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DEPARTMENT OF THE NAVY
NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
10 INDUSTRIAL HIGHWAY
MAIL STOP, #82
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IN REPLY REFER TO

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Code 1823\ME
MAY 28 1996

Ms. Kymberlee Keckler
Remedial Project Manager
U.S. Environmental Protection Agency
J.F.K. Federal Building (HBT)
Boston, MA 02203-2211

Subj: FINAL RESPONSES TO EPA'S COMMENTS OF APRIL 24, 1996 ON THE DRAFT AREA A LANDFILL GROUNDWATER/LEACHATE MODELING STUDY REPORT FOR THE NAVAL SUBMARINE BASE-NEW LONDON, GROTON, CT

Dear Ms. Keckler:

Please find enclosed the Navy's responses to your comments on the Draft Area A Landfill Groundwater/Leachate Modeling Study Report for the Naval Submarine Base - New London (NSB-NLON), Groton, CT dated April 24, 1996.

I hope that all outstanding issues the EPA may have had regarding this groundwater/leachate study are resolved by this Response to Comment Letter. If you have any other questions regarding the responses please do not hesitate to contact me at (610) 595-0567 ext. 162.

Sincerely,

Mark Evans

Mark Evans
Remedial Project Manager
By direction of the
Commanding Officer

Copy to:
Mr. Mark Lewis, CTDEP
Mr. Andy Stackpole, NSB-NLON
Mr. Jean-Luc Glorieux, Brown & Root - Pittsburgh

RESPONSES TO U.S. EPA's APRIL 24, 1996 LETTER OF COMMENTS ON DRAFT GROUNDWATER/LEACHATE MODELING STUDY REPORTS AREA A LANDFILL REMEDIAL DESIGN NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

May 28, 1996

1. General

Comment: The groundwater model developed by the Navy is a simplified 3-dimensional simulation of the physical system which appears to be adequate for the purposes of evaluating landfill cap alternatives and passive, shallow dewatering alternatives such as toe drains and drainage trenches. Although the model is touted as 3-dimensional, only one stratigraphic layer is simulated (the landfill layer), reducing the model to essentially 2 or 2½ dimensions. In some locations, this simplification has resulted in the combination of geologic layers that have highly disparate flow parameters such as the soil and bedrock. Owing to the simplifications of the model to focus on the particular objectives of this study, the model should not be used for other purposes such as evaluation of groundwater extraction alternatives, should these ever be required.

Response: The groundwater model developed for this task is 3-dimensional. The dimensionality of the model should not be confused with the number of stratigraphic layers that are evaluated by the model. Because only one stratigraphic layer is modeled does not mean that the model is 2-dimensional. Complex flow patterns can occur within one stratigraphic layer which require the layer to be divided into multiple layers for modeling purposes. Many 3-dimensional models are developed which evaluate flow and contaminant transport within one stratigraphic layer.

The groundwater model presented in the report was designed to efficiently support the evaluation of Area A Landfill cap alternatives and passive, shallow dewatering alternatives, such as toe drains and drainage trenches. Important hydrogeological and groundwater contamination data, as well as project objectives, were considered to determine the appropriate modeling approach. Multiple layers were included in the model to simulate potential impact of the depressed surface of the dredge spoil on groundwater flow. With these multiple model layers, time-varying contaminant concentration profiles in the fill material under the current cap design can also be simulated with the developed model.

This model was not intended for evaluation of groundwater extraction alternatives. The need for a groundwater extraction system was not anticipated at the Area A Landfill.

2. General

Comment: The model appears to have been implemented much as described in the work plan and addendum, and as discussed in meetings.

Response: No response necessary.

3. General

Comment: The model has many "conservative assumptions" built into it, which may not be uniformly conservative. Rather, these assumptions just limit the ability of the model to simulate the real conditions. Many of these simplifying assumptions were tested in the sensitivity analysis, and do not appear to significantly affect the predicted water table in the model. However, predictions regarding groundwater and surface water quality should be regarded with caution, since the subsurface water budget is not modeled accurately.

