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LETTER REGARDING U S NAVY RESPONSES TO REGULATOR COMMENTS ON FINAL  
DRAFT FEASIBILITY STUDY AT OPERABLE UNIT 3 (OU 3) NTC ORLANDO FL  
3/12/1999  
HARDING LAWSON ASSOCIATES

00196

**Harding Lawson Associates**

March 12, 1999

Commanding Officer  
SOUTHNAVFACENCOM  
2155 Eagle Drive  
North Charleston, SC 29419-9010

ATTN: Ms. Barbara Nwokike, Code 187300

Subject: **Operable Unit 3**  
**Final Draft Feasibility Study Report**  
**Response to Comments**  
**NTC, Orlando**  
**Contract: N62467-89-D-0317**

Dear Barbara:

Attached are our responses to the FDEP and EPA comments to the Operable Unit 3 Final Draft Feasibility Study Report. We hope to discuss these responses in the OPT meeting in Orlando on March 17 and 18.

If you have any questions or need additional information, please call me at (904) 269-7012.

Very Truly Yours,

**Harding Lawson Associates**

A handwritten signature in cursive script that reads "Rick Allen".

Richard P. Allen  
Project Technical Lead

## Attachments

cc: Wayne Hansel, Southern Division  
Nancy Rodriguez, USEPA Region IV  
David Grabka, FDEP  
Lt. G. Whipple, NTC-Public Works Officer  
Robin Manning, BEI  
Steve McCoy, Tetra Tech/NUS  
Al Aikens, CH2M Hill  
John Kaiser, HLA  
Kim Nelson, HLA  
file

## PROJECT REVIEW COMMENTS

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Florida Department of Environmental Protection - David Grabka (2/8/99)

1. **One issue that was not addressed in the Remedial Investigation Report and therefore not addressed in this Feasibility Study Report was the leachability of the herbicides MCPA and MCPP. Both herbicides were detected in groundwater at concentrations several orders of magnitude above their respective groundwater cleanup target levels (GCTLs). MCPA has a leachability soil cleanup target level (SCTL) of .02 mg/kg. This concentration is several orders of magnitude lower than the maximum detected concentration of MCPA at Study Areas 8 and 9.**

The leachability SCTL (0.02 µg/kg) is not achievable by any current standard, cost-effective analytical method. Because arsenic is the primary contaminant of concern in soil and groundwater at OU 3 (based on widespread distribution and its potential health risk effects), and MCPA and MCPP in soil are co-located with arsenic, distribution evaluations in both the RI and FS used arsenic as the worst-case stand-in encompassing all contaminants of concern. The potential leachability of all COCs has been recognized, and was the primary reason for the 1997 IRA soil removals, as well as the number and distribution of groundwater monitoring points installed during the RI. The most effective means of addressing leachability potential is to eliminate or significantly reduce the source of contamination in soil. This has largely been accomplished already at SA 9 and proposed remediation alternatives (as summarized in the FS) will further reduce leaching potential in both SAs.

2. **MCPP does not have SCTLs computed for it. It is likely that SCTLs calculated for MCPP would be in the same range as those calculated for MCPA based upon their similar chemical structure. Both herbicides would probably have similar leaching potentials. Therefore, it is likely that the MCPP soil concentrations detected at both Study Areas would be several orders of magnitude above a calculated leachability SCTL.**

Agreed. Similar behavior between MCPP and MCPA was assumed for the purposes of health risk evaluation.

3. **The areal extent of the herbicides MCPA and MCPP have not been delineated to their respective leachability SCTLs. In order to eliminate further leaching of the two herbicides to groundwater, it may be necessary to expand the soil remediation scenarios.**

The leachability SCTL (0.02 µg/kg) is not achievable by any current standard, cost-effective analytical method. The areal extent of both compounds has been delineated to their respective detection limits. In addition, both herbicides have a relatively low frequency of detection in surface soil samples at SAs 8 and 9. MCPA was detected in only 6 of 54 samples at SA 8 and 1 of 25 samples at SA 9. MCPP was detected in only

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13 of 54 samples at SA 8 and 3 of 25 samples at SA 9. Given that herbicides are co-located with arsenic in soil, arsenic distribution is much more widespread, significant source area removals have already been completed (1997 IRAs), and soil removal volumes were based on the distribution of arsenic, no further expansion of soil remediation scenarios is anticipated. Further, the existing network of monitoring wells is appropriately positioned to monitor actual herbicide distribution in groundwater.

