DEPARTMENT OF THE NAVY
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE, NORTHEAST
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Ms. Christine Williams
U.S. Environmental Protection Agency, Region I
1 Congress Street Suite 1100 (HBT)
Boston, MA 02114-2023

Mr. Brian Balukonis
Office of Waste Management
Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908-5767

SUBJECT: TRANSMITTAL OF NOTES FROM 14 FEBRUARY 2007 TELECONFERENCE, NAVY RESPONSES TO EPA E-MAILS AND MEMORANDA SUBMITTED BY EPA TO SUPPORT 14 FEBRUARY 2007 TELECONFERENCE, AND NAVY RESPONSES TO FEBRUARY 2007 FOLLOW-UP COMMENTS FROM EPA AND RIDEM - DRAFT PHASE III QUALITY ASSURANCE PROJECT PLAN FOR INSTALLATION RESTORATION (IR) PROGRAM SITE 16 FORMER NAVAL CONSTRUCTION BATTALION CENTER (NCBC)DAVISVILLE, RI

Dear Ms. Williams/Mr. Balukonis:

Navy has prepared the listed enclosures related to the Draft Phase III Quality Assurance Project Plan for Installation Restoration (IR) Program Site 16 at the former Naval Construction Battalion Center at Davisville, Rhode Island.

Navy appreciates the time and effort shown by EPA and its consultant team by the information submitted via e-mail and subsequently attached to February 20, 2007 correspondence. The variety of information submitted helped to foster the technical discussions during the February 14, 2007 teleconference. Navy encourages vigorous discussion of the issues as it fundamentally serves to strengthen the overall program. Based on these discussions and the EPA follow-up comments referenced above, there remain several points of difference between the Navy and the EPA regarding the conceptual site model for Site 16, particularly with respect to the potential contribution of upgradient contaminant sources to the trichloroethene plume underlying Site 16. The upcoming Phase III Remedial Investigation has been designed, with input from EPA and RIDEM, to address existing data gaps. The results of this investigation will allow for further refinement of the Conceptual Site Model and guide us towards resolution of our differences.

It is important to acknowledge that, while we do have differences, the Navy, EPA, and RIDEM have reached consensus on a great majority of the scope of the Phase III Remedial Investigation. Accordingly, the Navy is proceeding with the completion of the draft final Phase III Remedial Investigation QAPP for Site 16 in order to maintain a favorable field work starting date in late May or early June 2007. The draft final document is scheduled to be published on

March 30, 2007.

If you have any questions, please do not hesitate to contact the Remedial Project Manager, Mr. Curt Frye, at 215-897-4914.

Sincerely,

David Barney
BRAC Environmental Coordinator
By direction of BRAC PMO

Enclosures:

1. Notes from the 14 February 2007 teleconference.
2. Navy response to EPA February 2007 memorandum re: Potentiometric Contouring.
3. Navy response to CDW February 2007 memorandum re: Major Data Gap Exists at Western Boundary of Site 16.
4. Navy response to EPA February 2007 memorandum re: Major Data Gap Exists at Western Boundary of Site 16, Additional Considerations and Recommendations.
5. Navy response to EPA email dated 14 February 2007 regarding the groundwater model.
6. Navy plan for investigations in the Site 16 upgradient area.
7. Responses to EPA Follow-up Comments on Navy Responses to EPA Risk and Forensics Related Comments originally received from EPA on September 20, 2006. The EPA follow-up comments were received from EPA in correspondence dated February 13, 2007.
8. Responses to EPA Follow-up Comments on Navy Responses to EPA Hydrogeological Comments originally received from EPA on September 20, 2006. The EPA follow-up comments were received from EPA in correspondence dated February 20, 2007.
9. Responses to RIDEM Follow-up Comments on Navy Responses to Comments originally received from RIDEM on November 28, 2006. The RIDEM follow-up comments were received via electronic mail (E-mail) on March 5, 2007. The RIDEM correspondence was dated February 19, 2007.

Copy to:
Mr. Curt Frye, NAVFAC Midlant (1 copy)
Mr. Rich Gottlieb, RIDEM (1 copy)
Dr. Ken Finkelstein, NOAA (1 copy)
Ms. Kathleen Campbell, CDW (2 copies)
Mr. Christopher Modisette, RI RCD (1 copy)
Mr. Steven King, Quonset Development Corporation (1 copy)
Mr. Jon Reiner, Town of North Kingston (1 copy)
Ms. Lee Ann Sinagoga, TtNUS Pittsburgh (1 copy)
Mr. Steve Vetere, TtNUS Boston (1 copy)
Ms. Maryellen Iorio, USACE (1 copy)

ENCLOSURE 1

NOTES FROM THE 14 FEBRUARY 2007 TELECONFERENCE

NOTES FROM TECHNICAL TELECONFERENCE ON 14 FEBRUARY 2007
SITE 16 PHASE III WORK PLAN/QUALITY ASSURANCE PROJECT PLAN
FORMER NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

PARTICIPANTS

David Barney (Navy)	Brian Balukonis (RIDEM)
Curtis Frye (Navy)	Rich Gottlieb (RIDEM)
Lisa Yeutter (Navy)	Lee Ann Sinagoga (TtNUS)
Christine Williams (EPA)	Scott Anderson (TtNUS)
Bill Brandon (EPA)	Jeff Schubert (TtNUS)
Conrad Leszkiewicz (CDW)	Steve Vetere (TtNUS)

C. Frye distributed the following via email on 13 February in preparation for the call:

- Figure 1 depicting Navy's interpretation of deep overburden groundwater flow direction, plume locations, and clean groundwater areas at the Site 16 and upgradient areas. The figure also includes tentative locations of the staff gauges to be installed in Davol and adjacent ponds and Allen Harbor.
- Section 3.0 tables from the Navy's Supplemental Phase II Data Package Report.
- Boring logs and well completion forms for MW16-55D, 55R, and 55R2.