Response: In order to evaluate the current cap design using the available information, conservative simplifications and assumptions were built into the model and subsequent calculation procedures. These were intended to provide conservative estimates regarding groundwater flow and contaminant transport at the Area A Landfill. Although the level of conservativeness may not be uniform throughout the model domain or among all the controlling factors, the final model output is considered highly conservative. Results of the sensitivity analysis confirmed that the simplified conceptual model developed is a very conservative presentation of the groundwater flow conditions at the Area A Landfill; and therefore, data uncertainty is not a significant factor when evaluating the modeling results.

It is agreed that the groundwater model that was developed does have many "conservative assumptions" built into it. In general the assumptions make the model over-predict groundwater and contaminant discharge to the Area A Wetland. Predictions are estimates of true conditions. The assumptions and data used along with the groundwater model flow results, provide conservative estimates of the bulk contaminant loading to the Area A Wetland. More extensive 3-dimensional contaminant fate and transport modeling, and additional data required to conduct such a modeling approach, would be necessary to predict the groundwater and surface water quality more realistically. However, for the purposes of this project, detailed 3-dimensional contaminant fate and transport modeling was not necessary.

4. Page 4-4, 2nd Paragraph:

Comment: The effect of the constant head nodes is unclear, and EPA has previously noted a preference for some other treatment to simulate the wetland cells. The Navy should provide additional discussion and analysis to support the use of constant head nodes for the wetland.

Response: During the model development, it was understood that the EPA had previously requested that constant flux conditions be used when possible (EPA Comment Letter, October 16, 1995). Generally, during model development a cell can be designated as one of three types; constant head, constant flux, or no flow. Areas along a model's boundary which can be assumed to have groundwater elevations which remain relatively constant with time are simulated with constant head nodes; areas which have relatively constant groundwater flux are simulated with constant flux nodes; and areas in which flow is perpendicular to the boundary are simulated as no flow (i.e., a special case of constant flux).

For the groundwater model/leachate that was created for this project, the northern boundary of the model, which falls within the Area A Wetland was simulated using constant head nodes. This area was assumed to have relatively constant groundwater/surface water elevations since it falls within the center of the valley which receives groundwater recharge and surface water runoff from the surrounding hillsides. The constant head nodes were estimated from measured water levels. The water levels were low enough so that they would not influence (i.e, reduce) the groundwater discharge from the landfill material.

The model grid was designed to allow intermediate grid blocks between the constant head nodes simulating the wetland and the grid blocks in the toe region of the Area A Landfill. By providing these intermediate blocks, the constant head nodes will not artificially influence the predicted groundwater table or groundwater discharge from the toe region of the Area A Landfill.

The Navy will provide additional justification for the use of the constant head boundary conditions in Section 4.3.1. The information discussed above will be included in this section as justification.

5. Page 4-9, 2nd Paragraph:

Comment: EPA has previously noted that the natural range of water levels in a well or group of wells over a one year period is not an adequate calibration target. The calibration results indicate some residuals over 2 feet. Please discuss the process used to calibrate the model. It appears that the decision was a qualitative one.

Response: For the modeling project the calibration goal was a maximum calibration error of 1 foot. This information was not stated in Section 4.4.2 but will be added for clarity. The paragraph previous to Section 4.4.2 discusses the range of water level measurements from various wells. This information was used to justify the calibration target (i.e., November 20, 1995 groundwater level measurements) but was not used to set the acceptable calibration error.

Every attempt was made during the calibration procedure to reach an absolute residual of 1 foot, or less, between the measured and predicted water levels. However, during calibration, model parameters were only modified within a reasonable range for that parameter. The reasonable range was estimated from field measurements or literature information. Therefore, if the parameters had been modified to their maximum limit based on the reasonable range for the parameter and the absolute residual between the predicted and measured values was not 1 foot, or less, the calibration was concluded and considered adequate.

Generally, the regions which had residuals over 2 feet occurred in areas which had very steep terrain and groundwater gradients and a very thin saturated zone. These areas can be difficult to simulate with a model. The regions of the model which had higher residuals were along the southern hillside in the center of the Area A Landfill and near the west-end dike where the ground slopes steeply into the Area A Downstream. The higher residuals should not significantly affect the results or conclusions of the modeling.

6. Page 4-9, 3rd Paragraph:

Comment: Discuss the degree of calibration for the deeper model layers, the mean absolute residual calibration error, and the absolute error.

