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Ms. Donna L. Powaukee, Manager
Environmental Restoration/
Waste Management Program
Nez Perce Tribe
P. O. Box 365
Lapwai, Idaho 83540-0365

Dear Ms. Powaukee:

RESPONSES TO GEOLOGIC FRAMEWORK FOR THE SITE-WIDE GROUNDWATER MODEL COMMENTS

This letter provides the U.S. Department of Energy, Richland Operations Office (RL) responses to comments, suggested changes, and clarifications outlined by Mr. Stan Sobczyk, of your staff, in a letter to Mr. Marcel P. Bergeron, Pacific Northwest National Laboratory, dated December 23, 1998. Each comment and response is provided below.

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Comment 1

The geologic framework is inadequately documented. Few geologic cross-sections are shown. Those that are shown should be labeled and tied to well control. Without being shown supporting data, it is difficult to assess the validity of the Pacific Northwest National Laboratory's (PNNL) proposed site-wide groundwater model. For example, cross section A. A' (Cole and others, 1997), shown in figures 6.2.and 6.3 is not labeled or shown in Figure 6.1. Wells shown in cross-sections (Figures 2 and 3, Thorne, 1998) are mislabeled. PNNL has interpreted hundreds of boreholes, but PNNL hasn't documented that the boreholes in the groundwater model have been interpreted in a consistent manner. This documentation could be quickly and cheaply accomplished by using Lindsey (1995) as the basis for the geologic framework.

Response:

This comment, which focuses on the geologic framework leads us to believe that we have not communicated or Mr. Sobczyk has misinterpreted the basis for the development of the **hydrogeologic** conceptual model of the proposed model. The early development of the model framework relied extensively on earlier geologic work by Hartman and Lindsey (1993), Lindsey (1991, and 1992), Lindsey et al. (1992), Lindsey et al. (1991), Lindsey and Gaylord (1990) and Poeter and Gaylord (1990). These references and others provide the foundation of the recent geologic interpretations found in Lindsey (1995). The sedimentary facies and geologic units of Lindsey (1995) are described in detail on pages 49-51 of the Draft Recommendations for Selection of a Site-Wide Groundwater Model at the Hanford Site (dated October 1998), which has been provided to Mr. Sobczyk. The conceptual model developed for groundwater modeling did not reinterpret the geology framework developed by Lindsey and other investigators but

rather grouped a few of the facies defined by Lindsey into different structural units based on similarity in hydraulic properties. As stated on page 51 of the Draft Recommendations for Selection of a Site-Wide Groundwater Model at the Hanford Site (dated October 1998):

> "To support development of the three-dimensional model, the lithofacies described by Lindsey (1995) were regrouped into nine hydrogeologic units based on similarity in expected groundwater-flow properties. Flow properties generally correlate to texture, sorting, and degree of cementation. Other geologic factors such as depositional environment, lithologic composition, and time of deposition were not considered in defining hydrogeologic units for the model. Therefore, the grouping of lithofacies was similar but not identical to that of Lindsey (1995).
>
> .... a difference in the model units is that the lower, predominantly sand, portion of Lindsey's upper Ringold was grouped with Unit 5, which also includes Lindsey's Ringold gravel units E and C. Part of Lindsey's lower mud unit was designated as Unit 6. However, sandy portions of Lindsey's lower mud unit were assigned to Unit 7, which also includes Lindsey's gravel Units B and D. Portions of the lower mud that occur below Unit 7 were designated as Unit 8."

Mr. Sobczyk may remember from the meeting of November 13, 1998, that Kevin Lindsey agreed that the differences between his geologic interpretation and the conceptual model units were minor. Mr. Lindsey also agreed that there should be differences in the way facies units are grouped for the purpose of modeling groundwater flow compared to a strictly geologic interpretation, and particularly that for groundwater modeling it made sense to include the predominantly sand portion at the bottom of the Upper Ringold with the Unit E gravels and sands that underlie it rather than with the very low permeability muds of the upper Ringold.

Mr. Sobczyk's comments and references suggest that he relied only on reports by Wurstner et al. (1995) and Cole et al. (1997) as his information base. The work done to support the proposed model development effort is not only documented in those reports but also on a body of work summarized in series of PNNL reports that do not appear in your reference list. They include the following reports:

Thorne, P. D., and M. A. Chamness. 1992. Status Report on the Development of a Three Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System. PNL-8332, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., and D. R. Newcomer. 1992. Summary and Evaluation of Available Hydraulic Property Data for the Hanford Site Unconfined Aquifer System, PNL-8337, Pacific Northwest Laboratory, Richland, Washington

Thorne, P. D., M. A. Chamness, F. A. Spane Jr., V. R. Vermeul, and W. D. Webber. 1993. Three Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 93 Status Report. PNL-8971, Pacific Northwest Laboratory, Richland, Washington.