4. A review of the EXTTOXNET Extension Toxicology Network Pesticide Information Profiles found that "MCPA and its formulations are rapidly degraded by soil microorganisms and has low persistence, with a reported half-life of 14 days to 1 month, depending on soil moisture and soil organic matter." It is also stated that "mecoprop's (MCPP) residual activity in soil is about two months." It may be that concentrations detected in soil and groundwater have been substantially degraded by microorganisms since soil and groundwater sampling for the Remedial Investigation was conducted. On the other hand, it is possible that concentrations of arsenic and other pesticides in the soil have created conditions in soil and groundwater that are not conducive to microorganism survival or growth. Further study of soil and groundwater microorganism populations and activities may provide new, potentially less costly remedial alternatives for the reduction in concentration levels of MCPA and MCPP. These alternatives could include restoration of microorganism populations in soil and groundwater, enhancement of microorganism growth and reproduction by addition of nutrients, etc. I have attached the EXTTOXNET profiles for MCPA and MCPP to this letter.

The additional chemical profile information on MCPA and MCPP is appreciated. We agree that the concentrations of MCPA and MCPP in soil and groundwater may have decreased since the collection of samples for the RI (February 1998) as a result of biodegradation and/or as a direct result of the elimination of source material during the October 1997 soil removal. A comprehensive groundwater sampling and analysis round is slated for 3/99 to provide some benchmark data prior to implementation of the selected remedial alternative.

We also agree that alternative treatment technologies exist for MCPA and MCPP. It should be noted that as arsenic and MCPA/MCPP are collocated in groundwater, and arsenic a) is not subject to the same biodegradation factors, and b) is the "risk driver" at OU 3, the overall duration of treatment (and consequently, the overall costs) would not be significantly affected by a reduction in organic treatment time or costs.

5. It would appear that concentrations of MCPA and MCPP as toxic organics in groundwater are the main drivers for the requirement for treatment prior to discharge to Orlando's POTW. Substantial reduction in the concentrations of the two herbicides could remove or

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reduce the amount of time UV/oxidation would be required to treat groundwater prior to either discharging to the Orlando POTW or to Lake Baldwin via a NPDES permit.

Agreed. Alternative G-4 will be revised to model the extraction system based on treatment of MCPA and MCPP as the endpoint for (UV-oxidation) treatment. Once treatment goals for MCPA and MCPP are met, the treatment system could be shut down, but the pumps would continue to operate in order for arsenic to be treated at the Orlando POTW.

6. **Modeled groundwater elevation contours for predicted steady state conditions after the pump and treat groundwater remedial alternatives for Study Areas 8 and 9 would be helpful. I am interested in the groundwater hydraulics created by pumping the recovery wells, especially in association with Lake Baldwin.**

Modeled piezometric head contours for steady state conditions will be added to Appendix F. A more rigorous evaluation may be appropriate as part of detailed design activities.

7. **The calculated groundwater retardation factor for arsenic was 24.2. Using this retardation factor in conjunction with calculated groundwater flow velocities at the site has arsenic being essentially immobile. However, based upon monitoring well analytical results, arsenic appears to be much more mobile than that. It may be that arsenic has a much higher mobility in groundwater than is predicted in the report. As the retardation factor for arsenic seems to be the main factor contributing to the predicted length of time a groundwater pump and treat system would need to operate, testing to determine the actual retardation factor may help refine actual pumping durations and cost estimates for the groundwater remediation scenarios.**

Agreed. Please see response to Comment #24 (USEPA).

**Comments from Bill Neimes, FDEP, Technical Review Section (1/29/99)**

8. **Soil Remediation Alternative. Of the remedial alternatives for the soil, the alternative that is the most promising is the excavation and disposal option. Although the cost of this alternative varies significantly, depending on whether the soil is considered to be hazardous or not, this alternative would not only eliminate most of the contaminated soil but would have the highest certainty of attaining site action levels once remediation is complete.**

Agreed.

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**Florida Department of Environmental Protection (Continued)**

9. **Hazardous Waste:** The criteria for determining whether the soil is hazardous is through a TCLP test. This test is only a characteristic test and assumes that none of the wastes are listed hazardous waste. For clarification purposes, has someone determined that the site soil is not a listed hazardous waste?