Response: Model calibration was performed by modifying key model parameters until the residual between the measured and predicted water levels was acceptable. All of the 19 water level data points used for the calibration were either from wells and piezometers screened across the water table or from staff gauges. Only one well (2LMW32F) in the Area A Landfill is screened in the lower portion of the fill. The water level measured in this well (71.66 feet) was almost identical to the water level (71.62 feet) measured in 2LMW32PZ, which was installed across the water table.

In addition, hydraulic conductivities were not assumed to vary in the vertical direction within the model, therefore in regions of the model with multiple layers modifications to hydraulic conductivities were made consistently to all layers. This method is acceptable because the material being simulated by the model was consistent in the vertical direction.

Based on the comparison the water levels at 2LMW32F and 2LMW32PZ and the use of consistent hydraulic conductivities, calibration in the deeper model layers was not considered necessary.

The justification for not calibrating the lower model layers will be added to the report.

7. Page 4-14, Section 4.6.2:

Comment: Any surface water flow from the wetland into the landfill material under the 100-year flood condition should be prevented by installing a vertical barrier into the low permeability dredged material.

Response: Installation of a vertical barrier into the low permeability dredge material will not appreciably reduce the inflow into landfill material during the 100-year flood condition because:

- The dredge spoil material exhibits very low permeability characteristics, therefore flow through this material is already minimal. In conjunction with the proposed cover system, there is very little soil material adjacent to the Area A Wetland that can serve as a flow path for infiltration into the Area A Landfill.

- Flood conditions will create a hydrostatic differential between the Area A Wetland and the Area A Landfill of four feet or less, and for a period of not more than a few days. As demonstrated by the analyses presented in the Groundwater/Leachate Modeling Study Report, this hydrostatic differential should result in minimal effect on the groundwater table conditions within the Area A Landfill.

The cost of a barrier wall installation into the dredge spoil will be substantial, because temporary dewatering and bracing methods may be required. As such, it is judged that the installation of a vertical barrier system is not cost-effective, in light of its very limited effectiveness.

8. Page 4-15:

Comment: It appears that the minimum groundwater table elevation beneath the Area A Landfill cover system is assumed to be 70 feet. Please clarify whether the post-capping groundwater table (70 feet for long-term) with a toe drain and intercepter trench is proposed, or the long-term groundwater table without the toe drain is proposed.

1) Equation 4.2: What is the rationale for choosing an upgradient distance of 100 feet?

2) Equation 4.3: Why is the Area A Landfill assumed to be the total capped area instead of the area with leachate level equal to the 100-year flood elevation?

Response: For the simple calculations discussed on page 4-15, no toe drain was assumed. The 70-foot groundwater elevation was determined from historical water level data for the Area A Wetland. This assumed constant groundwater elevation in the Area A Landfill provides a conservative estimation of hydraulic gradient toward the landfill during the evaluated flood condition.

The general distance between the center and the edge of the capped area is about 100 feet. Because the calculated gradient will be kept constant throughout the flood duration, the center to edge distance was considered as a reasonable distance for calculating the hydraulic gradient. A greater distance would reduce the gradient and the conservative nature of the calculation. The

actual gradient will rapidly decrease after the groundwater elevation starts to rise.

Based on the steady-state simulation under the flood conditions performed with the MODFLOW model that is discussed on page 4-15, the recharge from the Area A Wetland will impact the groundwater levels within almost the entire Area A Landfill. This information is discussed in the last paragraph on page 4-15 and Figure 4-39 indicates the impacted area. Because of the conservative constant gradient and the simulated zone of impact, it was considered appropriate to use the total capped area for performing the calculations. A longer duration of the flood was also assumed to calculate the groundwater elevation. The actual rate of groundwater elevation rise and the resulting maximum groundwater elevation along the toe during an actual flood are expected to be significantly lower.

9. Page 4-16, 1st Paragraph:

Comment: It is unclear whether this scenario allows water to flow into the toe drain from the wetland. If so, the simulation needs to be modified.