C. Williams of EPA distributed the following via email on 13/14 February in preparation for the call:

- Memorandum from B. Brandon discussing the EPA's position on the data gaps that exist in the upgradient area of Site 16, with recommendation of potential future actions to address these data gaps.
- Memorandum from C. Leszkiewicz describing a simplified groundwater model that was created to show that transport of CVOCs from the PR-58 Nike Site to Site 16 is a viable pathway.
- Figures showing potentiometric surface and CVOC distribution outputs from groundwater model.

D. Barney opened today's discussion by thanking the EPA and its contractor for the information that they sent to the Navy, and asking EPA to provide a brief description of the contents of this material.

B. Brandon summarized his memo by stating that he feels that there is enough uncertainty associated with the existing data to draw differing conclusions on the conceptual site model in the upgradient area. Therefore, additional data are needed in this area to improve the understanding of groundwater flow patterns upgradient from Site 16.

B. Brandon's memo makes reference to the groundwater model developed by C. Leszkiewicz which shows a hypothetical groundwater flow regime that starts with a slug-style release from MW03-14. Fifty years after this release, the model shows the center of CVOC mass around monitoring well PGU-Z3-11D, suggesting that there is a flow component that follows this southern route before entering Site 16. The flow portion of the model (i.e., MODFLOW) was calibrated to match recent groundwater elevation measurements.

B. Brandon sees a lack of data in the area between PGU-Z3-11D and MW03-11/EA-111D/EA-110D, and believes that more data are needed to determine if there is contamination entering Site 16 from the Nike Site along this inferred flowpath. B. Brandon views this investigation as "ruling out uncertainty" rather than testing the hypothesis that this is occurring.

R. Gottlieb asked what concentrations of CVOCs are being detected in PGU-Z3-11D, since this should provide an indication of whether this is a viable contaminant transport pathway. B. Brandon believes this well has not been sampled in some time. R. Gottlieb asked why one would expect that there are CVOCs passing through this area if there are none detected in this well. At this point, C. Leszkiewicz explained the EPA position regarding the upgradient area and provided an explanation why the absence of CVOCs

in wells does not necessarily rule out an upgradient source of CVOCs to Site 16. The following lines of evidence were discussed:

- Near Building 41, no CVOC source has been identified in shallow soils with 25 well clusters in this area over a reasonably tight sampling scheme.
- There is a well documented upgradient source of CVOCs at the Nike Site.
- Deep groundwater flow patterns suggest that some subsurface features such as a buried stream channel or weathered fractured bedrock zone with coarse overburden materials are present, providing a preferential flow through Nike and Site 03 to the Building 41 area.
- EPA feels there is inadequate monitoring of this potential pathway. Inflections in groundwater flow suggest gravelly stream bed or fractured rock zone that is likely to be 100 to 200 feet wide. With wells 500 feet apart, these features may have been missed.

C. Leszkiewicz cited the following lines of evidence from previous data collected at Site 16 that suggest the existence of a preferential flowpath through the Building 41 area:

- Previous geophysical information suggests highly fractured rock in this area.
- Slow coring times and drilling times were recorded at many locations (15-20 minutes/foot) at NCBC Davisville, but around Building 41 coring/drilling times were much faster, suggesting more fractured rock.
- During coring at MW16-14R, about 750 gallons of water were lost, suggesting that the bedrock might be fractured. However, the water might have been lost while drilling the overburden. C. Leszkiewicz believes the water was not lost in the overburden because the log for MW16-14D makes no mention of water loss in the overburden while drilling in that borehole.

C. Leszkiewicz reiterates that a lack of contamination in PGU-Z3-11D would not necessarily be evidence that there are no CVOCs passing through this area into Site 16, since the well density in this area is very low. Therefore, the wells present in this area are not sufficient to definitively rule out the presence of contaminant migration along the southerly route. C. Leszkiewicz offered two possible explanations for contamination traveling from upgradient areas into Site 16 (without being detected in the existing upgradient wells): 1) the contamination migrates onto Site 16 in the bedrock then discharges to the deep overburden near Building 41 or 2) a slug of CVOCs moved onto Site 16 at one point in time; however that slug is no longer detectable in the upgradient area.

D. Barney asked if C. Leszkiewicz believes that the area upgradient from Site 16 is adequately characterized. C. Leszkiewicz does not believe a full RI is warranted in this area, but reiterated that there is a potential pathway that needs to be further evaluated. EPA believes that DPT soil borings and Color-Tec screening are not adequate to characterize the upgradient area.