In conjunction with Interim Removal Actions conducted in 1997, a determination was made that soil from SA 9 would be considered Listed Hazardous Waste, because compounds detected in soil and reportedly stored at the facility are listed. The soil at Study Area 8 was not considered a Listed Waste at the time, because the Listed arsenical compounds were not reportedly stored at SA 8. Further, as stated in Section 1.3.1 of the RI (1998), SA 8 was only used for pesticide and herbicide storage, and the fenceline surrounding SA 8 was sprayed with herbicides to keep vegetation from growing along the fence. These chemicals were used for their intended purpose. As stated in Section 1.4.2 of the RI (1998), SA 9 was used to store and mix pesticides and herbicides and to clean application equipment for pest control activities. These operations consisted of mixing the pesticides and herbicides in containers placed on the soil. During these operations, spills are likely to have occurred. As a result, these chemicals detected were not used for their intended purpose and are therefore considered hazardous waste.

Prior to disposal, soils from SA 8 will be analyzed to determine whether or not they are considered a characteristic waste by TCLP method. The remaining maximum detected arsenic concentration is 90 mg/kg. The TCLP limit for arsenic is 5.0 mg/L. Using the "20 X Rule," any soil with an arsenic concentration below 100 mg/kg would likely pass the TCLP test. Therefore, the soil at SA 8 is most likely to be characterized as nonhazardous waste. Soil disposal costs will be revised to more accurately reflect the relative volume and likely characterization of soils from both areas.

10. **Groundwater Remediation Alternatives.** Even though I realize much effort and work went into reviewing and selecting groundwater remedial alternatives, I was disappointed in the recommended alternatives that were evaluated. I am not critical of the methodology of selecting the remedial alternatives nor am I being critical of the detailed, systematic approach used to generate treatment alternatives. What concerns me in the selection process of groundwater remedial alternatives is that 2 of the treatment alternatives are unproven at efficiently treating the mixture of contaminants and 2 treatment alternatives would require a very detailed and precise treatment train. Therefore, each of the selected alternatives, other than the limited action alternative, has either an unproven performance track record or would require a rather complicated treatment train. The two unproven technologies are permeable treatment walls and phytoremediation.

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Both the Navy and EPA strongly encourage and support the evaluation and implementation of innovative, unproven technologies at remediation sites. A wide range of potential technologies (both innovative and time-tested) were considered initially and presented to the OPT. Because the primary contaminant of concern (based on potential health risk) is arsenic in both soil and groundwater at OU 3, technologies with successful treatment of arsenic were considered favorably, even if their track record with organic treatment was less certain.

Given the limited distribution of organics in groundwater at OU 3, coupled with their inherent potential for biodegradation, the uncertainties associated with their reduction or removal by any of the proposed alternatives are acceptable and manageable. Both of the proposed treatment trains do have multiple components, but they have demonstrated successful track records at other CERCLA sites. Because the organics will likely be reduced to acceptable concentrations long before arsenic reductions are achieved, the trains will be greatly simplified over the life of the treatment.

11. **Permeable Treatment Alternative.** The difficulty I have in accepting a permeable treatment wall (Alternative G-2) as a viable treatment technology is because of the uncertainties involved in this technology. Page 5-36 of this report notes that "The reduction in toxicity of pesticides and herbicides by reactive walls is questionable." An appropriate question to ask the preparers of this report is "Has there ever been a reactive wall that effectively treated pesticides and herbicides?" I am not aware of any.

Permeable treatment wall is still considered an innovative technology, which by definition, has a relatively high degree of uncertainty associated with its application. There is no information readily available that describes an iron wall application at a site contaminated with pesticides. Much of the published data describes results from applications at sites contaminated with chlorinated solvents. However, pesticide biodegradation has been demonstrated under reducing (anaerobic) conditions which means chlorinated pesticide transformation would also be expected under the reducing conditions created by the zero valent iron.

HLA has conducted a bench-scale study (unpublished data) that measured the reduction of DDT in groundwater mixed with zero valent iron. This test was used to as a screening tool to evaluate the effect zero valent iron had on DDT transformation. Results showed rapid transformation to the compound 3,3'-dichlorodiphenylethane (compound identity confirmed using Mass spectrometry). The difference between the transformation product and DDT was that the trichloroethane moiety that is part of the DDT compound had been completely dehalogenated. Chlorines present on the phenyl groups were not affected. These data demonstrate the potential for chlorinated pesticide transformation

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using an iron wall. Pilot testing would certainly be recommended prior to implementation.

