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10 APR 1996

Maryland Department of Environment
Attn: Ms. True Noe
2500 Broening Highway
Baltimore, Maryland 21224

Re: Draft Site 1 Focused Feasibility Study, Allegany Ballistics Laboratory (ABL), October, 1994

Dear Ms. Noe:

Enclosed please find the Navy's responses to comments received on the subject document. Resulting changes have been made and are in the Draft Final Site 1 Focused Feasibility Study provided to you under separate correspondence from CH2M Hill.

The Navy requests you review these responses and the resulting changes to ensure they address and satisfy your concerns. Further, we request you provide any comments on these responses in advance of our meeting at the office of the West Virginia Division of Environmental Quality on April 30, 1996. We wish to discuss and resolve any differences at that time.

I thank you for your input and look forward to continued cooperation on all work we plan to accomplish at ABL. Please contact me at (804) 322-4795, should you have any questions or would like to further discuss any matter.

Sincerely,

J. J. KIDWELL
Remedial Project Manager
Installation Restoration Section (South)
Environmental Programs Branch
Environmental Quality Division
By direction of the Commander

RESPONSES TO COMMENTS
ON THE DRAFT SITE 1 FOCUSED FEASIBILITY STUDY REPORT,
ALLEGANY BALLISTICS LABORATORY, OCTOBER, 1995

As discussed and concluded during partnering meetings held on February 21-22 and March 14, 1996, the Site 1 Focused Feasibility Study Report (FFS) has been modified to only address contaminated groundwater, surface water, and river sediment. Subsequently, contaminated soil will be addressed in a future feasibility study and not in this FFS. This was done to ensure that additional time needed to establish soil cleanup levels does not delay future remedial action for groundwater at Site 1. Therefore, all references to soil cleanup levels, remedial technologies and remedial alternatives have been removed from the FFS. Site-wide remedial alternatives have also been changed as appropriate. Only responses to comments addressing contaminated groundwater, surface water, and river sediment are provided. Comments targeting contaminated soils will be considered in the future feasibility study for Site 1 soils.

Several of the general and specific comments on the Site 1 FFS Report refer to the groundwater models. Many of these comments are repeated in the comments section on **Appendix B - Numerical Modeling of Groundwater Extraction at Site 1**, which specifically addresses the design and execution of the groundwater flow models. Rather than repeating the responses to these comments here, the reviewer will be referred to the appropriate comment(s) on the modeling appendix for detailed responses.

This presents the Navy's responses to the comments from all regulatory agency reviewers. It is important to note that the responses to the questions refer to the original pages in the Draft FFS and not to revised pages with comments incorporated.

Responses to Comments from U.S. EPA

General Comments

Comments 1, 2, 4, 6-9, and 12-14 pertain to soils and will be considered in developing the future feasibility study for Site 1 soils.

3. **The State of Maryland, which is responsible for the North Branch Potomac River (page 2-5), may allow the designation of mixing zones in surface water bodies, if the discharge criteria can be met at the outer edge of the mixing zone (page 3-24). This critical determination must be made before the selection of a site-wide remedial alternative.**

   Most of the remedial alternatives could be impacted to various degrees if the State will not allow the designation of a mixing zone in the North Branch, especially for discharge of "listed" wastes. It will also eliminate Alternative 4 which proposes to extract groundwater only from the solvent disposal pit area and potentially increase the treatment requirements and associated costs for portions of some of the other alternatives.

   The Navy understands the States of Maryland and West Virginia have an informal agreement allowing West Virginia to manage the NPDES permitting for facilities in West Virginia even if their outfalls extend into the Potomac River. West Virginia would, in return, request comments from Maryland on all facilities impacting the Potomac. In addition, both states have indicated they will allow for the designation of mixing zones.

5. **The report contains conflicting statements regarding the quality of treated groundwater that will be discharged to the river. Page 3-30 states, "The air stripper treatment system is designed to meet the surface water discharge standard for TCE taking into account the dilution provided by the mixing zone." On page 4-29 it is stated that "In fact, the air stripper will be designed to meet the VOC MCLs at the end of the discharge pipe without the need for dilution in the mixing zone to attain discharge criteria." The context of the latter statement is reiterated in several other report sections including page 4-46; therefore, it seems apparent that treatment to levels allowing direct discharge without the need for a surface water mixing zone waiver is the intent of the alternatives evaluation presented in the FFS.**

   In Section 3, Development of Groundwater Treatment Criteria (page 3-25), a complete discussion was provided which addressed discharge criteria and treatment system removal requirements. The following statement is made on page 3-27, "The proposed treatment plants listed in the subsequent alternatives GT-1, GT-2, and GT-3, would significantly exceed the requirements for discharge to surface waters, and would meet MCLs at the end of the discharge pipe in most cases. The importance of the mixing zone is that the requirements stipulated for discharge to a mixing zone are the minimum which must be met." This statement adequately indicates that the minimum discharge requirements are those based upon the mixing zone calculations. However, the document simply points out that the specified technologies will exceed the minimum requirements such that MCLs will be met at the end of the discharge pipe in many cases.

10. **Although the modeling (see comments below) gives important information regarding capture zones and pumping rates, information regarding capacity of the treatment system should be based upon extraction well test data. Also, river water may infiltrate at such a rapid rate as to interfere with ground-water extraction. Stream-bed hydraulic conductivity data is essential in accurate estimation of leakage between the river and the bedrock and alluvial aquifers and in ground-water flow simulation. Additional aquifer test data, aquifer characteristic data, including stream bed hydraulic conductivity data should be collected and an updated ground-water flow model should be prepared.**

    Additional hydraulic data for the alluvial and bedrock aquifers at Site 1 will be gathered from the aquifer testing to be conducted during March and April 1996. All relevant information from the aquifer test results will be used during the remedial design phase, but because it is felt that the current models fulfill the objective of determining the feasibility of groundwater extraction at Site 1 (see comment responses in Appendix B), no revised models are planned for this FFS.

    Samples of the river bed will not be collected for hydraulic conductivity testing as part of this FFS. The stream bed conductance in the FFS models was higher than the vertical conductance of the underlying aquifer. Consequently, the stream bed materials were not a limiting factor that determined modeled leakage rates from the river. Additional model simulations were conducted in which the hydraulic conductivity of the river sediments was reduced by two orders of magnitude and the thickness of the sediments was doubled from 1.5 feet to 3 feet. This reduction in river bed conductance produced approximately 1 foot of additional drawdown around the extraction wells (i.e., stronger capture zone). To produce an equivalent capture zone to a simulation using the original river bed conductance, the flow rate of the individual extraction wells was reduced from 30 gpm to 26 gpm.

11. **It is not clear what length of time or sampling interval "periodic performance monitoring" is based upon. This is important because it will affect the cost. Performance monitoring for an extraction system should be performed at least quarterly for a couple of years after all the bugs are worked out of the system.**

    A quarterly performance monitoring interval was used in the cost estimates for each appropriate site-wide alternative. The actual performance monitoring interval will not be selected until the pre-design phase, when the scope of the extraction and treatment system will be more completely defined.

<u>Specific Comments</u>

Comments 4, 6, 20-25, 28, 29, 31, 37, 40, 43, and 44 pertain to soils and will be considered in developing the future feasibility study for Site 1 soils.

1. **Page 1-6, paragraphs 1-3. The major structural trend in the area has been documented here but the effect of these linear features on the ground-water flow in the area has not been fully discussed. The potential for ground-water flow along strike parallel linear features such as bedding plane partings is well documented in the Valley and Ridge and should be considered in future remediation scenarios.**

   The bedrock wells recently installed at Site 1 were oriented parallel to the orientation of fractures parallel to the trend of the Wills Mountain anticlinorium (i.e., N26°E) and the orientation of fractures oblique to this trend (i.e., N39°W). These wells will be used during a series of aquifer tests conducted at Site 1. The results are anticipated to provide an indication of whether bedrock groundwater flow is controlled by fractures and partings along bedding planes and to help optimize the selected groundwater remedial alternative.

