

RMRS COMMENTS ON
THE HYDROGEOCHEMISTRY OF PLUTONIUM IN SOILS OF ROCKY FLATS, COLORADO
Submitted by
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1. Page 1, Paragraph 2, sentence 1: Delete "comprehensive"
2. Page 1, Paragraph 2: Last sentence refers to 1 to 3.3 % of Pu and Am stored in surface soils to the groundwater. Note # 5 is cited. This note is "M.I. Litaor, Unpublished material." Since there is not a publication cited for the reader to refer to, please include the data and a brief explanation of (or cite a published document that describes) sample collection methods, analytical methods, and data interpretation.
3. Page 1, Paragraph 3: Quantifies the amount of Pu 239+240 mobilized during the May 17, 1995 storm, and cites note #5. Since there is not a publication cited for the reader to refer to, please include the data and a brief explanation of (or cite a published document that describes) sample collection methods, analytical methods, analytical results, and data interpretation methods.
4. Page 1, Paragraph 4: Discusses the advanced monitoring system and cites note #7. Pulling the note into the main text to explain what the MS is would help the reader. Also, a general schematic of each of the main components of the MS would assist in determining how the data were obtained and used. Cite the documents and/or publications where the MS is described in detail. What kind of data does the MS acquire remotely? Does the MS measure Pu 239+240? Were samples from the MS collected during/after the May 1995 storm?
5. Page 4, First Paragraph: Add piezometer numbers to both text and Figure 2. Show piezometer construction details in an attachment, including the elevation of ground surface and top of casing for each piezometer. From Figure 2 it is unclear if the depth is below top of casing or below the ground surface. Show the location of piezometers and elevation of top of piezometers and top of casing. either on Figure 1 or on a new figure (more detailed than Figure 1) .
6. Page 4, First Paragraph, Second Sentence: Which soil became completely saturated? Why did the water surface suddenly raise ten days after the storm? This is indicative of transient conditions.
7. Page 4, First Paragraph: How do your data and interpretation account for the focused recharge uphill from the study site caused by paving of the 903 pad (generating runoff) and the installation of a coarse subgrade that extends beyond the paved portion of the 903 pad increasing and focusing infiltration above what would be expected for undisturbed Rocky Flats Alluvium?

8. Page 4, First Paragraph: A figure showing the depth (or elevation) of groundwater over time at specified points would be informative. Also, geologic cross sections of the area would aid the reader in understanding the geologic setting.
9. Page 4, First Paragraph: There is no "sandstone aquifer" in the upper hydrostratigraphic unit at the study site. Clarify that there are sandstone lenses within the clay and siltstone. Showing a cross-section of the area, with the referenced piezometer(s) shown to be completed in the sandstone lens at the point under discussion would clarify this.
10. Page 4, Second Paragraph: Please show data used in the flux calculations. Explain how the lateral zero-tension sampler works. Include and reference a figure that shows an outline of the area for which flux was calculated. Over what time increment was the flux measured? A one-time measurement at the peak of the flow would not be representative of flow over the "saturated (65 days) period". How did you interpolate two very shallow zero tension data points over the whole area? How was this lateral flow observed across the toposequence? Is the lateral flow referred to and measured by the lateral zero-tension samplers surface or shallow subsurface? If it was shallow subsurface, how exactly was it observed "across the toposequence"? Define the "toposequence", does the discussion just refer to the instrumented site, or to a larger area?
11. Page 4, Third Paragraph, First Sentence: The sentence states "The nature of the piezometric surface and the azimuth and magnitude of the measure flux suggest two concurrently operating recharge mechanisms." What potentiometric surface? Show the potentiometric surface over the same topologic sequence area that the flux is calculated for. If there are two surfaces, show them both, and differentiate very shallow (<4.5m piezometers) and shallow (>4.5 m) surfaces. Which data specifically were used for the flux calculations? Also, cross reference to how the two zero tension data points were interpolated over the whole toposequence.
12. Page 4, Third Paragraph, last sentence, continued on Page 5: Referring to the 16 m of hydraulic head between Well 1587 and TR 1 and TR 2, no water level elevation data are included in the paper. Also, well completion diagrams are needed for the well and both TR 1 and TR 2, to demonstrate that they are screened across the same hydrologic interval.
13. Page 5, First Full Paragraph: Specify in the main body of the text the model used. The model boundaries and grid should be provided as a figure. Key points of interest (i.e., monitoring pits, wells, water surface elevations (known and inferred) should be indicated. Clarify what is meant by the "entire slope" what are the bounds of this calculation? Also, assumptions made as to the elevation/location of the aquitard should be provided. The Department of Energy should be provided with the model input and development notes for further evaluation.
14. Page 5, First Full Paragraph: Please be more specific regarding the statement regarding restricting calculation of flux in the upper 3 meters. More specifically at what points in the modeled area was flux measured? The

