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Baker

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February 9, 1998

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street (Building N-26)
Norfolk, Virginia 23511-2699

Attn: Ms. Katherine Landman
Code 18232

Re: Contract N62470-89-D-4814
Navy CLEAN, District III
Contract Task Order (CTO) 0312
Draft Groundwater Modeling Report
Operable Unit (OU) No. 9 (Site 73)
MCB, Camp Lejeune, North Carolina
Response to Comments

Dear Ms. Landman:

Baker Environmental, Inc. (Baker) is pleased to submit a copy of Baker's draft response to comments on the Draft Groundwater Modeling Report for Operable Unit (OU) No. 9 (Site 73) - Amphibious Vehicle Maintenance Facility (see Attachment A). Copies of the original comments are provided in Attachment B. The draft responses are included in Word Perfect 5.0 format on the enclosed diskette. Copies of these responses have also been submitted electronically to Messers. Neal Paul and Brian Marshburn at MCB, Camp Lejeune, Ms. Gena Towsend at USEPA Region IV, and Mr. David Lown at NC DENR. A hard copy will also be provided via regular mail.

Baker will contact USEPA, NC DENR and MCB, Camp Lejeune via telephone during the week of February 9, 1998 to discuss the draft response to comments and ensure each reviewer's concurrence. Subsequent to these discussions, the draft responses will be modified, if needed, and resubmitted as final. The Final Groundwater Modeling Report will be distributed to all parties in March 1998, unless additional comments are received.

If you have any questions regarding this correspondence, please contact Mr. Matthew Bartman at (412) 269-2053 or me at (412) 269-2063.

Sincerely,

BAKER ENVIRONMENTAL, INC.

Daniel L. Bonk, P.E.
Project Manager

DLB/lq
Enclosures

cc: Mr. Neal Paul, MCB, Camp Lejeune (w/attachments)
Ms. Lee Anne Rapp, P.E., LANTDIV, Code 18312 (w/o attachments)
Ms. Beth Collier, LANTDIV, Code 02115 (w/o attachments)

Draft Response to Comments
Submitted by the Commanding General, Marine Corps Base, Camp Lejeune on the
Draft Groundwater Modeling Report for
Site 73 (Operable Unit No. 9)
MCB, Camp Lejeune, North Carolina
Comment Letter Submitted by Mr. Scott A. Brewer, PE
Received by Baker Environmental, Inc., 5/19/97

Specific Comments

1. The residual (or error) at a well is defined as the difference between the measured value (of head) and the simulated (modeled) value. In a calibrated model, the residual mean (the average of the errors) should be close to zero, that is, the positive errors should be balanced by the negative errors. However, the residual mean does not describe the "spread" of data around the mean. The standard deviation of the errors (residual standard deviation) describes how the error is distributed around the mean. A large residual standard deviation indicates that the error values are rather large and widely spread; small values indicate a "clustering" of small errors close to the average. Text will be added to the Final Groundwater Modeling Report for Site 73, Section 3.6 to explain the significance and define the residual standard deviation (RSD) values.

2. The text will be changed as per the comment.

3. The text will be changed as per the comment.

4. Agreed, the model was rerun using a value of 390 feet (the distance between 73-DW03 and the bay). The result was only 0.415 mg/L TCE will be allowed to remain in the Castle Hayne aquifer instead of 0.456 mg/L as originally stated. This result is included in Appendix C. Modifications to the text of the Final Groundwater Modeling Report will be necessary to reflect the new result.

Draft Response to Comments
Submitted by the United States Environmental Protection Agency (USEPA),
Region IV on the
Draft Groundwater Modeling Report for
Site 73 (Operable Unit No. 9)
MCB, Camp Lejeune, North Carolina
Comment Letter Submitted by Ms. Gena D. Townsend
Received by Baker Environmental, Inc., 5/12/97

General Comments

1. Revisions will be made to Figure 4-1 since issuing the Draft Groundwater Modeling Report and the new Figure will replace the original. The isoconcentration lines are based on limited data obtained at the site. The scope of the Remedial Investigation (RI) conducted at the site was to delineate contamination horizontally and vertically. Due to the overall size of the site, soil borings and groundwater monitoring wells were placed several hundred feet apart in order to accomplish the objective. Once the analytical results were reported, the spacial relationship between the monitoring wells created a need for estimating the extent of contamination at the site.