   A seismic reflection survey is also being conducted for Site 1, with the anticipated results providing information about the distribution and orientation of fractures in the shallow bedrock.

2. **Page 1-8, paragraph 1. From past ABL reports, the head data was minimal and only showed very weak trends related to upward or downward flow of ground water from and/or to the alluvial and bedrock aquifers and the river. Interpretation of leakance between layers and the river should be regarded with caution until further data are collected to verify these trends.**

It is unclear what the reviewer means by referring to the head data as minimal and exhibiting very weak trends. Table 5-3 of the Site 1 Focused RI shows that the vertical component of hydraulic gradient between the alluvium and shallow bedrock at all Plant 1 well-pair locations is downward. Furthermore, no confining unit has ever been encountered between the alluvial and bedrock aquifers and the piezometric surfaces of both units have similar elevations, which suggest that the alluvium and bedrock are in good hydraulic connection. However, additional data collected during aquifer testing at Site 1 is anticipated to better define this connection.

3. **Table 3-2, Page 1. It is doubtful that pump and treat technology will be effective in removing contaminated ground water from the silt/clay zone within the alluvial aquifer. The ground-water flow model outlined in Appendix B has a number of problems which lead to the conclusion that pump and treat remediation will be effective. Review of the model indicates that the layers were not apportioned effectively and that inappropriate hydraulic conductivities were used in the uppermost portion of the model.**

   Please refer to the responses to comments #1 and #14 on Appendix B at the end of this document for detailed responses to the comments made above. Because it is believed that the current groundwater-extraction models fulfill the objective of determining the feasibility of groundwater extraction at Site 1, no changes to Table 3-2 will be made.

5. **Page 3-7, paragraphs 3 and 4. The slurry wall is an alternative which should be evaluated in greater detail in conjunction with a more accurate ground-water flow simulation. Due to the extremely low hydraulic conductivity of the silt/clay upper alluvial aquifer, a slurry wall may be the only remedial alternative in conjunction with source removal in the trench area which may prevent future release of contaminants from the alluvial and bedrock aquifers to the river.**

   In several simulations of the groundwater-extraction models, a slurry wall is evaluated for the top model layer (i.e., alluvium). All simulations indicate that the presence of a slurry wall does not enhance groundwater capture, which can be attained in the alluvium and bedrock with or without the slurry wall. However, the use of a slurry wall or barrier will be considered during the remedial design phase.

7. **Page 3-15, paragraph 1. Although capping will reduce recharge to the alluvial and bedrock aquifers, it will not completely eliminate all recharge. Groundwater will still flow through the alluvium, even the portion capped, and contaminants will continue to discharge to the North Branch Potomac River. The discharge of contaminants will continue to accumulate in stream sediments. However, if pumping wells are used to reverse the gradient, an updated groundwater flow model will need to be prepared with proper layers and hydraulic conductivities to test the adequacy of potential pumping schemes.**

   As discussed in the responses to comments on Appendix B, the groundwater-extraction models are considered to have been appropriately developed to determine the feasibility of groundwater extraction to prevent off-site contaminant migration. The model simulations indicate that groundwater capture in the alluvium and bedrock beneath Site 1 is attainable and that groundwater discharge from these units to the North Branch Potomac River adjacent to Site 1 can be prevented. Therefore, no updated models will be prepared for this FFS.

8. **Page 3-17, cost paragraph. Provide more detail on the cost estimate of $230,000 for the Institutional Control Alternative.**

   The following sentence has been added; "Capital items include institution of deed and groundwater use restrictions and installation of a chain-link fence."

9. **Page 3-18, paragraphs 2-3. Review of past ABL documents have suggested that the upper silt/clay alluvial and even the sand/silt/gravel alluvial layer are highly impermeable. Low permeability silts and clays would typically be expected to allow only minimal ground-water and contaminant transport. The possible problems with assumptions made in the original ground-water-flow model are apparent here. If the alluvial layer cannot be pumped effectively, then pumping the bedrock aquifer cannot be expected to remediate the overlying alluvial layers. The vertical hydraulic conductivity is typically much less than the horizontal hydraulic conductivity, especially in environments such as those found at ABL where silt and clay lenses are common throughout the alluvium. Leakage through the overlying layers would therefore be minimal. Any future model needs to use the most current aquifer testing results.**

   The Navy disagrees with the reviewer's comments that past ABL documents suggest that the silty sand and gravel alluvium are highly impermeable and that groundwater extraction from the bedrock will be ineffective at producing capture in the alluvium. The groundwater-extraction models, which use actual data collected from Site 1 alluvial wells, indicate that groundwater extraction from the alluvium is not a feasible approach to preventing off-site migration of alluvial groundwater. However, because there is a good hydraulic connection between the alluvial aquifer and the underlying bedrock, groundwater extraction from the bedrock can produce capture in the alluvium.

   As stated in the response to Comment #14 on Appendix B, groundwater withdrawal from the silty clay unit is not necessary, because any groundwater remaining in the silty clay unit after groundwater extraction has dewatered the sand and gravel will drain by gravity into the capture zone underlying the sand and gravel.

10. **Page 3-20, conclusion paragraph. Any selected alternative must consider the use of containment options for DNAPLs.**

   The conclusion paragraph on page 3-20 is drawn for Alternative GC-3, which addresses only groundwater extraction across Site 1. Not targeting possible DNAPL areas at Site 1 is recognized as a potential shortcoming of this alternative. Therefore, Alternative GC-5 (page 3-22 through 3-23) is presented that couple site-wide groundwater extraction with targeting DNAPL zones. Further, the FFS does not intend to select an alternative. Instead the goal is to develop and evaluate a range of alternatives.

11. **Page 3-20, paragraph 5. Construction of a slurry wall could prevent further releases of contaminated ground-water and soil to the North Branch Potomac River if enough ground water could be withdrawn from the alluvial aquifer to keep the hydraulic head in the aquifer below the upper portion of the slurry wall. The slurry wall itself would not, however, prevent the downward percolation of contaminated ground water from the lower alluvial to the bedrock aquifers and discharge to the river. A revised and accurate ground-water flow model could test the effectiveness of the slurry wall in combination with potential ground-water extraction scenarios. Additionally, the use of slurry wall downgradient of the trenches may be effective for the containment option for the DNAPLs.**

    It is recognized that a slurry wall will not prevent the downward migration of contaminated groundwater from the alluvium to the bedrock, which is considered to be likely at Site 1 because of the similar piezometric surfaces and the absence of a confining unit between the two aquifers. The groundwater-extraction models, which are considered to have been appropriately developed to meet the objectives of this FFS (see response to comments #1 through #3 on Appendix B), indicate that the presence of a site-wide slurry wall in the alluvium does not enhance groundwater capture, which can be attained in the alluvium and bedrock with or without the slurry wall. Therefore, no revised groundwater-extraction models will be produced for this FFS. However, a slurry wall(s) in the area of the solvent disposal pits will potentially be considered during the remedial design phase.

12. **Page 3-23, Alternative GC-5. It is noted that additional costs would not be incurred if some wells were taken out of commission and others added because volumes would be approximately the same for the purposes of the treatment system. However, it is possible that the contaminants "left over" may be more concentrated and require additional treatment, leading to higher costs.**

    It is possible that concentrations of VOCs in the influent will increase if targeting of DNAPLs requires future extraction from the DNAPL zone only. However, potential costs associated with improving the air stripper removal efficiency should be relatively minimal and covered by the twenty percent contingency included in the estimate. Further, one of the primary goals of modifying the extraction well network will be to reduce the number of extraction wells and flow requiring treatment, subsequently increasing the removal efficiency of the air stripper for more concentrated flows.