Response: Under the first toe drain scenario evaluated, water is allowed to flow into the toe drain from the wetland. This scenario is discussed in paragraph 1 on page 4-16. The Area A Wetland boundary elevation is set at 71.0 feet and the bottom of the toe drain is set at 70.0 feet. The results of this simulation are shown on Figures 4-41 and 4-42. Under the second toe drain scenario evaluated, water is not allowed to flow into the toe drain from the Area A Wetland. This scenario is discussed in paragraph 5 on page 4-16. The wetland boundary is maintained at 71.0 feet for this scenario, but the bottom of the toe drain is raised to 71.0 feet, thus eliminating the gradient between the Area A Wetland and the toe drain. The results of the second simulation are shown on Figures 4-43 and 4-44.

Modifications to the first toe drain scenario evaluated using the model are not necessary. The results of this scenario provide useful information and the results of the second scenario provide modeling results under no flow conditions between the wetland and toe drain. The results of the first scenario provide potentially realistic conditions that would be present if a toe drain is installed because of the difficulty of installing a hydraulic barrier in the toe drain. The best hydraulic barrier that can be created between the toe drain system and the wetland would be a low permeability boundary along the bottom and the downgradient side of the toe drain. If the gradient between the wetland and the toe drain is high enough, water will flow under the barrier and into the toe drain. Therefore, the first toe drain scenario provides a worst-case scenario for the amount of water that would need to be collected by the toe drain.

10. Page 4-20, 2nd Paragraph:

Comment: The contaminant discharge estimates are based on a very simplified approach. The partition coefficients were calculated from a ration of soil and groundwater concentrations, without regard to the organic carbon content of the soil, and without recognition of the fact that the landfill is heterogeneous. Therefore, a simple ration of soil and groundwater concentrations is probably not representative of the true partition coefficient. The approach used assumes complete equilibration, but this could lead to conclusions about contaminant mobility that are not correct. Furthermore, Appendix D indicates that literature values were used for most of the organic contaminants, but no information regarding organic carbon is presented.

Response: In contrast to the comment, the simple ratio of soil and groundwater concentrations provides the best estimate of the true partition coefficient that can be obtained with the data which is available. This method provides a more realistic estimate of partition coefficients than literature data because it accounts for site-specific conditions, including the organic content and

heterogeneity of the soil. The measured contaminant concentrations in the groundwater that were used to estimate the partition coefficient are the result of contaminant transport through the heterogeneous soil of the site. This transport process occurs over a long period of time, thus the site conditions can be reasonably considered to be at equilibrium. Batch tests or column studies, using site-specific soil and groundwater, would be the only other techniques for acquiring estimates of site-specific partition coefficients.

For the organic contaminants, literature values of K_{OC} (organic carbon partition coefficient) and f_{oc} (fraction of organic carbon) were used to estimate K_ds (partition coefficients). The values of K_{OC} and f_{oc} which were used to estimate K_d for each contaminant and the literature sources of the values should have been provided in Appendix D.5. The information will be included in Appendix D.5 and it will be consistent with the parameters used in the Draft Final Phase II RI Report.

11. Page 4-21, 2nd Paragraph:

Comment: This analysis does not account for the longer contact time between groundwater and soil in the post-capping scenario. In addition, because of the apparently conservative flow assumptions built into the model, the post-capping Q values are probably lower than the model predicts, resulting in possibly higher leachate concentrations.

The analysis does not distinguish between leachate generated in the unsaturated zone versus the saturated zone. An approach analogous to the Summers Model should be used.

Response: It is unlikely that the contact time between the groundwater and soil under the post-capping scenario would significantly impact the quality of the groundwater. It is reasonable to assume that the current conditions are at equilibrium and that contaminant concentrations will not increase. This assumption is reasonable because soil and groundwater data collected from the fill material in the dredge spoil depression in the eastern part of the Area A Landfill were used to estimate the partition coefficients. The groundwater in this area has been trapped there for a long period of time due to the low permeability of the dredge spoil. Therefore, the conditions should be at equilibrium.

Under post-capping conditions the infiltration rate is reduced significantly and the mass of contaminants being transported from the vadose zone to the aquifer will be reduced. In addition, the current model over-estimates the level of the water table in the fill material and provides a worst-case scenario in regards to the amount of contamination that can leach from the saturated fill material. With the cap, the discharge rate from the Area A Landfill will be reduced and also the thickness of saturated fill material will be reduced. This reduction in the thickness of the saturated material will reduce the amount of contamination being discharged into the Area A Wetland.