   The contamination observed at monitoring well 73-MW17 is bounded on the east, north and west. Monitoring wells MW-13, MW-16, MW-08, MW-16, 73-MW19, 73-MW20, 73-MW21, and A47/3-13 were all sampled for chlorinated organics during the RI. Additional work is presently being scoped for the site to better define the size of the plumes within the vicinity of Building A-47. Analytical results obtained from the additional investigations at the site will better define the shape, orientation, and extent of the plumes portrayed in this figure.

2. Figures 4-1, 4-2, and 5-1 will be corrected in the Final Groundwater Modeling Report.

3. The text will be adjusted to reflect that Figure 4-2 is a simple, graphical representation of the best chemical indication for the occurrence of natural attenuation. The lines connecting the dots are meant to show the apparent trends over distance. The collection of additional, pertinent data will provide support to (or will refute) the theory that natural attenuation is occurring. This type of additional data is inherent in the natural attenuation remedial alternative. The natural attenuation remedial alternative (with long-term monitoring) will provide additional data (both spatially and temporally) by which the theory that natural attenuation is occurring will be evaluated and will document the degree to which the TCE and degradation products are being mitigated.

Specific Comments:

1. Agreed, the changes will be made.

2. Hydraulic conductivity data were reviewed during the model setup. The text will be changed to reflect this.

3. The current version of the software used to print the figures (GMS) has no direct utility to print the units. They will be added manually.

4. (See response to Comment #3)

5. (See response to Comment #3)

6. "RM" will be added to the acronym list.

7. "C-drn" and "C-riv" will be added to the acronym list.

8. The language in the referenced paragraph will be clarified for the Final Groundwater Modeling Report.

9. Agreed, the changes will be made to Figure 4-1.

10. The boundaries of Site 73 are not depicted on Figure 5-1 because the entire area shown is the site. The site is surrounded on three sides by wooded areas and on the remaining side by Courthouse Bay. Because there are no adjoining facilities, Baker opted not to identify an arbitrary boundary. Rather, the boundaries of the site are ultimately defined as the extent of the study area which is marked by various sample point locations depicted in the figure.

Draft Response to Comments
Submitted by North Carolina Department of Environment and Natural Resources (NC DENR) on the Draft Groundwater Modeling Report for Site 73 (Operable Unit No. 9) MCB, Camp Lejeune, North Carolina
Comment Letter Submitted by Mr. David J. Lown, LG, PE
Received by Baker Environmental, Inc., 10/02/97

General Comments in the Cover Page Text -

1st ¶ - "...if the water supply wells at Courthouse Bay are being contaminated by the Site 73 plume, this (bioremediation) remedy will require a variance to the North Carolina groundwater standards."

Response: The responses below explain how the data indicate that the supply well BB-44 was not impacted by releases from Site 73. TCE was detected in supply well BB-44 at a concentration of 1 µg/L during the Wellhead Monitoring Study conducted in 1992 by Greenhorne and O'Mara, Incorporated. A groundwater sample was collected from supply well BB-44 during the Site 73 Remedial Investigation (RI) and the chemical analysis of the sample indicated no detectable concentrations of organic compounds.

2nd ¶ - "A different approach would be to see if a model can be designed, using the suggested range of data, to produce the contamination found at the water supply well (BB-44), and then use the worst-case model to suggest what additional field data is needed to show that the contamination is not coming from Site 73."

Response: The objective of the calibration process was to match the observed data. Within the limits set forth in the report, the current model satisfies that objective. The following facts suggest that contamination originating at Site 73 cannot intersect the zone of influence created by supply well BB-44:

- The average water levels in the well clusters near the shore on the west (Site 73) side of Courthouse Bay indicate that there is a higher average water level in the upper and lower Castle Hayne aquifer (ranging from 2.0 to almost 3.0 feet above sea level) than in Courthouse Bay (sea level); thus demonstrating an upward gradient into the bay. Regardless of an actual hydraulic connection, potentially contaminated water in the surficial unit cannot travel vertically downward in close proximity to the bay; neither could it migrate horizontally under the bay toward well BB-44.