Thorne, P. D., M. A. Chamness, V. R. Vermeul, Q. C. MacDonald, and S. E. Schubert. 1994. Three Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1994 Status Report. PNL-10195, Pacific Northwest Laboratory, Richland, Washington.

Much of the information Mr. Sobczyk is interested in is included in these reports. The details of the historical evolution of the definition of the major hydrogeologic units mentioned briefly in Wurstner et al. (1995) and Cole et al. (1997) is largely documented in these reports. Specific discussion of the technical approach and results of the hydrogeologic interpretation is documented on pp. 20-32 in Thorne et al., 1992; pp. 13-26 in Thorne et al., 1993, and pp. 4.1 to 4.14 in Thorne et al. 1994. These reports are referenced in both Wurstner et al. (1995) and Cole et al. (1997) and have been referenced in the workshops that have been conducted since last spring in the model consolidation process. If Mr. Sobczyk has not had a chance to examine these documents, we have attached copies of the reports for his future examination and reference.

Mr. Sobczyk's overall comments on the lack of geologic cross-sections in two reports he references are well taken. However, four detailed cross-sections tied to well control points will be included in the Draft Recommendations for Selection of a Site-Wide Groundwater Model at the Hanford Site (dated October 1998). These cross-sections and the supporting well data were also presented at the November workshop attended by Mr. Sobczyk. Earlier cross-sections that document hydrogeologic interpretations from the 200-Area Plateau to the Columbia River are provided in Figures 8 through 11 of Thorne et al. (1992). The other reports rely more heavily on the use of areal extent and isopach maps rather than cross-sections to describe the geometry of the major units. If Mr. Sobczyk has specific suggestions for locations of additional cross-sections or other information that could be used in this final report, his input would be appreciated.

RL has also examined the specific comments about two instances of documented cross-sections that you reference and provide the following information. The cross-section referred in Figures 6.2. and 6.3 in Cole et al. (1997) is model cross-section drawn through a limited number of model nodes to illustrate a point about model predictions of vertical distributions of tritium related to water supply wells at FFTF. Because of the focus of the discussion and the limited length of the cross-section, it was not included in Figure 6.1.

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With regard to the other cross-sections referenced, the Thorne (1998) report, there does appear to be some inadvertent labeling errors on the cross-sections. Particularly, the eastern well on Figure 2 should be labeled 699-S30-E14 rather than 699-S30-E13 and the southern well on Figure 3 should be labeled 699-S30-E14 rather than 399-5-2. This information will be passed on the author for correction. The interpretations provided are for the wells intersected by the lines of sections in Figure 6.1, which is labeled correctly.

Comment 2

Presently, information from about 600 boreholes is used to develop the geologic framework. Eventually, the geologic framework should incorporate all available and useable borehole information. Site programs and entities use about 2400 wells for groundwater monitoring (USDOE, 1995).

Response:

As indicated in Wurstner et al. (1995), a total of 576 wells/boreholes were considered in the development of the **hydrogeologic** conceptual model of the proposed site-wide groundwater evaluated. While it is acknowledged that the Hanford Site may have available about 2400 wells for groundwater monitoring (i.e., Currently only monitoring about 720 wells) the quantity and quality of geologic data and other information that is required for a rigorous development of the site-wide hydrogeologic framework is highly variable and in many cases totally lacking for a large number of these wells. If Mr. Sobczyk would review Appendix D in Lindsey's 1995 report, which provides his interpretations for the 426 wells and boreholes he used in his work, you can plainly see that even for many of the wells he used, information of the geology of the unconfined aquifer sediments was not available.

The specific wells that provide the basis for the hydrogeologic framework for the proposed model are documented in Figure 3.1 in Thorne et al. (1994). The data sources for the information used is provided on p. 3.1 of the same reference. This will be included in the hydrogeologic unit interpretations for all the boreholes that were used in developing the conceptual model in the report documenting the site-wide model when the revisions are made following peer review. Lindsey's geologic picks could be included for comparison's sake if Mr. Sobczyk feels such a comparison would be useful.

Comment 3

The rationale for regrouping Lindsey's (1995) Ringold Units into model layers is not adequately stated in either USDOE (1998) or Wurstner and others (1995). In particular, model layer 5 contains Lindsey's (1995) unit E and a portion of the Upper Ringold. As the energy of the depositional environment has a direct correlation with porosity and permeability, it appears that units from a high-energy depositional environment (Unit E) are incorrectly grouped with units from a low-energy depositional environment (Upper Ringold) to create model layer 5.