C. Frye stated that back in October, the Navy conceded that additional upgradient investigation is warranted, and at that time it was decided that further discussion about the differences in data interpretation could wait until further data was collected. Today's discussion should focus on what the Navy should do to collect the right data to provide answers. C. Leszkiewicz stated that his concern was the Navy has not committed to performing geophysical investigations and that the EPA would like to see permanent monitoring wells rather than Geo-Probe borings and Color-Tec screening.

C. Frye clarified the Navy's position on upgradient investigations from the October meeting. Navy agreed to advance borings and use the information from these borings to locate wells, and agreed to look into geophysical methods. L. Sinagoga added that the Navy moved DPT/temporary well locations from the other Site 16 investigative areas (Areas 1 to 3) to the upgradient area (there are now 10 upgradient borings planned) based upon recommendations by EPA in October. There is one well cluster planned based on the results from the borings. The Navy also researched geophysical options, but has concerns over the efficacy of the geophysical methods and ability of these methods to achieve the objectives.

S. Anderson provided further insight on the ability of the geophysical methods to achieve the project objectives. Recent correspondence from EPA suggested a "narrow ribbon" where contamination may be moving through the area. This type of feature is not likely to be discernible using geophysical methods.

However, the permeable feature that was discussed earlier in this call was described as a buried stream channel that may be 100 to 200 feet in width. If this is the case, geophysical methods would be more useful.

C. Williams clarified EPA's concerns. EPA is concerned that Geo-Probe borings will not be capable of reaching the bedrock surface. EPA would like 3 to 5 well clusters in the upgradient area, and would like to use geophysical methods to find the best locations for these clusters. B. Brandon added that EPA is interested in looking immediately upgradient from Site 16, along a line between MW-Z4-02 and MW16-55 (a distance of 500-700 feet), where there is very limited data available. The MW-Z4-02 well has not been sampled in some time and EPA believes a key interval (i.e. the intermediate zone) was missed in MW16-55, as evidenced by the elevated FID reading at the 46 to 48 bgs interval in the boring log for MW16-55D.

S. Anderson asked, in reference to MW16-55D, why an elevated reading at one discrete 2-foot interval in the intermediate zone would be observed while no CVOCs were observed in the deeper screened wells. B. Brandon suggested that this would occur if low permeability layers were present. S. Anderson noted that the boring logs only show fine sands above and below this interval. B. Brandon suggested that perhaps this feature was overlooked which resulted in S. Anderson questioning whether EPA believes the lithologies as represented in the boring logs. C. Williams expressed that EPA does believe the lithologies presented in the boring logs. S. Anderson and B. Brandon agreed that the ability of the geologist is the limiting factor. D. Barney intercedes that discussing details at this level are not conducive to the bigger picture items to be discussed.

B. Brandon acknowledged that geophysics will not be capable of identifying smaller, narrower features, but they should be capable of identifying significant fractures, if they exist. B. Brandon recommended running a geophysical line perpendicular to potential interferences, perhaps along a NE to SW transect from MW16-55D to intersection of Davisville Road and Thompson Road, but agreed that a second method would probably be needed to make the geophysical work worthwhile. B. Brandon suggested the possibility of retrieving the existing geophysical data and reprocessing it using newer software (this approach is discussed in his memo as well). B. Brandon mentioned that he spoke with Mark Blackey of Geophysical Applications Inc. (the previous contractors who performed the seismic refraction lines in various areas of the Davisville site) and this option should be considered as a first step. At a minimum, this re-processed data will assist in confirming the bedrock elevation to ensure that samples reach the required depths.

J. Schubert discussed the permeability of bedrock at Davisville and the slug testing and chemical data trends that are evident from the existing data. Navy review of the slug tests that were performed in the Nike/Site03/Site 16 areas indicates a permeability of less than 1 foot/day. The one test from the Nike site (i.e., well EA-106R) that exceeded one foot/day was found to be incorrectly interpreted. Also, two bedrock wells on Site 09 were documented to yield no water. J. Schubert noted that if fractures are present in bedrock that carry groundwater from Nike to Site 16, they would have to be numerous and continuous in order to for a pathway that is 0.5 mile long. J. Schubert also noted that nowhere on Nike, Site 03, Site 16, Site 07, or Site 09 has there been contamination in bedrock where there is no contamination in the deep overburden as well.

C. Leszkiewicz replied by stating that he does not think this evidence provides a definitive argument against bedrock being a pathway even if no contamination is observed in the deep overburden. C. Leszkiewicz did not state that bedrock is a definite pathway, but did state his opinion that there is a lack of evidence to rule out the possibility. R. Gottlieb pointed out that not enough distance between the source and investigation well may have been allowed in order to see contamination in just the upper bedrock unit. J. Schubert stated that several investigations have traced impacted groundwater over 1000 feet, more than sufficient for this effect to be observed if viable at the site. J. Schubert re-iterated that nowhere at any monitoring well location has contamination been observed only in either the deep overburden or upper bedrock.

R. Gottlieb wondered how a major groundwater pathway would be undiscovered if monitoring wells were installed in the deep overburden upgradient from Site 16. S. Anderson noted that this is the Navy argument against the Nike Site to Site 16 pathway. Based on the groundwater model presented by EPA,

it looks as if there is a wide zone through which contamination is moving, with primary migration in the deep overburden. DPT borings installed in the upgradient area would encounter this contamination, if it is present. S. Anderson added that even if Geo-Probe borings cannot reach the final depth of bedrock, they should be capable of detecting some of the contamination contained in the groundwater model's hypothetical plume.