- The average water levels in the well cluster on the east side of Courthouse Bay (73MW-36, 73DW-13, and 73GW-05) indicate that a higher average water level exists in the lower Castle Hayne than in the upper Castle Hayne; thus providing evidence that an upward head gradient within the Castle Hayne aquifer occurs at this location. Also, the water levels in all three wells in this cluster are 2.3 to 3.0 feet higher than sea level; therefore, groundwater in the upper Castle Hayne must move toward the lower head (into the bay) and cannot move downward within the Castle Hayne aquifer.

- The comparison of water levels from the east and west sides of Courthouse Bay within the upper Castle Hayne aquifer (see Figure 3-12 of the Draft Groundwater Modeling Report)

indicates that the imaginary contours under the bay must be connected such that horizontal flow is into Courthouse Bay. That is, the 2.3 contour must be bent southward to pass near well 73DW-13 (elevation 2.35) on the east side of the bay. The model shows this observed flow pattern in Figure 3-13 of the Draft Groundwater Modeling Report.

- The comparison of water levels from the east and west sides of Courthouse Bay within the lower Castle Hayne aquifer (see Figure 3-17 of the Draft Groundwater Modeling Report) indicates that the groundwater contours passing beneath the bay must also be connected such that horizontal flow is into Courthouse Bay. That is, the 2.8 contour must be bent southward to pass near well 73GW-05 (elevation 2.82) on the east side of the bay. The model shows this observed flow pattern in Figure 3-18 of the Draft Groundwater Modeling Report.

- The capture zone of BB-44 was simulated as part of the response to these comments (discussed in more detail below) and it extends, as it must, upgradient and northeast from the location of the well. It does not indicate that well BB-44 draws any water from Courthouse Bay or from the vicinity of Site 73. A figure (and a discussion thereof) illustrating the capture zone of Supply Well BB-44 will be included in the final report.

The water level data mentioned above are strong evidence of the three-dimensional flow directions in the vicinity of Courthouse Bay; they indicate that it is a discharge area for the surficial unit and for the entire thickness of the Castle Hayne aquifer. It is believed that Site 73 is not the source of contamination in well BB-44. The previously mentioned information will be added to the text for the Final Groundwater Modeling Report.

3rd ¶ - "At present, the following factors have not been adequately modeled or field tested:"

"1. The conductance of the sediments beneath the floor of Courthouse Bay."

Response: As discussed here and in more detail below, the conductance of the river cells was not a sensitive parameter in the model. A reduction of the river cell conductance value was performed as a response to this comment and resulted in less than one foot of head increase over the entire model domain. The flow directions and pattern remained exactly the same as in the calibrated model. This indicates that the model is not sensitive to changes in river cell conductance.

"2. The impact of highly conductive limestone layers being pumped by the water supply wells."

Response: While this approach is a reasonable one, it wouldn't provide additional benefits to the model as it currently exists. See detailed discussion in Specific Comment 5, below.

"3. The configuration of the Castle Hayne Confining unit beneath Courthouse Bay."

Response: The clay located at the site is the only soil unit that has shown evidence of confining vertical groundwater flow. The clay is actually within the undifferentiated deposits of Quaternary age (i.e., the surficial soils). This is not the same as the Castle Hayne aquifer confining unit known as the Belgrade formation. At Site 73, the Belgrade formation is not confining vertical flow, however it is referred to as the Castle Hayne aquifer confining unit because on a regional basis it does restrict vertical flow. As far as the

site groundwater model is concerned, the clay is the confining unit between the surficial and Castle Hayne aquifers. The RI described the units according to regional characteristics allowing a correlation between the site geology/hydrogeology and literature that is commonly referenced such as Cardinell et al. (1993) and Harned et al. (1989). This distinction has been documented in the Final Remedial Investigation Report (Baker, 1997) and will be discussed in the Final Groundwater Modeling Report.

According to the United States Geological Society (USGS) (Cardinell et al, 1993 and 1990, Harned et al, 1989), the clay unit is located at or near sea level and thus would be absent beneath Courthouse Bay and the New River.

"4. The chemistry of VOC's detected at BB-44..."

Response: The contamination detected by Greenhorne and O'Mara, Incorporated was TCE at a concentration of 1 µg/L. However, Baker collected a groundwater sample from the well during the RI. The chemical analysis of the sample indicated that no organic contamination exists in the well.