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Response:

Mr. Sobczyk's comment seems to indicate another misunderstanding of our interpretation that RL will try to clarify. The description of unit 5 on p. 4.5 of the Thorne et al. (1994) and the correlation of Unit 5 with units identified in Lindsey (1995) shown in Figure 2.8 in Wurstner et al. (1995) indicates that Unit 5 is composed Lindsey's Unit E and a lower sandy facies sequence located in many areas of the site at the base of the Upper Ringold. This sandy sequence of sediments corresponds to a sand dominated portion of the Taylor Flat member described on p. 31 of Lindsey (1995) who identifies it as interbedded fluvial sand and overbank fines. This sand dominated portion of this unit is clearly significantly more permeable than the overbank-sediment dominated portion or the overlying Savage Island lacustrine deposits in the Upper Ringold; thus, where present, it made sense to group these sediments with more permeable Unit E directly below it. The Taylor Flat Member is identified in many of the cross sections provided in appendix C in Lindsey (1995). This particular interpretation is a very good example of how to regroup some of Lindsey's units that he grouped from a geological standpoint into different hydrogeologic units. RL will attempt to more clearly articulate the basis for the identification of the major hydrogeologic units and their correlation to existing geologic units in the final model report that will publish in the coming year. Any specific suggestions in this regard from Mr. Sobczyk would be appreciated.

Comment 4

The cross-sections shown in Poeter and Gaylord (1990) do not appear to support the isopach of unit 4 (Figure 2.21) shown in Wurstner and others (1995).

Response:

Without more specific information on where Mr. Sobczyk thinks the inconsistencies are, it is difficult to respond to this comment. The conceptual model unit 4 correlates with just the low permeability sequences (the uppermost mud sequence) depicted in the cross-sections in Poeter and Gaylord (1990). If Mr. Sobczyk has specific comments on these figures, RL would be glad to address them.

Comment 5

Paleoflow directions and landforms associated with the cataclysmic floods shown in Figure 1.1.6 (USDOE, 1988) do not appear to support the isopachs of unit 4 (Figure 2.21) and unit 1 (Figure 2.27) shown in Wurstner and others (1995).

Response:

Without more specific comments on how Mr. Sobczyk believes the information in the cited figure does not support the isopach maps of unit 4 and 1, it is difficult to address his concern. The potential for correlation of the isopach map of unit 4 (Figure 2.21) with the paleo-flow directions and landforms associated with the cataclysmic floods shown in the cited is not very likely since the deposition of the unit 4 Upper Ringold deposits predates the time of the Missoula flood deposits that are depicted in the figure. The iospach map of unit 1, given in Figure 2.27, reflects the total thickness of pre-Missoula gravels, Hanford formation and overlying eolian sediments extending from the top of the Ringold Formation to land surface. RL believes the pervasive extent and thickness of unit 1 is indeed consistent with the widespread nature and types of deposition you would expect with the paleo-flow directions and major landforms illustrated in Figure 1.1-6 of DOE (1988). If Mr. Sobczyk has specific comments or concerns about these figures, RL would be happy to address them.

Comment 6

A map of the distribution of transmissivity (Figure 3.3, Cole and others, 1997) is shown for the site; however, this map masks the transmissivity of each aquifer. The transmissivity of each model layer, that represents aquifers, should be shown so that the spatial distribution of transmissivity can be assessed for each aquifer.

Response:

This map is not intended to mask the transmissivity of each of the major permeable units as alluded to in the comment but rather to provide the distribution of transmissivity measurements from aquifer pumping tests that were used in the development of the model. Whether a particular measurement pertains to the entire aquifer thickness or just one of the permeable units at that location depends on the well completion configuration and the nature of the aquifer. Additional information on these transmissivity estimates and others are provided in the following reference, which has been included in the transmittal.

Thorne, P. D., and D. R. Newcomer. 1992. Summary and Evaluation of Available Hydraulic Property Data for the Hanford Site Unconfined Aquifer System, PNL-8337, Pacific Northwest Laboratory, Richland, Washington

RL would generally agree with the spirit of Mr. Sobczyk's comment and will commit to reporting the major hydrogeologic unit for available transmissivity estimates used to develop the hydraulic properties used the model in our final report.

RL hopes that the information provided will help Mr. Sobczyk better understand the thinking and interpretation of the hydrogeologic framework that provides the basis for the proposed site-wide groundwater model.

If you or Mr. Sobczyk would like to discuss the responses or need additional information, please don't hesitate to contact me by phone at (509) 373-9626, by fax at (509) 376-4360.

Sincerely,

R. Douglas Hildebrand, Project Manager
Groundwater Project

GWP:RDH

Attachment

cc w/o attach:
J. H. Bell, NPT
M. P. Bergeron, PNNL
L. E.Gadbois, EPA
D. Goswami, Ecology
M. J. Graham, BHI
W. Riggsbee, YIN
S. M. Sobczyk, NPT
R. M. Smith, PNNL
P. D. Thorne, PNNL
P. Wierenga, U. of Arizona