It is also worth noting that, given the reported potential for natural biodegradation of the primary pesticides of concern (MCPD and MCPA), there may be little or no need to rely on the reactive wall to treat the pesticides, just the arsenic.

12. **Phytoremediation Alternative.** Phytoremediation (Alternative G-3) is another questionable technology which has been processed through the screening as a recommended alternative. Although the plants have demonstrated an ability to reduce contaminant concentrations, the underlying question is whether plants can efficiently reduce concentrations in the groundwater to acceptable levels for disposal. For example, on Page 5-37, this report notes removal efficiencies between 40 - 90% for VOCs and SVOCs. Is this technology with removal efficiencies such as these acceptable for discharging to either Orlando's POTW or via an NPDES discharge?

The primary contaminant of concern at OU 3 is arsenic. Phytoremediation has been tested on arsenic-contaminated groundwater and has demonstrated effectiveness. The organic contaminants of concern (primarily MCPA and MCPD) are of limited distribution; given the effects of mixing during the groundwater extraction process, the actual organic compound concentrations entering the phytoremediation process are certain to be lower than the (pre-extraction) values used in calculating required removal efficiencies. The reported removal efficiencies for organic constituents are believed to be acceptable for achieving discharge requirements to either endpoint.

13. **Pump and Treat Alternatives.** Both Alternatives G-4 and G-5 are treatment processes involving several different stages in the overall treatment train. For both of these treatment processes, I am concerned on the reliance of relatively complex system adjustments for both of these processes to operate effectively. Alternative G-4 requires a significant pH alteration to preclude precipitation of metals during the UV oxidation process.

Given the relatively low concentration of contamination and the relatively small plume size for both of these areas, the estimated cost to treat each gallon of water recovered is \$0.067/gallon for Alternative G-4 and \$0.081/gallon for Alternative G-5. This is assuming a groundwater recovery rate of 1.5 gpm and pumping for 18 years at SA 9 and a recovery rate of 10 gpm while pumping for 30 years at SA 8.

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Both of these treatment trains are proven technologies that have been implemented at several contaminated groundwater sites, including CERCLA sites. Cost estimates for both alternatives include costs for treatment system O&M including: system maintenance, treatment chemical usage, carbon and filter replacement, sludge management and disposal, utilities, and influent and effluent sampling.

14. **Estimate Time for Groundwater Extraction.** There is a discrepancy in this report estimating the time involved with groundwater extraction from SA 8. In Appendix F, the amount of time calculated was 38 years. However, a 30 year cleanup time was used for the cost estimates in Appendix G.

A 30-year period was only used to develop a reasonable cost estimate, not the endpoint of treatment (estimated at 38 years). The 30-year time period is recommended by CERCLA guidance (USEPA, 1988), when developing present worth cost estimates.

15. **Arsenic Contamination in Wetland.** This report estimates an area of 315' by 375' as the square footage of land in SA 8 requiring remediation to achieve the residential action level of 1.0 mg/kg. However, only 75% of this contaminated area is being considered for remediation. The other 25% of this contaminated area is considered off-limits since this area is dense wooded wetlands. What should be a concern in this wetland area is that the highest concentration of arsenic on record at this site was sampled in this area.

We could not confirm the highest concentration of arsenic on record in the wetland area as referenced by the reviewer. Beginning with the site screening investigation of SA 8, the highest concentration of arsenic detected in soil was 322 mg/kg from a location inside the fence, not in the wetland. Following removal actions in 1997, the highest remaining arsenic in soil concentration is 90 mg/kg, also from a location inside the fence. The highest arsenic in groundwater concentration was 295 µg/L, also from within the fenced area.

Due to existing ARARs associated with designated wetlands areas, as well as the proposed future designation of this wetlands area as an undevelopable buffer zone, the potential benefits gained from remediation activities in the wetland were far outweighed by the deleterious effects resulting from disturbance or destruction of the habitat. Additional soil remediation activities will be undertaken in the source area (inside the fence) to further reduce the overall potential health risk posed by arsenic in surface soil. Even without institutional controls, the potential human exposure in the wetlands is very limited, and the remaining concentrations would pose no unacceptable ecological or human health risk.