Specific Comments:

1. Page ES-2, 1st ¶ - The model has already proven to be a useful tool in that it has been calibrated to site-specific data for the purpose of simulating the three-dimensional groundwater flow regime. Based on that data, and the limitations thereof, it is also useful in predicting the future fate of contaminants. The accuracy of the model can only be proven or disproven by continued monitoring of the plume. Additional data collection and subsequent incorporation of that information into the model will improve the accuracy of the tool.

2. Page ES-2, 3rd ¶ - The text is referring to health-based, promulgated state or federal surface water standard for cis-1,2-dichloroethene (DCE). A site-specific DCE standard calculated to be protective of the environment at Site 73 will be acquired from Ms. Dianne Reid from the Surface Water Section of the Division of Water Quality. This information will be useful for modeling and decision-making purposes.

3. Page 1-1, last ¶ - Statement, no response required.

4. Figure 1 - A scale will be added to the figure.

5. Page 2-2, 3rd ¶ - The Draft-Final version of the BRAGS model (Baker, 1997) did incorporate the "highly productive" limestone unit into a separate layer on a sub-regional basis. That approach is currently under review. There is no hydrologic data specific to this limestone unit because the pumping tests performed at MCB Camp Lejeune calculated the hydraulic conductivity over the entire thickness of the aquifer. If, however, a value of transmissivity, T, was calculated at 820 ft^2/day for the well and divided by the thickness of only the limestone unit (b = ~10 feet), the resulting hydraulic conductivity, K, would be 82 ft/day, rather than the value of 3 ft/day used in the model.

   Such an approach would be reasonable but the result would be that the capture zones associated with the pumping wells would be more narrow than they are currently. This means that the wells would draw water from a smaller area than the model is currently simulating. The difference between

capture zone size in the two scenarios can be regarded as a "safety factor." The present model is the more conservative approach (i.e., worse case scenario). This information will be added to the text of the Final Groundwater Modeling Report.

6. The regional infiltration rate to the Castle Hayne aquifer (1" per year) would only be applicable over a regional model that incorporates the recharge and discharge zones for the entire region (i.e., the model would have to be larger than the BRAGS model). The sub-regional BRAGS model is a model of a regional groundwater discharge system only; therefore, the simulated infiltration rate to the Castle Hayne aquifer (per the model) cannot be the same as the regional value. Water entering the sub-regional modeled system as recharge to the surficial unit is discharged to the New River and its tributaries. Therefore, the value of net infiltration to the Castle Hayne is likely to be at or near zero. Nevertheless, a calculation will be performed to determine the modeled value of sub-regional infiltration to the Castle Hayne aquifer and this information will be used in the final groundwater model.

7. No VOCs were detected in water supply well BB-44 during the RI (Baker, 1996). There was a one-time occurrence of TCE in the BB-44 when sampled by Greenhorne and O'Mara, Inc. (1992).

8. See response to Comment 5.

9. A reduction in the values of river cell conductance (C_{riv}) for the model was performed as a response to this comment. The result was that head increased by less than one foot of head over the entire model domain. The horizontal and vertical flow directions and pattern remained exactly the same as those in the calibrated model. Therefore, the model is not sensitive to changes in river cell conductance. However, the suggested values of C_{riv} in the rerun (reduced by a factor of 100 or 10,000%) will be used in the final model as they are of the same magnitude as those in the BRAGS model for the New River.

10. Figure 3-6 shows the areal distribution of hydraulic conductivity, K, in Layer 2. It shows the configuration of the "hole" in the clay. Using the model as it currently exists is no different from assuming an impermeable clay (horizontal no-flow boundary) in Layer 2. The model does not show any type of numerical dispersion problems for groundwater flow when a high conductivity layer is next to a vertical or horizontal no-flow boundary. The model will be checked to ensure that this problem does not exist.

11. The clay located at the site is the only soil unit that has shown evidence of confining vertical groundwater flow. The clay is actually within the undifferentiated deposits of Quaternary age (i.e., the surficial soils). This is not the same as the Castle Hayne aquifer confining unit known as the Belgrade formation. At Site 73, the Belgrade formation is not confining vertical flow, however it is referred to as the Castle Hayne aquifer confining unit because on a regional basis it does restrict vertical flow. As far as the site groundwater model is concerned, the clay is the confining unit between the surficial and Castle Hayne aquifers. The RI described the units according to regional characteristics allowing a correlation between the site geology/hydrogeology and literature that is commonly referenced such as Cardinell et al. (1993) and Harned et al. (1989). This distinction has been documented in the Final Remedial Investigation Report (Baker, 1997) and will be discussed in the Final Groundwater Modeling Report.