13. **Page 3-24, paragraph 3/paragraph 4. The RI data does indicate ground water discharge near the 1GW3/1GW9/1GW13 well cluster is above MCLs but there was not enough data to make the statement that this is the only discharge area with high values. Additional areas my be at the open burn landfill, the inert burn landfill, and at the spill location to the northeast of the burning grounds. The discussion of using a mixing zone in the river and the type (listed) of waste being released should be expanded.**

Comment incorporated. The last two sentences of paragraph 3 have been changed to read: "The data collected at Site 1 indicate that groundwater discharging to the river in the vicinity of the 1GW3/1GW9/1GW13 well cluster has resulted in MCL exceedances in the river. This alternative prevents groundwater with the highest detected VOCs at Site 1 from discharging to the river."

Paragraph 4 has been reworded to reference the discharge requirements established by the West Virginia Division of Environmental Protection (DEP).

14. **Page 3-26, paragraph 2, Appendix C. The evaluation of the mixing zone should be recalculated.**

The mixing zone calculation has been redone following WVDEP, Office of Water Resources Toxic Pollutant Control Strategy.

15. **Page 3-27, paragraph 1. Discharge to a mixing zone may not be the minimum requirement to be met. Mixing zone dilution may not be allowed by West Virginia and additionally, the groundwater may be considered a RCRA waste under the contained in rule and will need to be treated before it is discharged.**

Discharge to a mixing zone as defined by WVDEP will be the minimum requirement unless calculated values exceed the Best Available Technology effluent limitations tabulated in 40CFR414.101. The contained-in-rule does not apply to the discharge.

16. **Page 3-27 paragraph 3. The low flow characteristic of the river should be used in any mixing zone evaluation.**

The 7Q10 was used in the revised calculations.

17. **Tables 3-7 and 3-8. AWQC (fresh water, chronic) for PCE is 840 ug/L, for iron it is 1,000 ug/L, and for aluminum it would have to be evaluated based on pH.**

These tables have been changed significantly to reflect the revised mixing zone calculations.

18. **Page 3-34, paragraph 2. What would the estimated volumes of sodium chloride and sodium carbonate be? Please discuss the potential impact to the river if discharge is proposed.**

The anticipated volumes would be very low. Actual volumes will be determined during the design phase. If the effluent concentrations exceed discharge requirements, then it would be treated. If the sodium carbonate was discharged in relatively large volumes, it would likely increase the pH. Relatively large volumes of sodium chloride would increase the salinity of the river.

19. **Page 3-38, paragraph 3. In the second line, please exchange the costs for the different proposed volumes.**

Comment incorporated.

26. **Page 4-13. Alternative 3 will only be viable if ground water can be extracted effectively from the alluvial aquifer and if the cap can significantly reduce recharge to the alluvial aquifer.**

Please see response to Specific Comment #9 above and responses to comments #1 and #14 on Appendix B for discussions on groundwater capture in the alluvium. Capping alternatives will be addressed in a separate FS on Site 1 soil.

27. **Page 4-16, paragraph 3. Because some of the contaminants in the groundwater are listed (RCRA) wastes, the groundwater will have to be treated before discharge is allowed so a mixing zone in the North Branch of the Potomac can not be used.**

See responses to general comment 3 and specific comment 15.

30. **Page 4-19, paragraph 1. The EPA has a containment policy for groundwater that is contaminated with DNAPLs. The zone of DNAPL contamination is isolated and the zone of dissolved contamination is clean-up. Under Site 1, the zone of DNAPLs needs to be identified and a well placement scheme developed to isolate this zone.**

The DNAPL zone can best be delineated during long term groundwater extraction. This is the primary goal of alternatives involving the targeting of DNAPLs. The design of the extraction well network will be determined during the design phase after aquifer testing and seismic reflection survey results have been evaluated.

32. **Page 4-21, paragraph 5. Additional aquifer characteristics data (hydraulic conductivity, transmissivity, and saturated aquifer thickness) for the silty/clay layer, sand/silt layer, and fractured bedrock aquifer as well as vertical hydraulic conductivity between layers is needed for input into a revised and more accurate ground-water flow model. Review of past reports has revealed that there is virtually no data on the hydraulic conductivity of the upper silty/clay layer. Use of the slug test data for the sand/silt layer as a surrogate for the hydraulic conductivity of the silty/clay layer is probably the most significant error in the construction of the initial ground-water flow model. The upper silty/clay layer is where most of the soil and ground-water contamination is located and there is virtually no aquifer characteristic data for this layer. Laboratory tests of soil cores would provide some data of the hydraulic properties of the silty/clay layer although in-situ tests are more accurate because laboratory tests tend to overestimate porosity/permeability due to secondary fractures which form in the core when it is removed from the soil. Collection of additional aquifer test data especially for the silty/clay layer is mandatory for effective analysis of potential remedial alternatives.**

Please see responses to comments #1, #9, #10 and #14 on Appendix B.

33. **Page 4-25, paragraph 3. There are several other areas of groundwater contamination along Site 1. The DNAPL zone near the solvent pits should be contained and the dissolved phase and other potential source areas remediated.**

Other areas identified in the RI and the FFS as likely sources of groundwater contamination are contaminated soils north of the east and west ends of the burning ground, the inert burn area landfill, and the open burn area landfill. DNAPLs are suspected to exist in areas downgradient of the solvent disposal pits as indicated by high VOC concentrations detected in wells 1GW3 and -9. It is possible that DNAPLs also exist at the other areas identified. No DNAPLs were observed in the wells or soil borings during the DNAPL investigation. Therefore, DNAPLs at Site 1 likely exist in the form of globules in interstitial spaces in the vadose zone, or in fractures in the bedrock. The only way to contain DNAPLs would be to construct an impermeable barrier around all sides and more importantly below the DNAPL zone. Given the depth DNAPLs have likely migrated into the fractured bedrock (approximately 100 feet) this would be technically impractical. Consequently, all of the groundwater extraction alternatives are designed to control contaminated groundwater migration by reversing the hydraulic gradient effectively preventing off-site migration of contaminated groundwater. Groundwater extraction alternatives including the targeting of DNAPLs will not only remediate the dissolved phase but also minimize the dissolution of DNAPLs into the aquifer and enhance contaminant removal.

34. **Page 4-25, paragraph 4. Because of the potential for groundwater containing "listed" wastes, the extracted groundwater can not be discharged directly without treatment.**

Extracted groundwater will be treated and discharged to the river for all groundwater extraction alternatives.

35. **Page 4-26, paragraph 5. Page 4-28, paragraph 1. Contaminated groundwater can not be allowed to continue to discharge to the river. One of the remedial objectives is to stop this discharge. Surface water near well 1GW4 was not analyzed for VOCs so we can not confirm that groundwater in that area is not discharging to the river at a level above MCLs.**

Only groundwater with contamination below the discharge requirements will be allowed to continue to discharge directly to the river without extraction and treatment in this alternative. Using revised discharge requirements as required by WVDEP will significantly reduce discharge requirements greatly shrinking the area where groundwater contamination is below the discharge requirements.

36. **Page 4-30, paragraph 3. A surface water monitoring program at Site 1 should insure the river does not have contaminant concentrations above Ambient Water Quality Criteria for both surface water and sediments and not just MCLs.**

Comment incorporated.

38. **Page 4-38, paragraph 2. Drop the last two sentences and put them in the section of the Focused Feasibility Study that compares the alternatives.**

Comment incorporated.