flux measurements noted from TR 2 and TR 3 on page 4 were from depths of 0.5 and 0.7 m. Is it inferred that the same magnitude of flux would occur at the 3.2 to 4.5 m depths the piezometers in Figure 2? Figure 2 is referenced in regard to the piezometric surface. Figure 2 does not show a surface, it presents hydrographs for three unspecified points at unknown locations. As noted previously, please show the two potentiometric surfaces over the area for which flux is calculated, and note what wells/piezometers and trenches were used to construct the surfaces.

15. Page 5, Second Full Paragraph, Third Sentence: A steady state model may not be appropriate for analysis of this transient phenomena. Where did the water table remain at the surface? See also comments 4, 7, and 13.
16. Page 5, Last Paragraph, First Sentence: Are the observed heads average values? If so, what dates were used to obtain the averages? If not, what date was used and why was a single date used? Were the observed heads used all for the same date, or were different dates used for different points?
17. Page 5, Last Paragraph, First Sentence and Table 1: The data shown in Table 1 are for trenches and 1 well that are located in relatively close proximity to each other. Is the model limited to this area for which data are used and a sensitivity analysis was performed? It is not clear over what area the flux has been calculated (modeled).
18. Page 5, Last Paragraph, Last Complete Sentence: The conceptual model of the site is that of an aquifer overlying an aquitard which forces flow to daylight at a seepage face. Figure 1, as well as field observation, following the May storm shows that this seepage is concentrated into two areas of surface flow. Measurements of surface flows at these culverts would provide a good check on the estimated magnitude of model fluxes. Measurement of both dissolved and total actinide concentrations at these points would also be an excellent indicator of actual Pu/Am flux resulting from combined surface water and groundwater flows. Please provide any measurements of flow or actinide concentration at these points.
19. Page 5-6 continued paragraph: Could the "profound difference between the modeled and observed flux" also be related to the very shallow (0.5 -0.7 m) depth the flux was measured at?
20. Page 6, First (incomplete) paragraph: "Ponding, intermittent surface flow, and rainfall recharge were observed during most of the saturated period (65 d) but were not considered in the calibration process because of the large heterogeneity of these processes across the toposequence." Reconcile this statement with the use of a steady-state model.
21. Page 6, Second Full Paragraph, Last Sentence: What is a "soil solution" ?
22. Page 6, Second Full Paragraph, Last Sentence: Please explain the meaning and units of the variables F and P.