The clay could extend across the bay as described in the reviewer's comment; however, if the clay were present beneath Courthouse Bay it is expected that water levels in the Castle Hayne aquifer would be much higher in the vicinity of the bay because groundwater would lack an outlet. Additionally, a portion of the bay is suspected to be associated with the paleochannel discovered on the eastern portion of the site. Therefore, it is suspected that the clay may have been eroded in areas beneath the bay just like portions of Site 73.

According to USGS references (Cardinell et al, 1993 and 1990, Harned et al, 1989), the clay unit occurs at or near sea level and thus would be absent beneath the new River due to fluvial erosion. Evidence of a major erosional event is indicated by the absence of the clay unit in the northeastern portion of Site 73 (Baker, 1997). This type of event would have likely removed the clay and formed a channel-like structure in the southern and/or eastern direction (beneath a portion of Courthouse Bay) toward the ocean.

12. Because MODFLOW assumes that each well screen completely penetrates the layer in which it is placed, it is necessary to discretize the aquifer vertically to account for partial penetration. In this way some of the BB-series wells can pump from one or more discrete depths within the Castle Hayne Aquifer. Generally speaking, vertical discretization within a single aquifer helps to minimize inaccuracies in a vertical profile much as the increased horizontal discretization around a pumping well increases the accuracy of the solution near the well. That is because without vertical discretization, MODFLOW assumes that the head value in a cell is averaged over the entire cell depth. A more accurate vertical profile can be obtained by discretizing as many layers as is practical.

    Also, see the response to Specific Comment 5.

13. All the wells in the surficial unit are screened above the confining clay unit. The B-series wells (e.g., 73MW-01B) are screened below the clay unit and during the modeling effort were classified as being in the upper Castle Hayne aquifer.

14. In the modeling report, the B-series wells are already included as part of the upper Castle Hayne aquifer.

15. Figure 3-17 and 3-18 show only the horizontal component of groundwater flow. Text has been incorporated into the Final Groundwater Modeling Report to provide a better explanation of the three-dimensional groundwater flow at the site. All the complete well clusters (i.e., surficial, upper Castle Hayne and lower Castle Hayne) show an upward head gradient from the lower to the upper Castle Hayne aquifer. Those that are not affected by localized effects of man-made structural features (e.g., the concrete dock) also show the upward head into the surficial unit and the bay. The average water levels discussed below can be found in Table 3-1 of the Draft Groundwater Modeling Report.

    The first cluster (73MW-31 and 73DW-06) is incomplete because it does not contain a lower Castle Hayne well. Although a downward head may exist between the surficial and upper Castle Hayne, an upward head still likely exists from the lower to the upper Castle Hayne. Without the availability of a well in the lower Castle Hayne aquifer, it can not be determined if downward migration continues.

The second cluster (73MW-09, 73DW-02, and 73GW-02) is directly behind the dock and is strongly affected by the dock which has been characterized as a no-flow structure blocking direct horizontal flow to the bay and tends to artificially raise the head in the surficial unit. Conclusions regarding the nature of the groundwater flow into the bay cannot be made at this location. Nevertheless, there is still an upward head from the lower (2.06' msl) to the upper Castle Hayne (1.89' msl) here.

Data from the third cluster (73MW-15, 73DW-04 and 73GW-03) indicate a continuous upward head from the lower Castle Hayne (2.50' msl) through the upper Castle Hayne (1.86' msl) to the surficial unit (1.23' msl).

16. See response to Specific Comment 9. In light of the results of the model rerun, the statement in the text regarding the expected response to changes in river conductance was incorrect. That statement will be edited to reflect the results of the changes made to the values of C_{riv} and will describe the lack of sensitivity of the model to this parameter.

17. On site, the confining layer was only "removed" where there was an actual absence of the clay. In off-site areas, the clay layer was mostly continuous except for areas in which there was apparent communication between the surficial unit and the upper Castle Hayne aquifer (i.e., similar water levels in the two units). The extent of such areas were adjusted during the calibration process and were interpreted as being within an erosional feature of limited areal extent.