39. **Page 4-39, paragraphs 1 and 2. Extraction wells are needed downgradient of the proposed capped area where contaminated soils have been excavated and disposed of. Extraction wells are also needed in areas of severe ground-water contamination such as in the vicinity of the solvent disposal pits. It is possible that the capped area would be a source of ground-water contamination for decades if not hundreds of years. Assuming that contaminants would not leave the capped area would not be wise, as some ground-water flow through and beneath the capped area is inevitable, unless the capped soils are totally encapsulated with an impermeable cap.**

Capping alternatives will be addressed in a separate FS for Site 1 soil. The location of the extraction well network(s) at Site 1 will be determined during the remedial pre-design and design phases after additional chemical and hydraulic information has been collected.

41. **Page 4-44, last paragraph. All the alternatives 1-5 do not compile with both RAOs.**

Comment incorporated. The phrase "alternatives 1-5" has been changed to "alternatives 3-5".

42. **Page 4-45, last paragraph. Alternative 4 does not attain ARARs for groundwater across the site.**

Comment incorporated.

45. **Page 4-53, paragraph 2. Extraction wells, unless they are positioned directly in and pump the DNAPL, do not provide control of the mobility of the DNAPL.**

Comment noted. The fourth sentence of paragraph 2 has been changed to read: "Additional extraction wells targeting the DNAPLs would be installed to enhance contaminant removal, better control the dissolution of DNAPLs into the aquifers, and produce a more efficient extraction system."

Review Comments for Focused Feasibility Study, Allegany Ballistics Laboratory Superfund Site Appendix B - Groundwater Flow Model

General Response to Review Comments on the Site 1 Groundwater Extraction Model

In judging the validity and applicability of the Site 1 groundwater flow models, it is essential that their purpose not be misinterpreted. As stated on page B-1 in Appendix B of the Site 1 Focused Feasibility Study, the models were developed only to demonstrate the feasibility of various extraction scenarios and not as calibrated, predictive models of the site. The models were intended to capture certain essential features of groundwater flow at Site 1 and to evaluate the effects these features would have on the ability of multiple extraction wells to hydraulically control off-site migration of groundwater.

The most basic features represented were realistic horizontal hydraulic gradients, hydraulic conductivities, and aquifer thickness. If the analyses were limited to these features, a simple analytical model such as the capture zone type curves of Javandel and Tsang (GROUND WATER, September-October 1986) would have been sufficient. However, the modeling was intended to include several additional features of the groundwater system at Site 1 that were expected to affect the viability of a groundwater extraction system. These included the relatively thin alluvial aquifer overlying the fractured bedrock, vertical flow between alluvium and bedrock and within the bedrock, the downgradient river boundary, and the potential for both vertical and horizontal anisotropy in the bedrock aquifer. These aspects of the system cannot be included in a simple analytical model, so a pair of relatively simple numerical models was used instead. The two models represented areas of Site 1 having different observed hydraulic gradients, hydraulic conductivities, and potentially different boundary conditions at the river. Taken together, they are intended to represent a range of likely aquifer behaviors rather than a comprehensive calibrated model of the site.

Editorial changes will be made where appropriate in Appendix B to maintain focus on the true nature and objectives of the models.

1. **Page B-3, paragraph 3. The assumption of only a two aquifer system is not the best representation of this site. The model has been established with three layers. A three layer model is probably sufficient for this site. However, the layers used in this model are not appropriate. The model has been set up with one alluvial aquifer layer and two bedrock aquifer layers. The model would have been more realistic if it had been set up with three layers consisting of an upper semi-confining silt/clay layer, an intermediate sand/clay aquifer, and a lower bedrock aquifer. There appears to be no legitimate reason for breaking the bedrock aquifer into two layers. Also, the ground-water-flow model as proposed here does not take into consideration the extremely low hydraulic conductivity of the upper silt/clay layer. This is probably the most significant problem within the model and would result in an overestimation of the hydraulic conductivity of the upper layer as presently modeled. Also, since there is no data for the hydraulic characteristics of the upper silty/clay alluvial layer or the stream-bed hydraulic conductivity, additional aquifer characteristic data will have to be collected and a revised ground-water-flow model prepared.**

   The models were intended to represent the aquifer zones that take an active part in groundwater flow in the areas of Site 1 where extraction wells may be installed. Upgradient of these areas, the water table may be in the surficial silty clay layer. However, as shown in Figure 4-4 of the Site 1 Focused RI Report, the potentiometric surface in the vicinity of the Site 1 burning ground is in the sand and gravel layer. Even if, under normal groundwater flow conditions, the water table was in the silty clay, that layer would not contribute substantially to horizontal groundwater movement. Under pumping conditions, the water table is drawn down close to the bottom of the alluvial sand and gravel, and the presence of an overlying unsaturated silty clay layer does not substantially influence the flow.

Where the water table does reach the silty clay layer, it tends to limit the transmissivity of the alluvial flow zone and the model could overestimate the layer's ability to conduct water horizontally. In the modeled areas, this would happen only at a considerable distance upgradient of the extraction wells. By permitting groundwater to approach the extraction wells at a higher rate from upgradient, neglecting the silty clay might make the simulation of successful hydraulic containment slightly more difficult. However, the magnitude of this effect would be quite small and the effect is conservative from the design viewpoint. Therefore, it was not considered necessary to include the silty clay layer to ascertain the effectiveness of extraction wells on controlling off-site contaminant migration in the alluvium. A detailed explanation of why the silty clay layer was not simulated in the models will be given in revisions to the **Conceptual Hydrogeologic Model** section of Appendix B.

The reviewer also states that there does not appear to be a legitimate reason for simulating the bedrock with two layers. The reason the bedrock is simulated by two layers is because it is important to be able to observe the effects of vertical flow within the bedrock, which would not be possible if it was modeled as a single layer. By representing the bedrock as two layers, one can see the effects on deep-bedrock groundwater of extraction wells in the shallow bedrock.

2. **Figure B-1. The grid for the model could have been more representative of actual site conditions if it had extended to the other side of the river for the entire area adjacent to Site 1. The river is a major component of the hydrologic flow system and probably should not have been treated as a constant head boundary. The grid should incorporate the aquifer on both sides of the river and possibly the MODFLOW drain (DRN) or river (RIV) packages used to simulate the river. Also, two grids of varying cell sizes probably is not needed for this particular hydrologic setting. A single grid should be able to effectively simulate ground-water flow for Site 1.**

   Again, it should be recognized that the models are not intended as integrated representations of the site. Rather, they are used to test hypotheses about local groundwater capture and anisotropy. The Navy contends that the two different model grids shown in Figure B-2 adequately represent the two likely hydraulic relationships between the groundwater beneath Site 1 and the river.

   The bedrock piezometric surface map in the Site 1 Focused RI Report (Figure 5-2) shows that bedrock groundwater north and south of the river adjacent to the western portion of Site 1 (i.e., Site 1B) flows toward and discharges to the river, rather than flowing beneath it. Therefore, inclusion of the north side of the river in the Site 1B grid was not considered to be necessary. Furthermore, the base of the river is believed to be approximately the same elevation as the base of the alluvial aquifer. Therefore, alluvial groundwater originating beneath Site 1 would discharge directly to the river or downward to the bedrock.

Figure 5-2 of the Site 1 Focused RI Report does indicate that bedrock groundwater may move north beneath the river from the eastern portion of Site 1 (i.e., Site 1A). Therefore, as shown in Figure B-2, the model grid for Site 1A extends to the north side of the river and does incorporate the bedrock aquifer north of the river. Given the information collected to date, we believe that the two model grids developed for Site 1 adequately represent the two probable hydraulic relationships between the river and the alluvial and bedrock groundwater at Site 1.