23. Page 6, Last Paragraph, First Sentence and Figure 3: Please provide the data from which Figure 3 is constructed. Briefly explain how the data were collected, and cite the reference where both the data collection and data are discussed in detail. Are these data for filtered or unfiltered samples? Soil-water data for unfiltered samples would expect to correlate very well to soil data for the same depths. Figure 3 has no title or caption.
24. Page 6, Last Paragraph: Please provide the data sequence for Pu activity at SW-53 (and flow data if available). Is it possible that increased seepage velocities resulting from higher heads remobilized Pu in near surface soils at the point where the seep daylight? How were the seep samples collected? If the data are all for unfiltered samples, it is difficult to see how one could quantify the Pu bound to particulates and transported via surface run off from the Pu in the local soils at the seep, and further, how Pu bound to particulates would be quantified relative to Pu transported as a dissolved phase or colloidal (<0.45 μm) particles.
25. Page 7, First Paragraph, First Sentence: Please show the data used for constructing Figure 3 and note the locations where this data was collected. What percentage of the Pu in each soil horizon is assumed to be mobilized? What is the assumed relationship between soil and water concentrations? What is the basis for these assumptions? The authors should clearly state that calculations associated with plutonium flux are relative only to a single area within the soil column and not indicative of anticipated flux off the study site. See also comment 13.
26. Page 7, First Paragraph, Second Sentence: Add to first of sentence "Based on these calculations, an estimated"
27. Page 7, First Paragraph, Last Sentence: Please provide the assumptions related to the area/location of flux calculation and lateral and vertical Pu distribution as well as the assumptions regarding the relationship between Pu in water/soil relationship. Without this information these contaminant flux calculations are not supported.
28. Page 7, Second Paragraph, Second Sentence, Table 2: Provide the locations and data from which this table is derived. Provide a more thorough discussion of the use of the 75% Quartile. The concentration of Pu in soils and in unfiltered soil pore water from the same depths would be expected to have a high correlation.
29. Page 7, Second Paragraph, Third Sentence: Please provide the basis for this statement.
30. Page 7, Second Paragraph, Fourth Sentence: Please provide the data which shows that anaerobic conditions existed in groundwater during this event. This data would aid in supporting the authors' speculation that mobilization of Pu is facilitated by enhanced dissolution of Fe and Mn oxides. Would the authors anticipate that Pu would re-associate with Fe and Mn oxides upon resumption of aerobic conditions? Such conditions would likely occur at points where groundwater is forced to the surface at contact seeps such as those which occur in the author's study area.

31. Were any data on dissolved Fe and Mn collected from either the trenches or from local shallow groundwater monitoring wells following May 95? Do these data show an increase in *dissolved* Fe or Mn over historic values?
32. Page 7, Last Paragraph, Second Sentence: What are the data and assumptions used for this calculation? We are aware of only two measurements of total (unfiltered) Pu activity at this point. Was it assumed that these concentrations are constant?
33. Page 8, First Full Sentence: Please clarify what is meant by the terms "drainage efficiency" and "throughflow". The SID is designed to intercept surface water flows from plant site areas where soils are contaminated with significant quantities of actinides. If the authors are aware of tributary areas containing significant contamination which are not now captured by the SID then please immediately provide this information to the DOE and K-H so that this information may be acted upon. Otherwise, this type of alarming speculation should be deleted from this paper.

Should flows bypass the SID they would enter Woman Creek or its alluvium. Woman Creek eventually flows into Woman Creek Reservoir which is designed to protect the water supplies of Northglenn, Thornton and Westminster in the unlikely event of a release from Rocky Flats. This water does not supply the Greater Denver area. If the authors wish to retain a statement of this type, then this correction should be made.

34. Page 8. First Full Paragraph: Although the Remedial Investigation phase has been completed for Operable Unit 2 (the area containing the author's study area), this does not mean that no additional action will be required in this area. The final remedy selection and Record of Decision for this area is not scheduled until accelerated actions have been performed, removing most of the risk. As a matter of fact, this area has been identified as one of the top ten high risk Environmental Restoration sites at Rocky Flats. Remediation of the 903 Pad and surrounding soils is a very high priority to DOE and K-H. Funding reductions to the ER program in FY 95 were made with the full knowledge of the EPA and State and at the recommendation of the stakeholders. This funding reduction was done with full understanding of the RI/FS process and was done to provide more funding to higher risk plutonium stabilization activities. Even without the authors instrumentation, significant changes in Pu concentrations would be noted in the extensive surface and groundwater monitoring system at the site. In addition, Superfund regulation requires continued performance monitoring in support of a Record of Decision to account for the fact that the RI/FS process cannot reasonably anticipate all potential conditions.