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16. **Appendix B - Estimating Radius of Influence.** The equation used to estimate the radius of influence is a derivation of the Cooper-Jacob equation or modified Theis equation. This equation is used to calculate hydrogeologic values based on pump test data. The value of 100 days used by the designers in this equation based on a maximum time between rainfall events is not the correct use of the term. To obtain the value for time, one must plot the data of time versus drawdown as shown in the figure below. The time value in this equation is a plotted value from pump test data of the x-intercept at zero drawdown.

The time value at zero drawdown is typically a small value (in minutes) and would not be near 100 days. The resultant radius of influence would be a much smaller value than that indicated in this report.

As shown in Figure 9.24 and page 237 of Groundwater and Wells by Driscoll (1986), the radius of influence is commonly estimated by extending the distance-drawdown plot (a straight line on semilogarithmic graph paper) to the point of zero drawdown. The corresponding equation for the radius of influence in feet, derived from the Cooper-Jacob approximation to the Theis equation, is given as (see Eq. 9.12 in Driscoll, rearranged)

$$r_o = [2.25Tt/S]^{0.5}$$

where T is in ft<sup>2</sup>/day and t is in days. S is dimensionless.

It should be noted that by following the procedures demonstrated by Driscoll on pages 238 through 241 and Figures 9.25 through 9.28, the distance-drawdown plot can be constructed directly from the time-drawdown plot without calculating either the transmissivity, T, or the storativity, S, for a graphical determination of the radius of influence.

Since the distance-drawdown plot (a straight line on the semilog graph paper) is constructed for a specific time after pumping began, it will change positions as time progresses. The new positions of the distance-drawdown plot will simply be translations to the right (to greater radius) while maintaining the same slope as time increases (see Figure 9.28 in Driscoll). Therefore, the radius of influence increases with time as indicated by the above equation.

The choice of 100 days as a time to use in determining the radius of influence was arbitrary. It seems reasonable given the fact that continuous pumping without a rainfall event to cause a shrinking of the drawdown cone due to infiltration recharge is unlikely

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to occur for longer than 100 days. However, a longer or shorter duration could be used if desired and the corresponding radius of influence would be given by the above equation.

17. **Appendix B - Transmissivity Values.** The difference between the transmissivity values in SA 8 and SA 9 was 20 times (54.8 ft<sup>2</sup>/day at SA 8 and 2.8 ft<sup>2</sup>/day at SA 9). Considering that these two SAs are only a few hundred feet from each other and the aquifer depth and thickness were identical for both study areas, this is a rather significant decrease in transmissivity values.

Agreed. The difference in the T values seems excessive for two sites that are so close to each other. However, the boring logs indicate that the sands at SA8 may be cleaner (less fines) than those at SA9, and the lithology descriptions (included in the RI) are sufficiently different to suspect that there may be significant differences in the hydraulic conductivity at the two areas. Since we do not have pumping-test data showing otherwise, we assume that the data from the slug tests are indicative of these observed differences and that the actual conductivity values are substantially different at the two areas

18. **Appendix F - Pumping Rate.** When calculating the pumping rate for Study Area 8 and 9, the authors assumed an aquifer drawdown of 10 feet. I used the Cooper-Jacob equation to calculate drawdown and to compare it with the assumed value of 10 feet.

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2S}$$

Where:

Q = 2.7 gpm (value provided)  
T = 410 gpd/ft<sup>2</sup>  
t = 365 days (my estimate)  
r = 250 ft (value provided)  
S = 0.2 (value provided)

The calculated drawdown is 1.0 feet. This value is significantly less than the assumed drawdown of 10 feet. To achieve a 10 foot drawdown in a recovery well, the pumping rate would have to be approximately 28 gpm. The author should explain why a 10 foot drawdown was used for this equation.

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The Cooper-Jacob equation used by the reviewer will predict a drawdown of 10.4 ft at the pumping well if a well radius of 0.5 ft is assumed. We don't know where the reviewer obtained the 250 foot radius used in the calculation above, but that value should not be used for drawdown calculations in the pumped well. Of practical concern is, given a reasonable drawdown (say 10 ft in the well at a radius of 0.5 ft), how much discharge can be sustained by the pumping well? In this case it appears to be about 2.7 gpm.

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#### United States Environmental Protection Agency, Region 4 (2/11/99)

#### 19. Soil Cleanup Levels - Site Average versus Not-to-Exceed Levels

Cleanup levels bear a relationship to exposure point concentrations used in the risk assessment. EPA assumes that a receptor makes random contact with the soil in an exposure unit. Thus, the concentration contacted by the receptor is the long term arithmetic average of the soil concentrations from all parts of the exposure unit. The use of the 95% upper confidence limit (UCL) of the arithmetic mean as an exposure point concentration reflects the Agency's wish for health-protectiveness in the face of incomplete knowledge of the true average concentration in the exposure unit.

