

**From:** [Arlt, Hans](#)  
**To:** ["Robertson, Andrew"](#)  
**Cc:** [Orlando, Dominick](#); [Matt Ely](#); [Steve Austin](#)  
**Subject:** RE: Re: Courtesy review of USGS Shiprock report  
**Date:** Friday, July 10, 2015 5:57:34 PM

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**Robert:** Thank you for taking the time to respond to the comments. Hans

**From:** Robertson, Andrew [mailto:ajrobert@usgs.gov]  
**Sent:** Wednesday, July 01, 2015 11:57 PM  
**To:** Arlt, Hans  
**Cc:** Orlando, Dominick; Matt Ely; Steve Austin  
**Subject:** [External\_Sender] Re: Courtesy review of USGS Shiprock report

Good afternoon Hans,

Thank you very much for reviewing the USGS Many Devils Wash report. You provided excellent comments and the document is much improved by your review. I have addressed the comments from your review below. Please let me know if you have any questions or think of any further improvements to the report.

1.) Page 11: Abstract is almost 3 pages long which is rather unusual.

**Response:** Concur. We worked to limit redundant language.

2.) Page 15: As pointed out in the report, the water regime at this site during the mill operations and at present must have been considerably different. Therefore, when the purpose of the report is stated as, "to present evidence for the source of groundwater and solutes discharging to Many Devils Wash," this indicates to me that it is about the current hydrogeology and not answering the question if contaminants had flowed from the mill processing area into the Many Devils Wash in the past when the water mound was higher. This should be clearly stated.

**Response:** Noted. We agree that the investigation is centered on the current conditions, and that we are limited in interpreting past conditions due to the lack of historical data. However, we do feel that historical data and accounts that support or contradict the hypotheses presented in the report, are important to cite and incorporate into the conceptual model.

3.) Page 42: "These sites, which are believed to have similar geology and recharge processes to the Mill site, are referred to as "analog sites" and are located..." Information from the "analog sites" is extensively presented in this report and used as a basis to draw conclusions. Due to their importance, more detail should be provided as to the technical justification for using these sites as Shiprock analogs.

**Response:** Concur. Added the following text to justify the similarity. "The two arroyos drain the same silt loam soils as found in the Many Devils Wash watershed (Natural Resources Conservation Service, 2015) and they similarly down-cut into the underlying weathered Mancos Shale (New Mexico Bureau of Geology and Mineral Resources, 2003).

4.) Page 43: The  $^{234}\text{U}/^{238}\text{U}$  alpha activity ratios are a significant component for the

conclusions in this report. The ratios used are based on work by Zielinski and others (1997), who demonstrated that the  $^{234}\text{U}/^{238}\text{U}$  AR could distinguish between the U derived from weathering of local aquifer minerals and the U derived from processing mills. Are the findings from Zielinski and others (1997) generally accepted in the scientific community? Or can other studies or reports be cited that would provide additional confidence that information from Zielinski and others (1997) has been corroborated, e.g., what specifically does the Tricca and others (2000) report say.

**Response:** Noted. The 1997 study by Zielinski and others has been cited 29 times, largely by studies differentiating between anthropogenic and natural sources of uranium. The Tricca and others (2000) report and other references in the paper describe the underlying theory of the distribution of uranium isotopes and the fractionation mechanisms that support their application for delineating the source and where that application is appropriate.

5.) Page 49: “These earlier investigations document the movement of Mill water from the waste ponds into the alluvium and the flow outward from the cell to seeps above the bedrock. These investigations present no evidence that the groundwater flowed to Many Devils Wash.” If finding evidence that the groundwater flowed to Many Devils Wash was not a specified purpose of the earlier investigations, than the latter statement is somewhat misleading.

**Response:** Concur. Removed text.

6.) Page 61: Would a more accurate title for this section be, “Observations of Current Hydrologic Conditions?”

