OhioEPA

State of Ohio Environmental Protection Agency

Southwest District Office
401 East Fifth Street
Dayton, Ohio 45402-2911
(513) 285-6357
FAX (513) 285-6249

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George V. Voinovich
Governor

July 24, 2000

Mr. Johnny Reising
U.S. Department of Energy, Fernald Area Office
P.O. Box 538705
Cincinnati, OH 45253-8705

RE: COMMENTS GROUNDWATER MODELING SUBMITTALS

Dear Mr. Reising:

This letter provides Ohio Environmental Protection Agency comments on the following ground water modeling documents;

- Integration of Data Fusion Modeling with VAM3DF Contaminant Transport Code
- Great Miami Aquifer VAM3D Flow Model Re-Calibration

Some of our comments were briefly discussed during the meeting held on July 11, 2000. Because of the exceptionally complex technical nature of our comments, we would entertain proposals to resolve our comments with an exchange of e-mails, additional meetings, or by other expeditious methods.

If you have any questions, please contact Tom Ontko or me.

Sincerely,

Tom Ontko

for Thomas A. Schneider
Fernald Project Manager
Office of Federal Facilities Oversight

cc: Jim Saric, U.S. EPA
Terry Hagen, FDF
Mark Shupe, HSI GeoTrans
Francie Hodge, Tetra Tech EM Inc.
Ruth Vandergrift, ODH

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Ohio Environmental Protection Agency Comments on the Integration of Data Fusion Modeling with VAM3DF Contaminant Transport Code

1) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: G
Comment: Although figures in the report might look good in color, they are nearly illegible in black and white copy. Many contour plots do not have numbered contour lines and xy plots such as breakthrough curves are not clearly presented. In addition, most of the tables in the document do not have units specified.

2) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: M
Comment: The model as conceived uses data fusion to estimate rates for adsorption/desorption and precipitation/dissolution. Input to the calculations consists of flow system parameters and measured concentrations. If reasonable results are obtained for the near term planning horizon (i.e., 10 years), what is their validity over the long term (say 100 or 500 years)? For example, if geochemical conditions in the next 100 years vary slightly with regard to Eh and pH, how valid will be the data fusion predictions obtained for current conditions? Should adsorption/desorption and precipitation/dissolution sensitivities be investigated for plausible future variations of the site groundwater geochemical regime?

3) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: M
Comment: A major conclusion from the VAM3DF transport modeling analysis discussed in this document is that kinetic mass transfer is not a significant process operating at the site. It appears that if one were to contrast the new VAM3DF model with the old SWIFT model, the differences are that 1) Kd can be discretized at each model node in VAM3DF whereas this was not possible in SWFT and 2) VAM3DF has the ability to simulate chemisorption which was not an option in the previous model. Previous documents, however, cite field evidence (South Field area aquifer soils) that "the adsorption process is partially irreversible and the desorption process is usually slower" (taken from the Baseline Remedial Strategy Report, DOE, 1997). The VAM3DF result with respect to kinetic mass transfer as stated in the current report, therefore, is not consistent with field experience. With respect to the addition of a chemisorption term to the modeling analysis, no data has been presented to provide a reality check for this parameter. The chemisorption process provides a means for permanently removing uranium mass from the system. As a result, its use will have a significant impact on the projected time for cleanup to be achieved. The simulated chemisorption, therefore, needs to be based on actual site data with adequate spatial distribution (e.g., not a single value).

4) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6 Pg.#: 5-3 Line #: 28 Code: C
Comment: The verification of the model is based upon a simple two-dimensional model of transport of a conservative solute. It is best to start with simplified verification problems, but the model needs to be verified for all the important parameters and under the conditions (three-dimensions, etc.) that it is going to be used. A more complex verification model should be presented.

5) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.4.2 Pg.#: 5-5 Line #: 12 Code: C
Comment: The referenced text indicates that in the event that the Chi-squared test results in an n value greater than unity, caution should be exercised in the model results. Inspection of Tables 5.1 through 5.10 indicates that n is greater than 1 for a significant number, if not most, of the test problem simulations. For example, n for the initial plume estimation (Table 5.2) ranges from 1.32 to 3.10; for the spatially random Kd field (Table 5.4), n ranges from 1.16 to 5.44; for the spatially random Freundlich Kd (Table 5.8), n ranges from 1.36 to 2.19; for the estimation of linear trend in desorption rate coefficient (Table 5.9), the three test runs produced n values of 0.56, 37.5, and 23.22. In light of the guidance given the reader for interpreting these results, the model results are often of questionable validity. Is this result intended to be conveyed? If not, what are we to conclude from the Chi-squared test results?

6) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.5 Pg.#: 5-5 Line #: 16 Code: C
Comment: Table 5.1: Why were no tests performed for precipitation/desorption option? Why does this process seem to be disregarded? Are the authors saying it is not an important process for this site?

7) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.5.1 Pg.#: 5-5 Line #: 24 Code: C
Comment: For the initial condition test why was such a simple source used? The Fernald site includes multiple source areas with superposed plumes. Shouldn't a test that more closely represents actual application of the model be used?

8) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.5.4 Pg.#: 5-7 Line #: 14 Code: C
Comment: Why were the boundary conditions changed for the estimation of the polynomial trend in log effective porosity? Was the problem simulated with the original boundary condition? If so, where are the results? Was there a problem with the

analysis using a source that is turned off?

9) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.5.6 Pg.#: 5-8 Line #: 3 Code: C
Comment: The only dispersivity examined was the horizontal longitudinal term. How well would the model work with the other terms: horizontal transverse, vertical transverse, and vertical longitudinal. What if you were looking for values of all four?

10) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 5.5.8 Pg.#: 5-8 Line #: 26 Code: C
Comment: The referenced text states that in the case of the polynomial trend in desorption rate coefficient, all three α_d field estimates resulted in breakthrough curves that match the true breakthrough without matching the true α_d field. This result is contrary to the previous text stating that the closer the simulated breakthrough curve is to the true curve, the better the parameter estimate is (Section 5.4.1., page 5-4, line 8). In other words, the parameter field is a poor match yet the computed result is a good match. Is there a problem with using the code to estimate first-order parameters? Was the test problem poorly defined? Should the test have considered the use of a larger α_d value which may reflect the degree of influence of this parameter at longer time periods over larger scale models? Also, would the parameter have shown different results when used in conjunction with a higher Kd?

11) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.4.2 Pg.#: 6-3 Line #: 1 Code: C
Comment: Constant head boundaries on the local model were interpolated from the site model head solution. Were the interpolated constant-head boundaries adjusted during the simulation to reflect changes in remediation pumping rates/locations over time?

12) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-3 Line #: 23 Code: C
Comment: Table 6.2: What is the source of the data used in the sensitivity simulations? Specifically, what is the basis for the selected values used for K_d, Chemisorption Rate Coefficient, and Desorption Rate Coefficient?

13) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-3 Line #: 23 Code: C
Comment: Table 6.2: Could the actual desorption rate coefficient be higher than the perturbed value? Higher values than those used in the calibration should be

investigated in the sensitivity analysis.

14) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-3 Line #: 23 Code: C
Comment: Table 6.2: How sensitive is the system to the desorption rate coefficient at different K_d's? This is critical since the difference between the adsorption coefficient and the desorption rate coefficient become much greater at higher K_ds.

15) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-3 Line #: 39 Code: C
Comment: The text states that there was minimal sensitivity to the upstream weighting factor used. Would the model also be insensitive for the case where longitudinal dispersivity is set equal to 10 and transverse dispersivity is 1? The dispersivities that were actually used were $\alpha_l = 100$, $\alpha_t = 10$.

16) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-3 Line #: 39 Code: C
Comment: The text states that there was minimal sensitivity to the upstream weighting factor used. This conclusion appears to have been based on two simulations, the first with an upstream weighting factor value of 0.5, the second with a value of 1.0. An additional simulation should be performed assuming no upstream weighting (i.e., upstream weighting factor = 0). What is the resulting sensitivity of the model?

17) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-4 Line #: 2 Code: C
Comment: The conclusion indicated in the referenced text implies that the desorption coefficient has little influence on model results. This conclusion has a major implications on how Kd will be simulated and, therefore, requires rigorous, well documented, testing to support it. The minimal testing performed and the lack of associated text discussion are wholly inadequate for supporting this far-reaching claim.

18) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.5.2 Pg.#: 6-4 Line #: 5 Code: C
Comment: The breakthrough curves presented in Figures B-1 through B-5 (Appendix B, Pages B-1 to B-5) are not necessarily great matches. The resultant trends (not necessarily magnitudes) are similar for wells where little change occurs but not for wells where there is any real change of concentration (See Figure B-3). How was this small sampling of wells chosen? Are results at other wells similar or better or

worse?

19) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.6 Pg.#: 6-4 Line #: 29 Code: C
Comment: The text indicates that the MRF correlation lengths are consistent with the model used by DOE (1994) to krige the 1993 total uranium concentration data. The resulting correlation lengths of 1000, 1000, and 40, however, are not consistent with the lengths reported by DOE (2000, 2000, 2000). How does the indicated MRF standard deviation (0.3 nano lb/ft3) relate to the 1993 total uranium kriging variance presented in the DOE document?

20) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.7 Pg.#: 6-5 Line #: 1 Code: C
Comment: What was the basis of well selection for the subset used for concentration measurements? How would results differ if a different subset of wells were chosen? How good were results at wells that were not chosen for the subset? Irrespective of computational considerations, some sense of how the model performs at all available calibration targets is needed.

21) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.7 Pg.#: 6-5 Line #: 27 Code: C
Comment: How does the assumed prior error standard deviation relate to the actual standard deviations for each monitoring point?

22) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.8.3 Pg.#: 6-7 Line #: 3 Code: C
Comment: Why was a trend assumed for the MRF? What is the basis for selecting a linear trend? How does the error in the estimated parameters (in this case initial concentrations and Kd) vary with the form of assumed trend? How much error reduction is achieved because a trend is assumed (e.g., is the error reduction worth the loss in degrees of freedom?)?

23) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.8.3 Pg.#: 6-7 Line #: 7 Code: C
Comment: As indicated in the July 1998 Hydrogeologic, Inc. report "Development and Verification of VAM3DF: A Numerical Code for Modeling Flow and Transport in Groundwater," a specific objective in the development of aquifer restoration management support tools is to provide the ability to simulate kinetic mass transfer between liquid and solid phases. The mass transfer processes to be included are

adsorption, desorption, chemisorption, precipitation, and dissolution. The indicated text states that kinematic mass transfer was not included in the Kd estimation process. These processes should be accounted for in the estimation of Kd in keeping with the stated project objectives.

24) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.8.3 Pg.#: 6-7 Line #: 21 Code: C
Comment: The Kds computed from this analysis vary over two orders of magnitude. With the exception of some local highs, the Kds appear generally to increase with distance from the source area. What are possible physical explanations (e.g., aquifer material lithologic variation, relative age of the plume, etc.) for the computed Kd distribution?

25) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6.8.3 Pg.#: 6-7 Line #: 21 Code: C
Comment: The estimated Kd values must be compared with the spatial distribution of the direct measurement data available. Such data includes the laboratory measurements presented in the OU5 FS Report (DOE, 1995a) and the South Field Pumping Test Report (DOE, 1995b). Additional direct Kd measurement data should be collected to evaluate the reasonableness of the model estimates.

26) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 6 Pg.#: 6-7 Line #: 27 Code: C
Comment: Figures showing the spatial distribution of Kd estimation errors should be provided. Presentation of the simulation errors spatially permits more credible comparison of the simulations.