C. Leszkiewicz reiterated that EPA would like to see bedrock wells in the upgradient area, and EPA does not feel that the Geo-Probe will be able to reach the required depth. EPA believes that more than one well cluster is warranted. C. Frye noted that the Navy agreed to install two wells in this area during the October meeting. C. Williams expressed a concern over the language in QAPP, which says DPT wells will be advanced and a well cluster may also be installed. EPA would like a commitment to install well clusters and a commitment to perform geophysics to site the well clusters. EPA's preference would be between 3 and 5 well clusters between MW-Z4-02 and MW16-55.

C. Frye noted that this is more than was suggested by EPA during the October meeting. L. Sinagoga clarified the discussion in the QAPP to require one intermediate depth well at the MW16-55 location, and a second well cluster to complement the DPT and Color-Tec field screening effort. B. Brandon said that the October discussions proposed this as a minimum program, with the use of geophysics to verify that this minimum program was sufficient. EPA is concerned that the Navy is no longer planning to utilize geophysics.

J. Schubert summarized the situation as follows: 1) All parties agree that the primary area that needs to be investigated is the area west of Building 39 between MW-Z4-02 and the MW16-55 cluster. 2) Three primary methods are available with which to perform the investigation: DPT, conventional drilling, and geophysics. One, more than one, or all of these could be used. What needs to be found is a balance between the three that is agreeable to all parties.

J. Schubert proposed that VOC results (Color-Tec and fixed-base lab) from DPT borings could be used to rule out bedrock well locations, based on the fact that, elsewhere on the site, absence of contamination in the overburden indicates an absence of contamination in the bedrock aquifer. B. Brandon replied that EPA would like to see bedrock wells in areas where there is evidence that an unmonitored bedrock zone exists, even if there is no contamination in the overburden aquifer. Therefore, non-detects in the DPT borings would not be sufficient to rule out bedrock exploration in an area.

C. Frye asked what the objective of these borings would be, if they are not used to rule out potential bedrock exploration areas. C. Frye noted that the EPA suggested moving DPT borings from the Building 39/41 area to the upgradient area. C. Williams stated that EPA would agree that the DPT borings are not necessary if the Navy installed five well clusters in the area (I, D, and R) and reprocess the original seismic work. S. Anderson asked if five well clusters were installed on this transect and no VOCs were detected, would EPA consider this evidence that there is no upgradient contribution to Site 16? C. Leszkiewicz agrees that these wells, with a geophysical investigation, would prove the case. S. Anderson stated that he does not believe the geophysics would be necessary in addition to the five wells, as wells representing all potentially impacted zones would prove that contamination does not exist in the area. Additional geophysical work would not add anything to the understanding gained from the groundwater data.

D. Barney asked if the Army Corps would be tracking this potential fractured rock pathway as part of the RI at the Nike Site. R. Gottlieb stated that the Army Corps may do this type of study as part of the characterization of the Nike Site. D. Barney expressed a concern that the Navy will spend a lot of money investigating an issue for which they are not liable. C. Williams stated that in order to complete an FS for Site 16, the EPA needs to be reasonably assured that the bedrock contribution from upgradient does not represent a continuing source of contamination to Site 16. EPA is concerned that DPT boring will not be adequate to assess contamination in bedrock.

S. Anderson questioned C. Leszkiewicz about how the model boundary treated potential interactions of groundwater and Davol Pond. C. Leszkiewicz stated that the model did not include interactions with Davol Pond and placed a no-flow boundary along the southern edge of the model, so that no water can

flow into or out of this edge of the model. The model deals only with groundwater, not the ponds. There are other influences on pond such as stormwater runoff, etc. The flow model was built to match the groundwater elevations measured during investigations. S. Anderson then questioned C. Leszkiewicz as to whether or not he thought the ponds do receive groundwater discharge and should have been included in the model. C. Leszkiewicz stated that the model was only intended to show that there is a possibility that contamination could migrate from Nike Site to Site 16. B. Brandon noted that it is unknown what is happening at Davol Pond and added that Army Corps will be performing further investigation there during their next field event. B. Brandon also noted that the EPA has been asking the Navy to investigate the ponds for nearly 10 years.

L. Sinagoga asked EPA to summarize their thoughts. C. Williams responded by stating that the Navy proposal provided in their responses to comments included Geo-Probe borings in the parking lot near Building 39, then installation of one well cluster if these borings indicated the presence of contamination. Also, the Navy proposal included a temporary well near MW16-55. In order to have confidence in the data collected from these areas, EPA would like a greater commitment of permanent well clusters and EPA would like a rationale (other than even spacing) for the location of well clusters. EPA feels that geophysics should be used to site these wells. C. Frye stated that the Navy is willing to make a commitment to collect the data necessary to answer the outstanding questions, but would also like a commitment from the EPA on a maximum number of monitoring points so that costs of the investigative program are clearly understood.

B. Brandon recommended that the Navy propose a combination of DPT, conventional drilling, and geophysics to be used to investigate the upgradient area. J. Schubert noted that the current scope of investigation includes geophysics along a north-south transect on Thompson Road, advancement of DPT soil borings and analysis of soil samples using Color-Tec field screening and fixed-base lab analyses. The Navy plans to collect these data, draw cross-sections, then consult EPA to select one or two spots to install well clusters. B. Brandon agreed with this approach, but expressed a reluctance to agree on the number of wells without first seeing the data that are collected. J. Schubert acknowledged that if very high concentrations of CVOCs are detected, then a larger number of wells may be warranted. But at that point the Navy would be characterizing an upgradient plume for which they are not liable.