**Response:** Noted. We believe that the title is appropriate and therefore needs no further qualification.

7.) Page 61: Previous descriptions of the siltstone made no mention of the siltstone being a confining unit (or I missed it).

**Response:** Noted. It is discussed in the preceding section. \* [looked again but still could not find reported confining properties of the siltstone](#)

8.) Page 65: “The three greatest  $^3\text{H}$  concentrations (34.03, 33.21, and 19.98 TU) were measured in samples collected from wells 813, 815, and 827, indicating that the groundwater in these wells was recharged when the Mill was operating.”

However, well 813 is not labeled as mill-impacted in Fig. 5.

**Response:** Noted. Wells were distinguished as mill-impacted primarily with the uranium AR. The discrepancy between the model ages of the groundwater and the relatively high uranium ARs are discussed in the subsequent sentences.

9.) Page 71: “In particular, CFC concentrations suggest that at least some wells on the terrace (for example 813, 817, 824, and 833) have a substantial fraction of water that is composed of younger (post-Mill) water.” Both wells 817 and 824 are next to the disposal cell. Apparently well 824 received sufficient younger (post-Mill) water so as to be not to be labeled as mill-impacted while well 817 did not mix with sufficient younger (post-Mill) water and is still labeled as mill-impacted?

**Response:** Noted. The age-dating tracers are used to determine when groundwater becomes disconnected from the atmosphere, while the uranium AR are independent of the relatively short time periods that are modeled with CFCs and tritium. This being said, there would be 2 ways to interpret the apparent discrepancy you point out. The first, as you suggest, would be "increasing" the AR with younger water by adding uranium with higher AR values. The second possibility is the interactions with the material that the younger water is moving through. In the case of 817 the water could be from the surface remediation process and then redissolving mill-derived uranium, while the water sampled in 824 never interacted with the tailings. One way to conceptualize it is that if one just diluted the concentrations with water that had very little uranium, the result would be equivalent ARs but lower U concentrations. I believe that this is the case with the wells 730 and 830, which are located right next to the disposal cell. Groundwater samples from these wells and have low ARs, as one would expect, but unexpectedly low U concentrations.

10.) Page 74: "...therefore, the water quality at the site may include groundwater compositions that reflect either types or some combination of the two." What two types are these? If one of these groundwater types is referring to the unweathered Mancos Shale, an explanatory sentence would need to be added since previous sections had made clear that this unit was considered confining and wells screened in this unit were dry.

**Response:** Concur. Added text defining the types as weathered and unweathered.

11.) Page 90: "The U concentrations of groundwater from all sites not impacted by the Mill have a relatively small range (0.01–0.40 mg/L)..." Fig. 15 seems to show that the minimum value is less than 0.01 mg/L.

In addition, the difference in between the wells not impacted by the Mill and the analog wells seems to be greater than the difference in concentration variability between the wells not impacted by the Mill and the wells impacted by the Mill? Can references be provided showing that concentration variability between hydrogeologic locations is an established methodology to differentiate between different origins of solutes?

**Response:** Concur. Corrected the reported range. We also agree with the reviewers observation of the differences in the variability of the concentrations and we address that in the report stating "Much of the variability in well that are not designated as impacted, occurs in the terrace wells, which may be partially influenced by the mill". The authors are not aware of investigations that differentiate between different origins of uranium by variability in concentrations.

12.) Figure 15: There were 224 values for the mill-impacted wells and 378 values used for the terrace wells. Considerably less values were used for Figures 5, 6, and 12.

**Response:** Noted. Average values were chosen for most of the analysis that compared wells with one another. The box plots were constructed with the entire data set to capture the range of values.