Modeling the river as a constant head boundary is believed to be the most conservative representation. Groundwater-extraction simulations suggest that as groundwater is withdrawn by the extraction wells, the river will provide recharge to the aquifer system, making it more difficult for the extraction wells to attain capture. However, the amount of water moving from the river to the aquifer system is small compared to the amount of water flowing within the river. Therefore, groundwater extraction is likely to have little discernible affect on the water level in the river.

Modeling the river as a constant head boundary represents a worst-case scenario during groundwater extraction simulations, where the river provides continuous recharge that the extraction system must overcome in order to produce capture. Under these conditions, all model simulations indicate that groundwater capture in both the alluvium and bedrock is possible. If the river level was allowed to drop, less recharge would be available for the aquifer system, which would likely increase the ability of any extraction alignment to fulfill the objective of preventing off-site contaminant migration.

The reviewer suggested that the drain (DRN) or river (RIV) packages be used instead of modeling the river as a constant head boundary. Using the drain package to simulate the river would only be appropriate when the head in the aquifer(s) was greater than the head in the river (i.e., river acts as a drain for aquifer groundwater). When the head in the aquifer(s) drops below the water level in the river, the drain package would simulate the river as a no-flow boundary and river water would not be allowed to flow back into the aquifers. This configuration is not appropriate for simulations in which extraction wells reverse hydraulic gradients between the river and the wells.

Although the river package (RIV) was not used to simulate the river in either model, a 1.5-foot layer of fine sand with a characteristic hydraulic conductivity was simulated for the bottom of the river in the Site 1A model. By simulating the vertical conductance of bottom sediments and the bedrock between the river and the adjacent layer, the model essentially emulates the river package. The text of Appendix B will be revised to clarify the methods used to model groundwater interaction with river.

The primary reason for using a finer grid for Site 1B is that the extraction wells in several of the simulations are more closely spaced than those in simulations for Site 1A. Furthermore, Figure 5-1 of the Site 1 Focused RI Report shows that the hydraulic gradient in the western portion of Site 1 (i.e., Site 1B) is higher than that in the eastern portion of Site 1 (i.e., Site 1A). The higher gradients require a smaller grid-cell spacing to resolve these gradients.

3. **Page B-4. Only one layer was used to simulate the alluvial aquifer. The large differences in hydraulic properties of the upper silt/clay and lower sand/silt/gravel layers probably would be better simulated by a two layer model. Also, the hydraulic gradient data is contradictory and does not suggest that a two layer model of the lower bedrock aquifer is needed. A two layer bedrock aquifer requires that estimates of hydraulic conductivity data be used for the upper bedrock layer and transmissivity data be used for the bottom bedrock layer. An estimate of saturated aquifer thickness is also needed for the upper bedrock layer in a two layer bedrock aquifer. If a one layer bedrock model were used, the saturated thickness of the aquifer would not be required. This is advantageous as it is difficult to determine the extent of significant bedrock fracturing and ground-water flow in a fractured bedrock aquifer setting. Thus it is often difficult if not impossible to estimate the saturated aquifer thickness of a bedrock aquifer. A single layer bedrock aquifer model would eliminate the need to estimate the saturated aquifer thickness.**

Please see the response to Comment #1 for a discussion concerning the rationale for simulating the alluvial aquifer as one layer.

It is unclear what the reviewer means by referring to the hydraulic gradient data as contradictory. Table 5-3 of the Site 1 Focused RI shows that the vertical component of hydraulic gradient between the alluvium and shallow bedrock at all well-pair locations is downward. Nevertheless, the bedrock is not simulated with two layers based on the hydraulic gradient data. As stated in the response to Comment #1, the bedrock is simulated with two layers because the Navy believes it is important to be able to observe the effects of vertical flow within the bedrock in the vicinity of the extraction wells, which would not be possible if it was modeled as a single layer. By representing the bedrock as two layers, we are able to see the effects of extraction from the shallow bedrock on deep-bedrock groundwater.

The latter portion of the comment, which proposes the advantages and requirements of a one layer versus two layer bedrock, is incorrect. Transmissivity alone is required only for a confined layer, where the water level never drops below the top of the layer. Hydraulic conductivity and top and bottom elevations of a layer are required for an unconfined or confined/unconfined layer, where the water level can drop below the top of the layer, thereby reducing its saturated thickness.

For the groundwater extraction models, it was recognized that groundwater extraction from the bedrock could dewater the alluvial aquifer and draw the water level down into the bedrock in the vicinity of the extraction wells. Therefore, for layer 2 (upper bedrock), the top and bottom elevations and the hydraulic conductivity were required as input to each model so it could calculate an accurate transmissivity based on the layer's reduced saturated thickness. If the layer was simulated as confined (i.e., only transmissivity input to the model), the reduction in saturated thickness would have been ignored by the model, resulting in an overestimation of the transmissivity of the layer.

4. **Figure B-2. Same as comment for Figure B-1 above.**

   Please see response to Comment #2.

5. **Page B-6, paragraph 3. The river probably was not modeled as well as it could have been. First, the entire river should have been included within the model grid, not just the portion for Site 1A. Second, the leakage of water to and from the river and the bedrock and alluvial aquifers is a major component in the transport of contaminants from ground water to the North Branch Potomac River. The use of a constant head boundary assumes that the river is an infinite source of recharge to the two aquifers. This is probably an accurate assessment during periods of high recharge in the spring and winter but may not be an accurate assessment in the late summer or early fall when streamflow is low. Constant head boundaries do not effectively model the movement of water between rivers and aquifers. Possibly a variable head boundary could have been used in the model. Without good data for the stream-bed hydraulic conductivity of the North Branch Potomac River, any simulation is a guess and is subject to extreme variability. At present there is no data for stream-bed hydraulic conductivity and the simulation of ground-water and surface-water flow to and from the river has probably not been simulated sufficiently.**

   The comment has two main ideas. The first point made by the reviewer is that the entire river should have been included in both models, not just the one for Site 1A. As discussed under Comment #2, the river is believed to be the ultimate discharge point for alluvial and bedrock groundwater flowing beneath the western portion of Site 1 (i.e., Site 1B), based on the hydraulic head data from Site 1 wells (figures 5-1 and 5-2 of the Site 1 Focused RI Report). However, hydraulic head data from bedrock wells in the eastern portion of Site 1 (i.e., Site 1A) and to its north indicate that bedrock groundwater originating beneath Site 1A may migrate beneath the river to the north. For these reasons, flow beneath the river to its north side was permitted by the Site 1A model, but not for the Site 1B model.

   The other issue addressed by the reviewer concerns the simulation of the river as a constant head boundary. Please see response to Comment #2 concerning the rationale for how the river is simulated for sites 1A and 1B. As stated above, the river is simulated in the most conservative manner. When groundwater extraction creates hydraulic gradient reversals between the river and the extraction wells, the river provides a continuous source of recharge to the aquifer system beneath sites 1A and 1B during groundwater extraction. As the reviewer states, the assumption that the river provides infinite recharge to the aquifers during high-flow conditions is likely accurate. Therefore, if capture can be attained under these conditions, as the model predicts, then capture should be more easily attained during low-flow conditions when less recharge to the aquifers is available.

6. **Page B-7, paragraph 5. The comments made here that transmissivity only is required for the bottom layer of the model supports the argument made in comment 3 above, that the lower bedrock aquifer probably should have been modeled as a single layer rather than a two layer aquifer setting.**

   Please see response to Comment #3.