The discussion turned to geophysical methods. C. Frye said the Navy is not convinced that geophysics will accomplish the required objective. S. Anderson reiterated that the assumed width of the fracture zone or stream bed is a very important factor because it has a bearing on whether the geophysical methods will be useful. Based on the studies provided by D. Clemens, the seismic refraction method could be sufficient to identify relatively large fracture zones in the upper bedrock zone. S. Anderson noted that one of the lessons learned from the study was that low velocity zones were interpreted as either a buried stream channel or a clay-filled fractured, which are two completely different systems. S. Anderson summed up the Navy position by stating the geophysical methods will produce seismic velocity data that can be inferred to locate zones were groundwater transport is likely to be favorable. However, by advancing DPT borings and installing temporary wells (assuming getting close enough to the deep overburden/bedrock interface), the Navy will collect VOC field screening data at 10 foot intervals and potentiometric data that will enable a better understanding of groundwater flow direction and direct evidence of contamination. The Navy would rather use groundwater chemistry and potentiometric data to identify the high permeability zone(s) than geophysics which just produces inferred areas of potentially higher groundwater flow conditions.

B. Brandon replied that the existing bedrock elevation map (based on previous seismic lines) shows a bedrock trough in the MW16-55 area. Low spots in bedrock tend to be located where there are fractures, and EPA wants confidence that flow patterns in the bedrock in the upgradient area are understood. S. Anderson believes that DPT borings (if they reach bedrock/overburden interface) will detect contamination if it is present in this area. The Navy is planning 10 borings the upgradient area ("kite-shaped" area on Figure 4-2), and is willing to move them based on EPA suggestions. For instance, these borings could be reconfigured into a line along Thompson Road (between MW-Z4-02 and MW16-55). This would give enough coverage to identify the buried stream channel, if it is 100 to 200 feet wide as has been discussed today, as this would place a temporary well every 50 feet.

B. Brandon agreed and said that he would like to see the 10 borings in the “kite-shaped” area reconfigured into a line. J. Schubert asked if these borings were redistributed into a line of 10, would EPA still see the need for geophysics. B. Brandon said maybe not, but he would like to see the Navy reprocess and reevaluate the old geophysical data from transect 02-22, 02-23, 02-24, and 02-25 from this general area and use this as the basis for the DPT boring locations. S. Anderson added that the Navy could use a hollow-stem auger drill rig to reach greater depth if that becomes a concern.

The following action items were agreed upon at the end of the call:

- Navy will look into viability of reprocessing existing geophysical data.
- Navy will recommend a combination of DPT and conventional HSA soil borings and monitoring wells in the upgradient area that will enable the determination of the presence or absence of a preferential flowpaths in this area.
- EPA will provide the remaining EPA comments to the Navy by Tuesday, February 20.

The Navy has attached a revised proposal based on the discussions that occurred during this conference call.

Also attached to these teleconference notes is a Navy response to the EPA memos provided on the morning before the conference call.

ENCLOSURE 2

NAVY RESPONSE TO EPA FEBRUARY 2007 MEMORANDUM
RE: POTENTIOMETRIC CONTOURING

COMMENTS ON HYDROGEOLOGIC INFORMATION CONTAINED IN MEMO FROM MS. CHRISTINE WILLIAMS TO CURTIS FRYE ET AL. DATED 14 FEBRUARY 2007, 9:21 EST

Navy comments on this memorandum are presented on a paragraph-by-paragraph basis below.

***Paragraph 1 of EPA E-mail**:*

There is still a major disconnect with how the Navy is drawing the groundwater contours.

Navy Response to Paragraph 1: Comment noted.

***Paragraph 2 of EPA E-mail**:*

The 17 foot contour should be pulled around toward MW-Z4-02 (17.03 feet) at the south end of Thompson Road. The Navy figure ignores this location and incorrectly pulls it back close to PGUZ3-7D (17.99 feet) along the western segment of Davisville Road, thereby eliminating the inflection around EA-110D (16.74 feet). There is no basis for their interpretation.

Navy Response to Paragraph 2: The map prepared by the Navy shows a potentiometric surface for the deep overburden monitoring wells. MW-Z4-02 is a shallow monitoring well and the water level measurement was inadvertently posted on the map. The water level datum for MW-Z4-02 should not be used to construct contours. The Navy believes the 17-foot contour is correct as presented on the referenced figure.

***Paragraph 3 of EPA E-mail**:*

The depiction of the 16 foot contour at the western end of Building 41 is not correct. When I interpolate the 16 foot groundwater elevation at the western end of Building 41 near the water tower (Figures 10A and B) relative to wells PGU-Z3-10D and MW16-09D, -13D, -30D, -10D to up gradient wells MW16-55D, EA-110D, and MWZ4-02 there is a clear inflection pointed to EA-110D of smaller magnitude, but similar to the 17 foot contour. They also have no basis to draw the 16 foot contour to PGU-Z4-02D just to the east of MW-Z4-02 since no groundwater elevation exists for that well location.