13.) Summary: [One reader's interpretation]

CURRENT - Despite the difficulties in interpreting data from the tritium, helium-3 samples, carbon-13 and -14, chlorofluorocarbons, and major chemical ions studies due to mixing of water types over the years, these studies and the hydrologic conditions seem to indicate that current water recharge to the Many Devils Wash does not include water from the terrace;

PAST - however, due to the many uncertainties brought about by the mixing of younger and

different water types over the years, it is still not certain if recharge to Many Devils Wash in the past (immediate-post-mill-processing period) had included water from the terrace or not, i.e., if some quantity of terrace water had been able to bypass the buried channel located between the disposal cell and Many Devils Wash (roughly extending northwest from well 1058 to the escarpment) and reached the wash. If the authors did mean to exclude the possibility of terrace water recharge to Many Devils Wash in the past, then this probably should be made more explicit in the text.

**Response:** Concur. The interpretation you provide is largely the main idea the report was intended to convey. We would add that the age-dating evidence supports the other lines of evidence for the current conditions. In addition we would also suggest that regardless of past conditions, the groundwater in Many Devils Wash could be considered a natural composition.

Once again I want to thank you for the thoughtful review. I invite you to contact me if you have any questions or concerns regarding this report or the site in general.

Kind Regards,

Andrew

On Wed, May 20, 2015 at 4:42 PM, Arlt, Hans <[Hans.Arlt@nrc.gov](mailto:Hans.Arlt@nrc.gov)> wrote:

So, I did a quick review and this is what I came up with:

- 1.) Page 11: Abstract is almost 3 pages long which is rather unusual.
- 2.) Page 15: As pointed out in the report, the water regime at this site during the mill operations and at present must have been considerably different. Therefore, when the purpose of the report is stated as, "to present evidence for the source of groundwater and solutes discharging to Many Devils Wash," this indicates to me that it is about the current hydrogeology and not answering the question if contaminants had flowed from the mill processing area into the Many Devils Wash in the past when the water mound was higher. This should be clearly stated.
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mills. Are the findings from Zielinski and others (1997) generally accepted in the scientific community? Or can other studies or reports be cited that would provide additional confidence that information from Zielinski and others (1997) has been corroborated, e.g., what specifically does the Tricca and others (2000) report say.

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PAST - however, due to the many uncertainties brought about by the mixing of younger and different water types over the years, it is still not certain if recharge to Many Devils Wash in the past (immediate-post-mill-processing period) had included water from the terrace or not, i.e., if some quantity of terrace water had been able to bypass the buried channel located between the disposal cell and Many Devils Wash (roughly extending northwest from well 1058 to the escarpment) and reached the wash. If the authors did mean to exclude the possibility of terrace water recharge to Many Devils Wash in the past, then this probably should be made more explicit in the text.

Thank you for the opportunity to review this well done and interesting report. Hans

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**From:** Arlt, Hans  
**Sent:** Tuesday, May 19, 2015 11:06 AM  
**To:** 'Robertson, Andrew'; Orlando, Dominick  
**Cc:** Matt Ely; Steve Austin  
**Subject:** RE: Courtesy review of USGS Shiprock report

Thank you for the report.  
I have another project due by the end of the month, but will try to make your 5/27 deadline.  
Look forward to the read.

Hans D. Arlt, Dr.  
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NRC/NMSS/DWUP/PAB

**From:** Robertson, Andrew [<mailto:ajrobert@usgs.gov>]  
**Sent:** Monday, May 18, 2015 6:32 PM  
**To:** Orlando, Dominick; Arlt, Hans  
**Cc:** Matt Ely; Steve Austin  
**Subject:** Courtesy review of USGS Shiprock report

Good afternoon,

Please find the USGS Many Devils Wash report for your review. I look forward to hearing from you and reviewing your comments.

Please remember that this is a draft manuscript and is distributed solely for the purpose of courtesy review. The comments received will be addressed and treated as appropriate to ensure there is no conflict of interest. Its

content is deliberative and predecisional, so it must not be disclosed or released by reviewers. Because the manuscript has not yet been approved for publication by the U.S. Geological Survey (USGS), it does not represent any official USGS finding or policy.

It would be helpful if I could have your comments back in about a week (May 27, 2015). Please feel free to contact me if you have any questions or concerns.

Kind Regards,



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