Confusion regarding cleanup levels is most evident at the top of page 3-25 in the discussion of the Soil Recreational Action Level.

In Study Area 8, for example, the remedial goal option representing a  $10^{-6}$  cancer risk from arsenic for the recreational receptor is 7.2 mg/kg. Calculations for the volume of soil to be removed were made in appendix E. From the calculation map and worksheet, it appears that all areas with soil concentrations greater than 7.2 mg/kg are indicated for removal. Therefore, the value of 7.2 mg/kg, which is a health-protective measure of the average concentration, is being used incorrectly as a not-to-exceed level.

The maximum detected concentration of arsenic at SA 8 was 90 mg/kg and the 95% UCL used in the risk assessment was 25.3 mg/kg. Hence, the not-to-exceed cleanup level to attain a 95% UCL in the exposure unit of 7.2 mg/kg would very likely be higher than 7.4 mg/kg. Therefore, it seems possible and less costly to remove soil from the areas of higher concentration so that the 95% UCL for arsenic would be below 7.2 mg/kg.

These considerations for arsenic in SA 8 are applicable to other exposure scenarios and other chemicals of concern.

The summary of EPA's approach to health-protective goals is acknowledged and appreciated. The calculated volumes and remediation target levels as presented in the FS were purposely conservative to accommodate FDEP's approach to health-protective goals and remedial goals (Cleanup Target Levels). Based on past experience at Navy installations in Florida, there has been reluctance to allow any single point concentration to exceed the cleanup target, whether it be background, drinking water standards, or published cleanup goals. Any reduction in the volume of soil or groundwater media requiring remediation that would still result in achievement of health-protective levels acceptable to all parties should be considered.

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**United States Environmental Protection Agency - Region 4 (Continued)**

**20. Percent Removal**

The last column in Table 3-2, 3-3, 3-4, 3-6 and elsewhere is titled "Percent Removal." The numbers in this column represent the maximum detected concentration minus the cleanup level expressed as a percentage of the maximum detected concentration. Presenting this value as "percent removal" is misleading. Vis-a-vis soil, this title suggests wrongly that a certain percentage of the site will need to be remediated. In addition, the discussion above regarding the nature of cleanup levels as site averages or not-to-exceed levels should be considered. It may actually be better to remove this column from the tables.

This column will be deleted as recommended. Text referring to percent removal will be deleted as appropriate.

**21. Screening Level for Beryllium**

EPA no longer considers beryllium carcinogenic by the oral route. Hence, the screening level of 120  $\mu\text{g}/\text{kg}$  is incorrect. The correct screening level based on noncancer effects in children is 160  $\text{mg}/\text{kg}$ .

There is a coincidence involving the value "120" that appears to be at the heart of this comment. The value "120" associated with beryllium as reported in the human health risk assessment (Appendix A) is the calculated Exposure Point Concentration, not the obsolete RBC associated with beryllium. There is a difference in units as well (EPC reported in  $\mu\text{g}/\text{kg}$  and RBC reported in  $\text{mg}/\text{kg}$ ). The current USEPA Region III RBC for residential ingestion of beryllium (160  $\text{mg}/\text{kg}$  adjusted to 16  $\text{mg}/\text{kg}$  for a Hazard Quotient of 0.1) was used appropriately as the screening value for beryllium (Appendix A, Table 6-4).

**22. The formula presented on the first page of Appendix C for calculating the weighted average contaminant concentration in extracted groundwater contains a typographical error. The third term in the numerator should be  $C_3/D_3$  not  $C_3/C_3$  as shown. The calculations in Attachment B appear to be correct. An explanation of the factors used in the equation, similar to that presented in Attachment A, should be included with the introduction to the formula.**

The formula in Appendix C will be corrected as indicated above and an explanation of the factors will be provided. The concentration ( $C_x$ ) is the concentration of a given chemical from a given monitoring well and the distance ( $D_x$ ) represents the distance the monitoring well is from the recovery well.