Navy Response to Paragraph 3: The 16-foot contour is presented as a rounded contour passing just to the east of well PGU-Z3-10D (gw elevation = 16.07 ft msl) and just to the west of wells MW16-09D (gw elevation = 15.88 ft msl) and MW16-10D (gw elevation = 15.93 ft msl). The contouring is correct relative to these wells that have locations and elevations nearest the contour. The elevations are all within 0.12 foot of the contour value. The EPA is suggesting a very strong looping bend in the 16-foot contour near well MW16-09D, based on water levels in wells located farther to the east that have lower elevations and to the west that have much higher elevations. For example, well MW16-55D is the closest up-gradient well with a measured groundwater elevation of 16.50 ft msl. This well is about 750 feet west of well MW16-09D. The Navy believes the contour is correctly drawn based on the wells closest to the contour and not the ones 750 to 1000 feet to the west or the ones farther to the east away from the contour. In other words, the wells closest to the value of the contour should dictate how the contour is drawn. In addition, the Navy does not believe it is justified to base the “inflection” in the 16-foot contour on the EPA-drawn “inflection” in the 17-foot contour, when the EPA-drawn 17-foot contour was based on an invalid data point (please see preceding comment).

The Navy believes that the extension of the 16-foot contour over to GPU-Z4-02D is a good approximation. Although no water level was measured in this piezometer, the contour location was approximated using the elevations measured in wells MW16-10D, PGU-Z4-03D, and MW16-54D. These are the deep overburden wells and piezometers located closest to GPU-Z4-02D. The Navy agrees however, that the contours drawn in the vicinity of Building 214 are only approximate.

Paragraph 4 of EPA E-mail:

The groundwater inflections in the deep overburden are clearly presented on the USACE NED report for groundwater contours in Deep Wells for July 2000. These show the axis centered on EA-110D to MW-Z4-01 (not measured by the Navy) to between Buildings 39 and 41.

Navy Response to Paragraph 4: As detailed in the Supplemental Phase II RI Data Package Report for Site 16 (p. 3-14), the potentiometric contour maps presented in previous Site 16 RI reports and USACE figures are incorrect because the top of casing elevations for wells RMW-02S/D are approximately 3.5 feet lower than reported in the reports. Hence, the groundwater elevations in RMW-02D were calculated 3.5 feet too high in the earlier reports. This causes serious errors in the historical water level maps that cover the deep zone at Sites 03 and 16. Additional detail has been presented in the Supplemental Phase II RI Data Package Report, p. 3-14. The Navy believes that the potentiometric maps prepared in the Supplemental Phase II RI Data Package and the comprehensive map presented at the October 27, 2006 meeting (drawn 10/16/2006) have corrected this past error and are the best representation of the potentiometric surface.

Paragraph 5 of EPA E-mail:

Further, while the inflections are not as pronounced they are presented on two EFANE Phase II Hydrogeologic Study figures where both Site 03 and Site 16 are presented (November 2002: Figure 3-21 and March 2003: Figure 3-26). In addition, the direction of groundwater flow is clearly from Nike/Site 03 to Site 16 with groundwater moving between Building 39 and 41. Thus, there is a clearly documented pathway from Nike / Site 03 to the Site 16 area.

Navy Response to Paragraph 5: Please see comments regarding Paragraph 4.

Paragraph 6 of EPA E-mail:

Lastly, all of the Site 03 groundwater monitoring reports show deep overburden flowing to Site 16, not diverting to south into Davol Pond.

Navy Response to Paragraph 6: Based on the latest groundwater potentiometric map presented by the Navy (drawn 10/16/06), the Navy believes that some of the groundwater, if not a large proportion of the groundwater, flowing south and southeast from the Nike Site is discharging to one or more of the three ponds located in that direction (including Davol Pond). However, the Navy does not believe the flow rate is large. This is part of the Navy's conceptual model that is tentative at the present, but is being investigated during the synoptic site wide water level survey that will be conducted in cooperation with the U.S. Army Corps of Engineers in Spring 2007. Data will become available to better contour groundwater elevations in this area as a result of the upcoming investigations.

ENCLOSURE 3

NAVY RESPONSE TO CDW FEBRUARY 2007 MEMORANDUM
RE: MAJOR DATA GAP EXISTS AT WESTERN BOUNDARY OF SITE 16

NAVY RESPONSE TO CDW MEMORANDUM RECEIVED 14 FEBRUARY 2007
MAJOR DATA GAP EXISTS AT WESTERN BOUNDARY OF SITE 16

In order to provide the Navy's position on the above referenced document, the Navy has inserted brief comments within key portions of the text. The text of the memorandum is provided in italics to facilitate readability. It should be noted that, per our BCT meeting of October 26, 2007 and the technical teleconference of February 14, 2007, the Navy has already agreed to further investigate the upgradient area of Site 16. Please see the attached proposal.

Major Data Gap Exists at Western Boundary of Site 16.

No CVCO source identified near Building 41 with over 25 soil borings and well clusters.

Navy Response: While a specific release has not been identified, the Navy believes that a release or series of point-source releases may have occurred in the general vicinity of the former Building 41. Please note that a very limited amount of analytical data is currently available for the surface and shallow subsurface soils in this area. Please see the Phase II Supplemental Data Package Report (TtNUS, March 2006) for more details.