7. **Page B-8, last paragraph. As discussed in comment 5 above, constant head boundaries were used to simulate the effects of the North Branch Potomac River. Constant head boundaries may not be effective in simulating flow to and from the river. A variable head boundary may be more effective as it would vary with changes of head within the aquifers.**

   Please see response to Comment #5. In addition, MODFLOW does not have the ability to vary the boundary heads dynamically during an individual simulation. MODFLOW does have variable flux boundary options (i.e., the river or general head boundary packages) for which the boundary heads can be varied between pumping periods or simulations, but only through direct user input. Simulating the river as this type of boundary would not help to achieve the objectives of the modeling effort.

8. **Page B-9, paragraph 3. An average value of hydraulic conductivity (K) was used to simulate the hydraulic conductivity of the upper alluvial aquifer based on slug tests performed for the sand/gravel/silt alluvial layer. This is a major limitation of the model as presented here. The K of the silty/clay layer should be orders of magnitude lower than the K of sand/gravel/silt layer and assigning one value of K to both layers based on the K of the sand/gravel/silty layer is not appropriate. Simulating both alluvial layers as one greatly overestimates the hydraulic conductivity of the upper silty/clay layer.**

   Also, since the vertical hydraulic conductivity is calculated based on the hydraulic conductivity of overlying and underlying units, the hydraulic conductivity used within the model is probably orders of magnitude too high as well. This would result in a simulation of significant leakage between layers which probably does not occur within the actual ground-water-flow system.

   Please see response to Comment #1 for the rationale for a single layer alluvium with a uniform hydraulic conductivity. With respect to the comment concerning the vertical hydraulic conductivity, the vertical conductance calculation utilizes the hydraulic conductivities of two adjacent units (i.e., silty sand and gravel alluvium and bedrock). Because the silty clay layer is above the silty sand and gravel alluvium, its hydraulic conductivity would not be included in the vertical conductance calculations at the top of bedrock.

9. **Page B-9, paragraph 3. A hydraulic conductivity value of 4.2 ft/day was used in layer 1 of the model. The 4.2 ft/day K value is probably acceptable for the sand/gravel/silt layer but is orders of magnitude high to apply to the silty/clay upper alluvial layer. Typical K values for silt/clay range from about 1x10-1 to 1x10-7 and**

averages about 1x10-4. Applying the K value for sand/gravel/silt layer to the silty/clay layer constitutes a major error in the development of the original ground-water-flow model. Once again, the ground-water-flow model should be revised to incorporate 2 layers for the alluvial aquifer rather than only one layer. As there is no data available for the hydraulic conductivity of the upper silty/clay layer, laboratory tests should be conducted on cores taken from the silt/clay layer to determine hydraulic properties of this layer. Slug tests may be conducted in the silt/clay layer but the water levels may have to be monitored for a few days to obtain the necessary head change data. Also, only two data points were averaged to obtain the hydraulic conductivity value that was originally used in the model. A previous review comment suggested that a large amount of aquifer characteristic data would be needed to realistically simulate ground-water flow at the ABL site. The use of two data points to estimate the hydraulic properties of such a large heterogeneous anisotropic aquifer as that found at ABL is not acceptable. Evidently, the aquifer characteristic data was not collected and the contractor placed most of his field data collection activities on groundwater quality objectives. These shortcomings need to be corrected in the next version of the ground-water flow model.

As discussed under the response to Comment #1, the silty clay unit was not simulated because it is above the water table in the area of interest and, therefore, has no effect on the groundwater capture in the vicinity of the extraction-well alignment. Furthermore, the Navy was not attempting to produce a calibrated site-specific model.

Additional data for the silty clay are not believed to be necessary. Because the silty clay is likely to be unsaturated near the extraction wells and to have very low hydraulic conductivity values, it will have little affect on groundwater extraction, except to limit recharge from vertical infiltration of precipitation.

Additional site-specific data concerning the alluvial and bedrock aquifers will be gathered via the Site 1 aquifer tests. However, since the current models fulfill the objective of determining the feasibility of groundwater extraction at Site 1, no revised models are planned for this FFS. The Navy anticipates using all relevant data gathered during the aquifer tests, including updated values for hydraulic conductivities, in a more specific model(s) developed during the remedial design phase.

10. **Page B-11, paragraph 2. As the inappropriate hydraulic conductivity was applied to the upper silt/clay alluvial layer, it is reasonable to conclude that the vertical hydraulic conductivity estimates used in the preliminary model are also in error by orders of magnitude. The horizontal hydraulic conductivity of overlying and underlying layers is used to calculate the vertical hydraulic conductivity. Once good aquifer characteristic data has been collected, the data should be incorporated into a new revised ground-water flow model. Also, there is no data available for the stream-bed hydraulic conductivity of the North Branch Potomac River. This data will need to be incorporated in the revised ground-water flow model as well.**

Please see response to Comment #8. In addition, the slug tests performed on the alluvial wells at Site 1 provided estimates of the hydraulic conductivity of the sand and gravel alluvium, not the silty clay layer. Because the vertical conductance calculation utilizes the hydraulic conductivity of two adjacent layers, the hydraulic conductivity of the sand and gravel layer was appropriately used to calculate the vertical conductance between the bedrock and the alluvium.

Although samples of the river sediments have been collected for only chemical analysis, observations have been made in the field that suggest the river sediments are mainly composed of sand. Therefore, the model simulations used hydraulic conductivity values characteristic of silts and fine sands for the river sediments. A sensitivity analysis conducted on the hydraulic conductivity and thickness of the river sediments indicated that they did not appreciably affect groundwater capture by the extraction wells.

11. **Page B-11, last paragraph. The hydraulic conductivity and transmissivity values applied to the bedrock layer in the preliminary ground-water-flow model seem appropriate based on similar aquifer test data collected in the Valley and Ridge physiographic province. Also, a single layer could be used to simulate the bedrock layer and a two layer bedrock simulation is probably not needed.**

    Please see response to Comment #1 and Comment #3 for the rationale for the two-layer bedrock representation.

12. **Page B-12, last paragraph. It appears that the reasoning behind varying the heads here is flawed. If good aquifer characteristic data were available to suggest that these variations in hydraulic conductivity actually exist within the aquifer, then varying the hydraulic conductivity would probably be appropriate. However, since no such data is available, varying the heads to match hydraulic gradients is not acceptable. Additional aquifer characteristic data should be collected and incorporated into the model.**

    The hydraulic conductivity values were varied, not the heads as the reviewer suggests. Because slug-test results at Site 1 varied by more than an order of magnitude, it seemed justifiable to vary the hydraulic conductivities across the grid area to achieve the actual hydraulic gradients observed in Figure 5-1 of the Site 1 Focused RI Report. The simulated hydraulic conductivities were all within the range of the actual values calculated from Site 1 slug tests (please refer to slug tests results for wells 1GW8 and 1GW11 in Table 5-1 of the Site 1 Focused RI Report).

    Additional aquifer characteristic data will be collected during the upcoming aquifer testing, but no revised model is planned for this FFS. As stated under Comment #9, we anticipate using all relevant data gathered during the aquifer tests, including updated values for hydraulic conductivities, in a more specific model(s) developed during the remedial design phase.

13. **Page B-13, paragraph 4. The vertical hydraulic conductivity calculated based on the inappropriate upper layer horizontal hydraulic conductivity may be inappropriate as well.**

    Please see response to Comment #8.

14. **Page B-15, paragraph 3. The inappropriate application of the hydraulic conductivity of the sand/gravel to the silt/clay layer results in a situation in which the upper layer within the preliminary model is much higher than reality. Therefore, the model prediction that there will be ground-water capture within the upper layer of the model is probably in error. There will most likely be much less-ground-water capture from the silt/clay layer than estimated by the preliminary ground-water-flow model.**

    The Navy disagrees with the reviewer's conclusion that by applying the hydraulic conductivity of the silty sand and gravel uniformly to layer 1, the model's conclusion that groundwater capture within layer 1 will be attained is in error. By assigning a hydraulic conductivity appropriate for silty sand and gravel to all of layer 1, the model, as a worst-case scenario, overestimates the ability of layer 1 to transmit water toward the line of extraction wells. This would make it more difficult for a given extraction-well alignment pumping from the bedrock to attain capture in layer 1. However, the model indicates that groundwater extraction from the bedrock does produced capture in the overlying alluvium.

