduced) may be influential.

26. Page 42, §5.3.1, 1st ¶. The reasons for continuing Simulations 1, 5, 8, 9, and 10, but not the other simulations, through the stabilization phase should be noted.

27. Page 41, Table 5 - It might be more helpful if Tables 2 and 5 were combined, particularly as some of the simulations in Table 2 were extended through the stabilization phase. Alternately, Table 5 could be expanded to include the information about the extension of Simulations 1, 5, 8, 9, and 10.

28. Page 48, Column 1, carryover ¶ to Column 2 - It would be helpful to discuss why Simulation 10 was chosen as the basis for Simulations 11 through 19 (although the reviewers may have overlooked that discussion).

Conclusions

29. Page 65, last complete ¶ - The reference to the "first few pore volumes of ground water sweep" as "pore volume 1" is confusing, particularly given previous comments on the use of one pore volume of sweep in the simulations and the definition of pore volume (see Comments 11 & 15).

Overall Concerns

While the report addresses some of the issues which have been encountered in restoration efforts to date, some of the approaches used to address these issues limit the usefulness of the report.

Selection of Scenarios. It is not clear how the scenarios were selected. Some of the selections seem to be on a 'worst case' approach, e.g., the introduction of oxic groundwater during stabilization or the presence of 500 ppm elemental selenium in the ore zone. However, other selections seems more realistic. It would be helpful if the report included a brief discussion of the reasons the scenarios were selected.

Available Information. The report mentions a limited amount of "published" information on ground water quality during restoration and stability monitoring. In addition, the report references restoration cost estimates from 1994 and seems somewhat dated in references to other aspects of in situ mining. However, there is a significant amount of ground water quality data which operators are required to submit to regulatory authorities (e.g., in Annual Reports and in Restoration Reports to the LQD). In addition, operators are required to update estimates of restoration costs annually with the LQD to ensure restoration bonds are adequate. These data and estimates could have provided valuable information for this report. However, the LQD was not contacted about publicly available information in the LQD files. Also, to our knowledge, none of the operators were contacted to see if they would be willing to provide more up-to-date information, some of which the operators would not necessarily be required to submit to a regulatory authority. The LQD recommends that the more recent information be taken into consideration in any future NRC studies of the geochemistry of ground water restoration.

Commercial versus Research Operations. The studies referenced in the report were mostly from small-scale research operations or unusual circumstances (e.g., bond forfeiture at Bison Basin). Based on LQD's experience, there are issues that arise during larger-scale commercial operations that may not be encountered in research operations. Because data is now available from commercial wellfields, the LQD recommends that any evaluations of ground water restoration take the commercial operations into account too.

Terminology. The terms "'pore volume" and "excursion" are used without adequate definition given the critical aspects of these terms. For example, the volume in a "pore volume" varies considerably depending on the definition used, and various definitions are used by federal and state regulatory agencies and mining companies. Similarly, LQD considers "excursions" to be reportable incidents resulting from such loss of control of mining fluids that those fluids are detected at the monitor well ring (see Wyoming Statutes §35-11-103(f)(ii)). The LQD recommends that these terms be explicitly defined, and carefully used, in any documents on in situ mining.

Volumes. The concept of removing only one pore volume during ground water sweep is repeated several times in the text. As noted in the text-specific comments, this is seldom the case in practice. Also, the number of pore volumes of RO has varied considerably in practice. In addition, the use of the term "pore volume" in reference to stabilization allows for continuation of the simulations independent of time. However, the length of time required to move a "pore volume" of water is of considerable concern as a practical matter.

Bacterial Influences, Chemical Reactions, and Quality of Influent Ground Water. The report stresses the importance of the influent water quality both during restoration and during stabilization. In particular, the lack of long-term stability based on the simulation results is of concern. However, it would be helpful if the text were more specific about some of the simplifications and assumptions necessary in the model approach, particularly since some of these influence long-term stability. For example, the model is a non-kinetic model, which essentially eliminates any bacterial influences from naturally occurring desulfovibria and thiobacilus, and these influences may be as or more important to long-term stability as the addition of reductant during restoration. In addition, the role of pyrite during both restoration and stabilization is of concern. As noted on Page 25, a kinetic approach might result in simulations that more closely compared with observed conditions. Also, the potential source(s) of the oxic water entering the restored area during stabilization should be clarified. While the uranium was deposited on the interface from oxidizing to reducing conditions, those deposits have not migrated to any measurable extent, due to continued inflow of oxic ground water. While there may be wellfield-specific concerns due to inflow of oxic ground water from specific facilities, such as old underground and surface uranium mines adjacent to some wellfields, an assumption of the wide-spread occurrence of oxic ground water may not be applicable.

Low Permeability Zones. Such zones are used to explain the presence of residual lixiviant and residual mineral. As noted in the text specific comments, such zones do not seem to be of significant influence based on LQD's experience and there may other reasons (e.g., economic factors) that such residuals are present.

Lack of Recommendations. It would be helpful if the report included recommendations about the types of data that need to be collected and research that needs to be done to resolve some of the concerns identified in the report and simplifications necessary because of limited information. These recommendations could be combined with recommendations from the regulatory agencies and operators to develop some long-range plans for addressing areas of concern and limited information. For example, the LQD's recent experiences with the operators' efforts to simulate natural attenuation have highlighted the difficulties of obtaining reliable measurements of oxidation-reduction potentials, matrix carbon content, and related physical parameters that affect contaminant transport. While there are some recommendations in the text (e.g., Page 24, Column 2, 1st full ¶, 6th sentence), a compilation of the recommendations would be helpful.

The LQD appreciates the opportunity to comment on this draft report. If there are any questions about the comments or concerns noted above, please let us know.

Sincerely,

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