Significant CVOC DNAPL source documented to be present at Nike PR-58.
Prior USCOE investigation (1998-2000) and Pilot Study (2005)

The Nike PR-58 site is hydraulically up gradient both in Deep Overburden and Bedrock.
USCOE interpreted groundwater pathways – 1998 to 2000.
Navy Site 03 interpreted groundwater pathways - 2001 through 2005.
Navy Site 16 interpreted groundwater pathways – Remedial Investigations.
Combined Nike Pilot and Supplemental RI groundwater elevations 2004

Deep groundwater flow pattern suggests that it is controlled by a subsurface structural feature (Supplement RI Figures 10A and 10B). This may be a buried stream channel and/or a bedrock fault zone with coarse bed materials and/or fractured rock.

Lack of adequate monitoring wells across down gradient flow - Nike PR-58 to Site 16:

-No wells between MWZ3-03 and EA-111 (500 Feet).
-No wells between EA-111 and PGU-Z3-07 (650 Feet).
-No wells between MWZ4-01 and MWZ4-02 (675 Feet).
-No rock wells between MW16-10R and MW16-65R (475 Feet).
-No intermediate wells between MW16-13I and MW16-33I (325 Feet).
-Deep well separations are 235 feet (MW160-09D, MW16-10D, MW16-33D).

(Soil boring MW16-55, located near/on the inferred pathway had an FID with filter response of 500 parts per million with no well installed).

Seismic refraction surveys (various Geophysical Applications Reports) shows a weakened rock zone along GW pathway (< 13,000 feet per second). Velocities 13,000 feet per second or less suggest faulting. Bedrock surrounding weak zone ranges from 14,400 to 16,000 feet per second.

Extremely low RQD values for bedrock along GW pathway in Site 16 (Supplemental RI Figure 3-7). RQD values less than 50% indicate highly fractured rock. Even RQD values below 75% are considered to be indicative of fractures.

Drilling logs along this pathway show also suggest a highly fractured rock zone. Drilling logs generally show fast drilling times (< 5-7 minutes per foot). The log for MW16-24R lost 750 gallons of water. The log for MW16-08D describes slicken sides (faulting).

Navy Response: The Navy agrees with all of the preceding EPA statements. However, the Navy believes the investigations of this large upgradient area should be associated with the investigation of the Nike Site, not Site 16.

Groundwater discharges upward from bedrock to deep overburden at 50% of locations in Site 16 (Supplemental RI Figure 3-15) and 30% of locations from deep overburden to intermediate (Figure 3-13). This is indicative of a discharge zone; at a minimum the gradients are neutral and not predominantly downward.

Navy Response: The percentages quoted above do not agree with the data presented in the Phase II Supplemental Data Gap Report. Figure 3-15 (deep overburden to bedrock comparisons) shows 2 of 7 locations in the western area of former Building 41 exhibiting upward gradients (MW16-68 and 70), 1 neutral gradient (MW16-15), and 4 of 7 locations exhibiting downward gradients (MW16-14, 66, 69 and 71). Figure 3-13 (intermediate to deep overburden comparisons) only shows upward gradients at 2 locations (MW16-61 and 22) and downward gradients at 12 locations in this same western area of former Building 41. Additionally, no upward gradients are observed in Figures 3-12 (shallow to intermediate overburden comparisons) and 3-14 (shallow to deep overburden comparisons). Also, although upward gradients are observed between the bedrock and deep overburden at MW16-68 and 70, the magnitude of the downward gradients in the overburden zones far exceed the upward gradients measured in these two well clusters. This suggests that though there is an upward gradient present at only a few locations, from a water balance perspective, the Navy maintains that groundwater flow is predominantly downward.

No distinction between deep and bedrock CVOC concentrations. Short, deep well screens relative to long, bedrock open holes combined with sharp declines in vertical CVOC concentrations (gradient) above deep zone wells mutes any interpreted higher CVOC concentration in deep overburden compared to bedrock. Nonetheless, bedrock CVOC is higher at MW16-71R, MW16-60R while injection of 750 gallons of water, with less than 750 gallons removed during development, may have affected CVOC concentrations in MW16-14R. Also, while elevated CVOC is present at MW16-22D (no bedrock well) it is at a location with upward gradient to MW16-22I.

Navy Response: The Navy has shown from site-specific data that the CVOCs are nearly always higher in the deep overburden compared to shallow bedrock. In the paragraph above, the EPA points out a few very minor exceptions and implies that this is a common occurrence, which it is not. The Navy has responded previously concerning the length of open borehole in bedrock wells and how this might influence observed concentration gradients (please see Issue No. 8 in the Navy's response to EPA comments on the Draft Supplemental Phase II RI Data Package Report, dated May 15, 2006).

Simplified MODLOW modeling

A basic groundwater flow and transport model was developed for the area of concern using existing data and calibrated to Supplemental RI and Pilot Study December 2004 groundwater elevations (See Figures 1 through 3). Input used geometric mean for deep overburden hydraulic conductivity and the Navy low bedrock hydraulic conductivity.