    Furthermore, we are not concerned with capture in the silty clay because it likely transmits water poorly. However, any water remaining in the silty clay unit after groundwater extraction has dewatered the sand and gravel will drain by gravity through the silty clay and into the capture zone in the underlying sand and gravel.

15. **Pages B-15 to B-25. As the upper silt/clay layer was not simulated effectively, the analyses of remediation alternatives presented in the later portions of Appendix B are suspect. Therefore, a revised ground-water-flow model will have to be developed and the remedial alternatives reevaluated.**

    Please see the General Response and the response to Comments #14 and #9.

<u>Responses to Comments from MDE</u>

General comments 2 and 5 and specific comments 8-11 pertain to soils and will be considered in developing the future feasibility for Site 1 soil.

<u>General Comments</u>

1. **Sections of this document which discuss the use of mixing zones are still under review. Comments on this topic will be sent under separate cover.**

The Navy understands the MDE letter of February 2, 1996, regarding discharge to the river represents MDE's official position on the use of mixing zones. In reading same, the Navy infers mixing zone calculations are acceptable if they are below Best Available Technology (BAT) standards. In addition, the letter states that the 7Q10 or 5Q30 are acceptable flows to be used in mixing zone calculations.

Further, the Navy understands the States of Maryland and West Virginia have an informal agreement allowing West Virginia to manage the NPDES permitting for facilities in West Virginia even if their outfalls extend into the Potomac River. West Virginia would, in return, request comments from Maryland on permits for those facilities that impact the Potomac. Recent correspondence from West Virginia, Appendix C of the Draft Final Focused Feasibility Study, provides the methodology for determining discharge requirements for the proposed groundwater treatment at Site 1. In requesting reviewers' comments to these responses, the Navy requests MDE specifically respond to the methodology set forth.

3. **The MDE expects that all water pumped from Site 1 will undergo treatment before discharge to the North Branch Potomac River.**

   All groundwater extracted at Site 1 during groundwater remediation will be treated to meet the discharge requirements established by WVDEP prior to being discharged to the North Branch Potomac River.

4. **MDE recommends that groundwater containment be considered during selection of a remedial alternative for Site 1. This should be included in order to prevent off-site contaminant migration to sediment and surface water. An evaluation of remedial alternatives for contaminated surface water and sediment may be required if control of the source(s) of contaminants is not considered in the final remedial action at Site 1.**

   The FFS presents remedial alternatives that may be considered for selection, but does not recommend one alternative over others. However, preventing off-site migration (e.g., discharge to the North Branch Potomac River) of contaminated groundwater from Site 1 is one of the site-specific remedial action objectives stated in Section 2 of the FFS and will be used during selection of the remedial alternative. Alternatives including site-wide groundwater extraction attain groundwater containment.

Specific Comments

1. **Page ES-2, third paragraph. Please clarify the reference to "depauperate population" in the fourth sentence.**

   A depauperate population indicates the population is relatively low in abundance and in diversity of species.

2. **Page 1-35, first full paragraph. See specific comment # 1.**

See response to specific comment 1.

3. **Page 3-20, *Cost*. Please provide estimates for the following: 1) 20 extraction wells, and 2) operations and maintenance (O&M).**

   Comment incorporated. The cost for an extraction well system including 20 wells is approximately $1,200,000 and the O&M costs are $70,000.

4. **Page 3-20, Alternative GC-4, *Effectiveness*. Should "Alternative GC-4" on the last line of this page be changed to "Alternative GC-3?" Please clarify.**

   Comment incorporated.

5. **Page 3-24, *Effectiveness*, third paragraph**
   Some of the volatile organic compounds (VOCs) contained in the groundwater under Site 1 are listed hazardous wastes. Water contaminated with listed hazardous wastes cannot be directly discharged to the Potomac River without first undergoing treatment. Please modify this section to indicate that all groundwater extracted from Site 1 will undergo treatment to reduce or eliminate contaminant concentrations.

   As stated under General Comment #3 above, all groundwater extracted at Site 1 during groundwater remediation will be treated to meet the discharge requirements established by WVDEP prior to being discharged to the North Branch Potomac River.

6. **Page 3-28, last paragraph. Should the reference to "column 4" actually be column five? Please clarify.**

   No. The first two columns are actually under one heading and are therefore considered to be one column.

7. **Page 3-28, last paragraph**
   While some of the concentrations shown in Tables 3-7 and 3-8 may be below MCLs at the edge of the mixing zone, dilution is not a treatment. Please see general comment #3 and specific comment #5.

   Please see responses to general comment #3 and specific comment #5.

12. **Page 4-26, first complete paragraph. Please see general comment #3 and specific comment #5.**

    Please see response to general comment #3 and specific comment #5.

13. **Page 4-49, first sentence**
    During design of a groundwater treatment system, please consider the overall water usage in the vicinity of the Allegany Ballistics Laboratory, including nearby areas in Maryland.

In terms of water withdrawal, the extraction system is anticipated to remove an imperceptible amount of water from the North Branch Potomac River or groundwater from the Maryland side of the River.

Responses to Comments from West Virginia DEP

General comments I-III and specific comments 6, 9-14, 16, 21, and 22 pertain to soils and will be considered in developing the future feasibility for Site 1 soils.

Specific Comments

1. **ES-3, Ambient Water Quality Criteria for discharges are established as proposed in the Federal Water Pollution Control Act.**

   Comment incorporated.

2. **1-21 Delete the last sentence of the first full paragraph.**

   Comment incorporated.

3. **T1-4 & 1-5 Please reference figures to assist in determining sampling locations.**

   Comment incorporated. A footnote at the bottom of Table 1-4 was added that reads "Sediment sample locations are shown in Figure 1-21" A footnote at the bottom of Table 1-5 was added that reads "Surface-water sample locations are shown in Figure 1-20"

4. **2-1, References to the NCP sections 40CFR 300.430(f)(ii), etc. should read 40CFR 300.430 (f)(1)(ii), etc.**

   Comment incorporated.

5. **2-1, Third bullet. 40 CFR 300.430(f)(1)(ii)(D) continues to state that "Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in 40 CFR 300.430(f)(1)(ii)(A) and (B). Please include the full sentence as stated in the NCP.**

   Comment incorporated.

7. **3-19 The discussion of DNAPL should mention that DNAPL often exists in a residual phase, trapped or bound in soil pore space, unaffected by gravity forces and ground water advective forces.**

   Comment incorporated. The following sentence has been added to the end of the second full paragraph on page 3-19: "However, residual DNAPLs often exist in soil pore spaces bound to the soil particles by forces stronger than the force of gravity, which can result in the residual DNAPLs being highly immobile."

8. 3-24 The West Virginia State boundary along the Potomac River has been interpreted to be the low water mark on the West Virginia side of the river. West Virginia permits those facilities lying in West Virginia that discharge to the North Branch. Maryland has the right to review and comment on those permits. West Virginia has determined that technology based standards are applicable to discharges related to Site 1. These are distinct from, and considerably less than, limits derived by mixing zone calculations. (for a summary of these procedures, please refer to CERCLA Compliance with Other Laws Manual, pages 3-4 & 3-5).

Corrections reflecting this comment need to be made throughout the text.