References

U.S. Dept. of Energy, 1997, "Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration," Final, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995a, "Feasibility Study Report for Operable Unit 5," Final, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995b, "South Field Pumping Test Report," Draft, DOE, Fernald Area Office, Cincinnati, OH.

Ohio Environmental Protection Agency Comments on Great Miami Aquifer VAM3D Flow Model Re-Calibration

1) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: M
Comment: The calibration focused on boundary conditions rather than the simulated hydraulic conductivity distribution. What was the rationale for selecting the constant head boundaries as the most appropriate route for model re-calibration? With only four aquifer tests in the immediate area, it would seem that hydraulic conductivity is a greater unknown in the model (and, therefore, a stronger candidate for calibration changes) than are the boundary heads. Although hydraulic conductivity zonation in the model honors the available pump test data, zone boundaries appear to be arbitrarily drawn without regard to natural depositional trends in the aquifer. Abundant lithologic information is available on site to help guide the delineation of zones. Such information would include the extensive testing performed for the south field aquifer test, the lithologic logs presented in the OU 5 RI/FS report, and elsewhere. Direct evidence for aquifer heterogeneity was demonstrated by the necessity to prematurely shutdown South Field Extraction Well 31566 because of low pumping rates and high draw down. Subsequent excavation for the South Field soil remediation in the vicinity of the well revealed the existence of a locally silty zone in the upper GMA. A more accurate hydraulic conductivity field is needed in the model to provide results that are relevant to the pump and treat design issues. The calibration, therefore, needs to make fuller use of the available site data in order to develop strategies for better estimation of GMA hydraulic conductivities.

2) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: M
Comment: The modeling approach used was to perform a steady-state calibration using dry season conditions (October 1998) and to verify the calibration using head data from April 1998. Alternative verifications were conducted using head data from July 1998 and October 1999. The October 1998 calibration primarily consisted of changes to constant head and constant flux boundary conditions. The three verifications also involved changes to the model boundary conditions. The verification models do not verify the calibration but are, in essence, separate calibration exercises that essentially duplicate initial October 1998 calibration activity. No additional information regarding model accuracy is provided by each of the validation runs because the same parameters are changed in each case. A recommended verification procedure is described in the following. The October 1998 calibration is assumed to be a reasonable representation of average steady state conditions in the GMA under stressed conditions, i.e., conditions in the aquifer after the transient effects of the South Plume, South Field, and Re-Injection Demonstration modules' pumping have significantly diminished and precipitation is generally low. The October data representative of similar precipitation conditions but without the effects of the South

Field and Re-Injection Demonstration pumpage (e.g., Fall Quarter data from a year prior to 1998) would be appropriate for verification. With the stresses removed, the heads should provide an acceptable match to the verification conditions without modifications to the boundary conditions. In summary, model verification should not include changes to the same parameters that are modified during model calibration.

3) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: M
Comment: A sensitivity analysis of the calibrated flow model should be performed. The analysis should quantify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters, stresses, and boundary conditions. Specifically, the analysis should investigate the degree to which the constant head cells in the vicinity of the site affect the amount of predicted draw down near the existing and planned remediation extraction well modules. Model boundaries should be located sufficiently remote from the area of interest such that the artificial conditions of the boundary do not significantly impact the predictive capabilities of the model.

4) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: NA Line #: NA Code: G
Comment: All maps showing model results should be oriented with north toward the top of the page. All inactive areas (e.g., bedrock outcrop areas) should be clearly distinguished from active portions of the model grid. Primary site features (e.g., Wiley Road, Paddy's Run, etc.) should be labeled in order to provide a reference to the reader.

5) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.2 Pg.#: 3-1 Line #: 13 Code: C
Comment: The residual in the referenced text is defined as the difference between predicted and measured elevations. Later on this page, the residual is defined as the difference between the measured and predicted elevations. The standard is typically to calculate residuals as the difference between measured groundwater elevations and predicted (simulated) groundwater elevations: $\epsilon = h_m - h_s$, where ϵ is the residual, h_m is the measured groundwater elevation, and h_s is the simulated groundwater elevation. The equation on Page 3-1 is, however, correct and the utility computer program (CALERR) in Appendix B was also found to be correct. The text here and elsewhere in the document should be written to define the residual calculation consistent with accepted convention.

6) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.

Section #: 3.4 Pg.#: 3-2 Line #: 12 Code: C
Comment: A cross-sectional figure showing the 12 layer vertical discretization of the VAM3D model and the lithologic units which correspond to each model layer should be provided in this report.

7) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.4 Pg.#: 3-2 Line #: 14 Code: C
Comment: A summary of the grid dimensions should be included in Section 3.4. This should specify the number of rows and columns used and the node spacing of the VAM3D model. It is our understanding that the grid may have been re-gridded during re-calibration to better represent heterogeneity in the model domain. Was this considered or attempted during re-calibration?

8) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.4 Pg.#: 3-3 Line #: 4 Code: C
Comment: A table should be provided which list the extraction/injection wells included in the steady-state re-calibration, the corresponding VAM3D model layer in which they reside and the extraction/injection rate assigned to the well.

9) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.4 Pg.#: 3-3 Line #: 9 Code: C
Comment: One of the changes to the starting VAM3D model data set (VAMAB1) during re-calibration was interpolation of new boundary heads for a 2500 gpm net pumping case from the old SWIFT (6 layer) to the new VAM3D (12 layer) grid. How was this interpolation performed, what data is it based on, and what do these resulting heads look like?

10) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-3 Line #: 29 Code: C
Comment: How did the Fortran program use the contoured residuals to adjust specified boundary and river heads to calibrate the model? Was the procedure iterative? If so, please provide a summary of the procedure.

11) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-3 Line #: 28 Code: C
Comment: A figure or figures should be provided which shows the location and value of the final calibrated specified head boundary conditions in each layer used in the VAM3D model. The head values should be compared with the contoured head maps for the upper and lower GMA to allow an assessment of their relevance to actual

conditions.

12) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-4 Line #: 2 Code: C
Comment: The sign convention of the residuals discussed in the two bulleted items on this page is reversed. See previous comment.

13) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-4 Line #: 22 Code: C
Comment: A scatter plot of observed heads versus simulated heads needs to be included in this section of the report. The X and Y axes of the chart should have the same scale. Such a plot will help verify the quality of the calibration.

14) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-4 Line #: 22 Code: C
Comment: A calibrated flow model should have a spatial distribution of residuals which are randomly scattered across the model domain. An analysis of Figure 3-5 indicates that there are trends where the model is either under-predicting or over-predicting water levels. Running north-south through the site, the model is under-predicting water elevations. This area is bounded to both the west and east by over-prediction of water elevations. Further discussion is warranted in Section 3.6 concerning the calibration results. While there is discussion about the poor match of heads near Paddy's Run around well 2033, there is no discussion of an equally large area of model under-prediction around wells 2897 and 2898. In addition, calibration residuals for wells along the perimeter of the monitor network all show over-prediction of elevations by the model. These wells all have the highest error encountered of the calibration targets. These include well 2097 (model over-predicts head by 0.70 feet, the % error is 6.5%) to the east, well 2096 (model over-predicts head by 0.70 feet, the % error is 6.5%) to the west, well 2043 (model over-predicts head by 0.74 feet, the % error is 6.9%) to the north, and wells 2702 (model over-predicts head by 0.82 feet, the % error is 7.6%) and 2546 (model over-predicts head by 0.63 feet, the % error is 5.9%) to the south. What attempts were made to reduce this trend in spatial bias which is evident in the re-calibrated VAM3D model?

15) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-4 Line #: 23 Code: C
Comment: There are 90 wells used as calibration targets in the VAM3D model. Which model layer is each of the wells assigned to in the model? Tables A-1 and A-2 should include a column which lists the model layer each calibration well belongs in,

and the table should be sorted by layer number. This will allow for an analysis of the distribution of residuals by model layer.

16) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: Figures 3-7 & 3-9 Line #: NA Code: C
Comment: Figures 3-2 and 3-4 need to specify which model layer simulated heads the water level contours are based upon.

17) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.6 Pg.#: 3-5 Line #: 12 Code: C
Comment: Changes made to the model during re-calibration it included adjustments to specified-head boundaries at all lateral boundaries and at surface Great Miami River nodes. What is the justification for adjusting these values? Is there data to support the final values used in the calibration? Are surface Great Miami River nodes based on observed river elevations? If so, do specified head values fall within the range of observed elevations?

18) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 3.5 Pg.#: 3-5 Line #: 17 Code: C
Comment: A table or series of figures need to be included in this section of the report which show the values of hydraulic conductivity used in the re-calibrated VAM3D model. Extensive hydraulic testing has been performed at the site. The table should compare the model hydraulic conductivity values to those obtained from testing.

19) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 4.1 Pg.#: 4-1 Line #: 1 Code: C
Comment: The text indicates that extreme water level conditions were selected to conduct the model validation. Extreme water level conditions are a poorer approximation of steady-state groundwater flow as compared with the system under more typical conditions. High water levels such as those observed in April 1998 are generally the result of higher than normal areal recharge. Recharge, however, is a parameter usually associated with a high degree of uncertainty. Validation is more appropriately performed using typical conditions and a known stress that is imposed, such as pumpage. A recommended approach given this consideration was presented in a previous comment.

10) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 4.1 Pg.#: 4-1 Line #: 1 Code: C
Comment: Using validation as a check on the calibration as opposed to performing a

separate transient simulation is considered appropriate. The text should, however, discuss the option of a transient simulation and why one was not performed as a means to establish uniqueness of the model.

11) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 4.6 Pg.#: 4-3 Line #: 4 Code: C
Comment: The sensitivity analysis performed for the validation run should have been performed for the calibrated flow model data set instead. Model validation typically involves changes to aquifer stresses while leaving aquifer properties (hydraulic conductivity) unchanged. The sensitivity of the model to changes in conductivity should have been performed on the calibrated model (October 1998 heads). For the April 1998 validation data set, only the changes listed in items 1), 2), and 3) on page 4-2 need be discussed in Section 4.5.

12) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: 4.7 Pg.#: 4-3 Line #: 3 Code: C
Comment: The sign of the residuals need to be reversed, as per previous comments.

13) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: NA Pg.#: Figure 4-2 Line #: 4 Code: C
Comment: Figure 4-2 needs to specify which model layer the simulated heads the water level contours are based upon.

14) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix A Pg.#: A-1 through A-4 Line #: NA Code: C
Comment: The residuals should be recalculated as $\epsilon = h_m - h_s$ as per previous comments.

15) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix C Pg.#: C-1, C-2 Line #: NA Code: C
Comment: The sign of the Mean Error in Table C-1 needs to be reversed as per previous comments.

16) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix D Pg.#: D-3 Line #: NA Code: C
Comment: In Table D-1, the Target Rate should be re-labeled to indicate that it is the rate that was used in the validation model data set. Also, an additional column should be added which shows the well rates used in the calibrated model.

17) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix D Pg.#: NA Line #: NA Code: C
Comment: All the discussions of residuals in the text, in the figures and tables in this Appendix need to be recalculated as $\epsilon = h_m - h_s$

18) Commenting Organization: OEPA Commentor: HSI GeoTrans, Inc.
Section #: Appendix D Pg.#: NA Line #: NA Code: C
Comment: Figures D-2 and D-5 need to specify which model layer the simulated heads the water level contours are based upon.