Summer's model would not provide more reasonable or conservative estimates than the approach used. Summer's model is a screening model based on a mass balance of flow rates. The model estimates the contaminant concentration in the aquifer using the flow rate and contaminant concentration of the leachate from the vadose zone and combining it with the flow rate and contaminant concentration of the groundwater from upgradient of the mixing point. By using the existing groundwater concentrations, the process of mixing leachate from the vadose zone and groundwater has been accounted for. The maximum concentration in the saturated zone is used for the analysis to represent the worst-case scenario in regards to contaminant concentration. After capping, the contaminant loading from the vadose zone will be significantly reduced and the contaminant concentrations in the aquifer should decrease with time.

12. Page 4-26, 1st Paragraph:

Comment: Indicate that the predicted saturated thickness is based on a simplified model that likely overestimates the thickness of saturated material after capping.

Response: It will be indicated in the text that the predicted saturated thickness is based on a simplified model that likely overestimates the thickness of saturated material after capping.

13. Page 5-4, Section 5.2.3:

Comment: If Area A is reduced and the flow rate is increased, then the water table raising rate into the landfill will be higher than what is assumed. Therefore, there is the potential for 1) toe instability owing to weakening of the toe area by saturation, and 2) leachate migration into the wetlands from rapid drawdown of the groundwater table after a 100-year flood event. EPA recommends that the toe drain system shown on Figure 6-1 along the northern limit be used to safeguard the proposed remedy.

Response: The Navy does not agree with the EPA's conclusion that a toe drain system is necessary based on the results of this study.

As explained in the Response to Comment No. 8, the estimated water rising rate is already sufficiently conservative. With this constant rising rate the calculated water table rise in the Area A Landfill is less than 0.1 feet even if the flood last 3 times longer than the actual condition. However, the stability analysis used an even more conservative estimate of the groundwater elevation (i.e., the same as the maximum surface water elevation). Therefore, the stability analysis was not modified and the design is adequate. A toe reinforcement system was included in the design to offset hydrostatic uplift beneath the cover system that would result from the elevated water table in the Area A Landfill due to the flood conditions. This toe reinforcement system will provide stability to the toe even if the toe area is saturated.

As demonstrated by the calculations described in the Groundwater/Leachate Modeling Study Report, there is little change in groundwater table conditions within the Area A Landfill, in response to a 100-year flood event. As such, any rapid drawdown occurrence, if any will be minimal. In addition, any rise and fall of the groundwater level within the Area A Landfill is unlikely to provide sufficient contact time between contaminated soil and clean water to result in significant contaminant concentrations. Therefore, leachate migration into the Area A Wetland from rapid drawdown is not a concern.

14. Page 7-2, 6th Paragraph:

Comment: The incorporation of a toe drain will provide additional dewatering of the saturated waste material, and should be considered as a means to increase the protectiveness of the remedy.

The conclusions indicate that the gabion reinforced toe might not be needed, but no recommendation regarding this option is presented.

Response: The Navy does not agree with the EPA's conclusion that a toe drain system is necessary based on the results of this study.

It is agreed that the incorporation of a toe drain will provide minimal additional dewatering of the saturated waste material, but it does this with a significant increase in cost (i.e., $1.6 million). In addition, based on an analysis of groundwater/leachate concentrations collected in a toe drain,

all COC concentrations would be less than MCL criteria (for COCs with available MCLs). This suggests that even if groundwater/leachate was collected in a toe drain, the collected water would meet drinking water standards. Therefore, the toe drain system provides limited additional benefit for a substantial increase in cost and does not seem to be necessary or viable.

The gabion-reinforced toe was initially incorporated into the design to provide conservative slope stability conditions. Subsequent (and less conservative) calculations, performed in conjunction with preparation of the Groundwater/Leachate Modeling Study Report, demonstrated that the reinforced toe may actually represent an "overdesign", hence the conclusion presented on page 7-2. However, to further assure EPA that the overall closure design conservatively addresses all slope stability aspects of the project, the Navy does not recommend the deletion of this reinforcement and the text of Section 7.2 will be modified by adding this recommendation.