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23. Appendix C, Attachment B gives the transmissivity of Study Area 9 as 2.8 ft<sup>2</sup>/day. Appendix F gives the transmissivity of Study Area 9 as 6.5 ft<sup>2</sup>/day determined from a slug test, then proceeds in the next paragraph to use 2.8 ft<sup>2</sup>/day in the calculations without any explanation. A difference between calculated drawdowns, travel times, clean-up times, etc. due to the difference between these two transmissivity values probably will not be significant, but where did the 2.8 ft<sup>2</sup>/day come from and why was it used rather than the apparently site-specific value from the slug test.

The reported transmissivity value of 6.5 ft<sup>2</sup>/day in Appendix F is a typographical error. At Study Area 9, the site-specific value of the two slug tests produced hydraulic conductivity (k) values that ranged from 0.068 ft/day to 0.209 ft/day (Table 3-2, RI, 1998). Therefore, the average hydraulic conductivity (k) at SA 9 is 0.139 ft/day. The average transmissivity value (T) is determined by:

$$T = kb$$

where k = hydraulic conductivity (ft/day), and  
b = aquifer thickness (20 feet).

Therefore, the calculated transmissivity (T) value at SA 9 is 2.8 ft<sup>2</sup>/day. Appendix F will be revised to reflect the correct transmissivity value and associated pumping rates. No changes are necessary with respect to transmissivity in Appendix B.

24. Appendix F Sections 2.2-3.0 utilizes well-accepted procedures to estimate times to flush arsenic contamination out of the groundwater system using pumping wells. The calculations, as presented, are correct and the input and results are not unreasonable. The Kd value for arsenic is one of the critical factors in these equations. Kd values are presented in Table F-1, which indicates a reported range in Kd for arsenic between 1 and 200. A Kd value of 4 was used in the clean up time calculations (Section 2.2).

Part 5 of the EPA Technical Background Document (TBD) (USEPA, 1996, *Soil Screening Guidance: Technical Background Document, Second Edition*, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC 20460, May, 1996, EPA/540/R95/128), states:

“Arsenic. Kd values developed using the empirical equation for arsenic (+3) range from 25 to 31 L/kg for pH values of 4.9 to 8.0, respectively. These values correlate fairly well with the range of measured values reported by Battelle (1989)—5.86 to 19.4 L/kg. They are slightly above the range reported by Baes and Sharp (1983) for arsenic (+3) (1.0-8.3). The estimated Kd values for arsenic (+3) do not correlate well with the value of 200 L/kg presented by Baes et al. (1984). Oxidation state is not specified in Baes et al. (1984), and the difference between

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the empirical-derived Kd values presented here and the value presented by Baes et al. (1984) may reflect differences in oxidation states (arsenic (+3) is the most mobile species)."

Note that the studies by Baes, et. al. (1984) and the Baes and Sharp (1983) described above are the source of part of the data presented in Table F-1. The EPA guidelines (TBD Table 46) indicate that a Kd of 29 is an appropriate value for a soil pH of 6.8. This will raise the retardation coefficients calculated in Appendix F, making the arsenic less mobile and increasing the calculated clean up time. Because the results are proportional to the ratio of the Kd values used (29 versus 4), calculated clean up times by pumping could exceed 150 years. This estimate seems excessively long, given that the site has had only a few decades for contaminant to disperse through the aquifer, so the site-specific value may be less than 29.

Site specific Kd values were not used in the calculations and apparently have not been collected. Therefore, it may be more appropriate to use a higher estimated Kd value in the clean up time calculations, and be aware that there is a relatively large degree of uncertainty in the time to clean-up estimates and cost for groundwater remedial options G-4 and G-5 presented in Table ES-2.

We agree that the soil distribution coefficient for arsenic is a critical factor in estimating contaminant flushing duration. Development of site-specific Kd values was beyond the scope of this FS; collection of such data would be an appropriate component of detailed design activities if a pump-and-treat alternative were selected.

An arsenic speciation study was conducted during the OU 3 RI (HLA, 1998) which indicated that 80% of the arsenic in groundwater existed as arsenite ( $As^{+3}$  valence), the more mobile and less stable valence state. As reported in the USEPA Soil Screening Guidance (1996): "...the [Kd] range reported by Baes and Sharp (1983) for arsenic (+3) (Kd = 1.0-8.3). The estimated Kd values for arsenic (+3) do not correlate well with the value of 200 L/kg presented by Baes et al. (1984)...arsenic (+3) is the most mobile species." As a result, the selected Kd value of 4 ml/g (Table F-1) is appropriate.