Comment noted. All text referencing mixing zone calculations have been edited to incorporate the discharge requirements established by WVDEP.

15. This Office is not sure if the North Branch has been designated as a Wild and Scenic River. Regarding the sediment and erosion control requirements mentioned that would have to be met, be advised that West Virginia, under the States NPDES program, permits construction activities that have the potential to affect water courses. The substantive requirements are:

- develop a storm water pollution prevention plan that outlines proposed measures to **control storm water discharges during and after construction.**
- **Develop a sediment-erosion control plan capable of controlling runoff from a 10-year-24 duration event.**

Comment noted.

17. 4-18, The State regulatory preference for above ground piping is not necessarily a requirement. Under ground piping may be deemed appropriate in consideration of other factors. Such factors would include nature of the fluid conveyed, type of piping to be installed, method of leak detection, system safeguards, etc. Also considered would be threats that above ground installation may pose to system such as freezing or vandalism.

Comment noted.

18. 4-26 The discussion regarding TCE.

When technology based limits are applied (69 μg/l as a daily maximum, 26 μg/l as a monthly average) this argument is not valid. Additionally, this alternative may not comply with NCP or the state Groundwater Protection Act which require, if strictly interpreted, that over time aquifers be restored to drinking water use.

The discussion regarding TCE on page 4-26 has been changed to reflect the discharge requirement changes that have been made throughout the text per Specific Comment #8.

19. **Compliance with ARARs. The State Groundwater Protection Act must be addressed in this section.**

The State Groundwater Protection Act is addressed in this section since the section discusses chemical-specific ARARs. However, text has been added to Section 2 discussing the Act and it's applicability as a chemical-specific ARAR for groundwater.

20. **4-34 Last bullet. Wells that no longer produce contaminants above MCLs would have to be further monitored for the rebound effect.**

The rebound effect describes the phenomenon where concentrations rise after the well is shut off. Post-shut off monitoring is customary to look for and respond to such behavior.

23. **T A-2, Discharge to groundwater from a regulated unit. While not strictly applicable, this requirement has been deemed relevant and appropriate by EPA for similar circumstances at the West Virginia Ordnance Works NPL site. In all likely hood, the five year review process and anticipated monitoring of any ground water extraction system will functionally satisfy this requirement should it become an issue.**

Comment noted.

<u>Comments to Appendix B: Numerical Modeling of Groundwater extraction at Site 1.</u>

<u>General</u>

The model developed is a useful tool for analysis of the hydrogeologic regime at Site 1. Comments developed are not meant to be a rejection of conclusions drawn, but rather as considerations for future development.

If after more data is known, and after future refinements are incorporated into the model, simulations still indicate that extraction from the alluvial aquifer is impractical, a horizontal collection trench should be evaluated as part of the ground water extraction-containment alternatives. This evaluation could occur in the design stages and not necessarily have to be considered in the feasibility study document.

Comment noted. Additional data will be collected during geophysical and aquifer testing conducted at Site 1. However, because it is felt that the current models fulfill the objective of determining the feasibility of groundwater extraction at Site 1, no revised models are planned for this FFS. The Navy anticipates using all relevant data gathered during the aquifer tests, including updated values for hydraulic conductivities, in a more specific model(s) developed during the remedial design phase.

Other remedial alternatives, such as groundwater interceptor trenches, may be considered during the pre-design and design phases, but the current groundwater-extraction models indicate that groundwater capture in the alluvium is attainable through groundwater extraction from the bedrock, without the need for additional containment alternatives.

Specific

Site 1a

The choice of constant head boundaries for the river in layers 1 & 2 and northern boundary in layers 1, 2, & 3 probably precludes the simulation of ground water flow beneath the river. The stream or river package may be more apt to evaluate this possibility. Another easily implementable option would be to assign constant head values to river cells in layer 1 only and vary the layer 1/layer 2 Vcont for those cells over a reasonable range. Varying vertical conductivity values over a range is attractive for this portion of the site in that bedding planes approach the horizontal toward the eastern portion of the site. It would be expected that anisotropy is considerable.

Another option to the constant head assignment for the extreme northern boundary would be to artificially charge those cells through recharge or stream infiltration to match field conditions.

The second paragraph under Site 1a boundary conditions on page B-8 incorrectly states that the river was simulated in layers 1 and 2 by assigning constant-head values to the cells representing the river. For Site 1a, the river was actually simulated as the reviewer's comment recommends. Constant-head values were assigned for the river cells in layer 1, but the hydraulic communication between the river and layer 2 (shallow bedrock) was controlled by a modified vertical conductance calculated using the hydraulic conductivity of the shallow bedrock and the hydraulic conductivity of a layer of sediment at the bottom of the river. In this scenario, water was able to move between the river and layers 1 and 2, as well as move beneath the river. The text in the second paragraph under Site 1a boundary conditions on page B-8 has been edited to correctly discuss the boundary conditions in layers 1 and 2.

Site 1b

It is recommended, similar to the above comment, that other options to the constant head assignment to layers 1 & 2 for the river be evaluated.

Conductivities reported for the alluvial aquifer are reported to range from 0.6 to 5.7 ft per day. Values assigned range from 0.6 to 3 ft per day with the majority of the aquifer represented in the range of 0.6 to 1.8 ft per day. Similar head distributions are attainable with assignment of cell conductivities toward the higher end of the range. The difference would not be reflected in head distribution, but rather in the flow through the zone of interest. To fully evaluate the dewatering simulated in certain runs, or the practicality of alluvial extraction wells, and barrier wall effectiveness, a high end assignment of cell conductivities should be considered.

Layer 2 & 3 horizontal anisotropy could be related to strike and predominant fracture orientations reported as a result of fracture trace analysis.

The assignment of relatively higher conductivity to layer 2 as compared to layer 1, which may be reflective of site conditions, would bias results in favor of extraction from that layer. Future data should shed light on this point.

Water-level data collected from monitoring wells within Site 1b suggest that all alluvial and shallow bedrock groundwater does discharge to the river for the following reasons: First, the bottom elevation of the river adjacent to Site 1 is approximately the same as the bottom elevation of the alluvium at Site 1. Therefore, groundwater moving through the alluvium at Site 1 would have to discharge to the river or move downward into the shallow bedrock. Second, water levels measured in two bedrock wells north of the western portion of Site 1 (i.e., Site 1b) were much greater than bedrock water levels at Site 1b, which suggests that groundwater moving through the shallow bedrock at Site 1b would be prevented from flowing beneath the river to the north side. Furthermore, water-level measurements from a pair of bedrock wells indicated that there is likely an upward gradient from the deep bedrock to the shallow bedrock. Therefore, bedrock groundwater at Site 1b likely discharges to the North Branch Potomac River. For these reasons, the river was simulated as a constant head boundary for layers 1 (alluvium) and 2 (shallow bedrock).

Although conductivities based on slug-test data for the alluvial aquifer range from 0.6 to 5.7 ft/day, Table 5-1 of the Site 1 RI Report shows that in the vicinity of Site 1b the hydraulic conductivity is at the low end of the range. Therefore, the values assigned to the cells were kept low to reflect what was measured in the field. Furthermore, doubling the assigned hydraulic conductivity values would not likely have a substantial affect on the model results. However, during aquifer testing at Site 1, additional alluvial-aquifer data will be collected. This additional information will be evaluated during the pre-design and design phases.

Re: Draft Site 1 Focused Feasibility Study, Allegany Ballistics Laboratory (ABL), October, 1994

Enclosure

Copy to:
Allegany Ballistics Laboratory (Mr. Hulburt)
COMNAVSEASYSCOM (Mr. Hoffman, Code 0923)
COMNAVSEASYSCOM TECHREP (Mr. Williams)
CH2MHill (Mr. Mott)

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