Groundwater Flow and Contaminant Transport

Figure 1: *Deep overburden groundwater contours.*
Figure 2: *Calibration plot comparing calculated and measured heads (95%).*
Figure 3: *CVOC distribution from a Slug of CVOC released at MW03-14 after a period of 40 to 45 years. (Continuous release could have larger plume).*

- *Sufficient time has elapsed for CVOC to have migrated to Site 16.*
- *Inflections in groundwater contours only possible with fractured rock and/or highly permeable overburden zone.*
- *Flow into Site 16 likely along preferential pathway in bedrock/deep overburden.*
- *Potential for a major core of CVOC plume encroaching Site 16 from the west.*

Navy Response: Please see the Navy's responses to Email_Sent_2_14_2007_0613AM. While the Navy agrees that the model-predicted hydraulic heads appear to be a good match to the target data, the model has the following significant limitations:

- The model is over-simplified versus actual site conditions (model layers are flat, whereas the lithologies vary in thickness at the site),
- The model is based on a subset of data from only one site (Site 03),
- The model ignores Davol Pond and adjacent ponds to the south as possible recipients of groundwater discharge,
- The model assumes transport of contamination in the overburden (inconsistent with the hypothesis proffered by EPA that contamination is reaching Site 16 via the bedrock), and
- The model produces a CVOC plume that matches neither of the CVOC plumes observed at Sites 03 and 16.

While the Navy understands that the modeling was performed as a visual aid, the results are at variance with the principle transport pathway suggested previously by the EPA (i.e., contaminant transport in bedrock with upwelling to the overburden units); the model output is also at variance with the Nike PR-58 Site plume outline presented in the October 2006 Navy map. The Navy does not agree with the final two statements concluded by EPA. First, the Navy does not believe that the model is sufficiently large enough in area, sufficiently complex, or sufficiently calibrated and validated to confirm the EPA hypothesis that there is a strong preferential pathway for groundwater flow along the southerly route proposed by the EPA. While the EPA may believe the model results supports the hypothesis that there is contaminant migration from the Nike Site along a path south of Davisville Road, the Navy believes this possibility is unlikely. In addition, the last EPA bullet uses the modeling results to suggest that a major slug of contamination may be "encroaching" on Site 16 from the west; this does not explain the plume that already exists at Site 16.

Concerns:

The Feasibility Study cannot be completed without a thorough assessment of this pathway. In addition to the general interpretation of the source of CVOC near Building 41, there is a major unknown relative to the large plume core to the west of Site 16.

Geoprobe® soil borings will not be adequate to address this pathway in the deep overburden (gravel stream bed) or fractured bedrock.

The pathway is likely to be relatively narrow and will require several deep and bedrock monitoring wells to identify. This should be supplemented by geophysical investigations and review of existing seismic survey data (reprocessing).

Navy Response: Please see the attached Navy plan for investigating the upgradient area of Site 16 in the vicinity of the intersection of Davisville and Thompson roads. Also, EPA has not provided any direct evidence that a large plume core exists west of Site 16. While the modeling effort performed by the EPA is appreciated, the utility of the modeling results is limited by the significant uncertainties described in the preceding narrative. Hence, the modeling results should not be used to infer that there is a slug of contaminated groundwater to the west of Building 41.

ENCLOSURE 4

NAVY RESPONSE TO EPA FEBRUARY 2007 MEMORANDUM
RE: MAJOR DATA GAP EXISTS AT WESTERN BOUNDARY OF SITE 16,
ADDITIONAL CONSIDERATIONS AND RECOMMENDATIONS

NAVY RESPONSES TO MEMORANDUM FROM W. BRANDON TO C. WILLIAMS

SUBJECT: MAJOR DATA GAP EXISTS AT WESTERN BOUNDARY OF SITE 16; ADDITIONAL CONSIDERATIONS AND RECOMMENDATIONS

In order to provide the Navy's position on the above referenced document, the Navy has inserted brief comments within key portions of the memorandum. The text of the memorandum is provided in italics to facilitate readability. The Navy appreciates the efforts expended by EPA and their consultants GF-CDW to provide technical rationale for their hypotheses regarding the connection between Site 16 and the Nike PR-58 Site. It should be noted that, per our BCT meeting of October 26, 2006 and the technical conference of February 14, 2007, the Navy has already agreed to further investigate the upgradient area of Site 16.

EPA Memorandum

From: W. Brandon, Hydrologist (US EPA)
To: C. Williams, RPM, (US EPA)
Cc: C. Leszkiewicz, (CDW Consultants)

Date: 2/13/07

Subject: Major Data Gap Exists at Western Boundary of Site 16; Additional Considerations and Recommendations

The Modflow simulation and supporting information recently prepared by C. Leszkiewicz is insightful and prompts a number of key questions. In further reviewing this information in conjunction with additional data provided by the Navy via email today, in additional to further discussions with geophysicists leads to a variety of follow-up comments which are listed below with the intention of facilitating future BCT discussions. At this time, a number of basic recommendations can also be made. Topics considered below include the following:

Uncertainties with respect to "Upgradient" areas to Site 16;

Geophysical Considerations;

MW-16-55D/R/R2;

Short- and Longer-term Recommendations

<u>Uncertainties with respect to "Upgradient" areas to Site 16</u>: CDW's modeled simulation and the Navy's plume representations included on "Figure 1_GWFlow_Plumes_CleanGWAreas_Staff_Guages.pdf" in effect represent alternative interpretations of a limited data set. The differences between the two point to some significant data gaps, and as such, indicate areas and data needs where additional efforts should be focused toward.

<u>Navy Response</u>: While the Navy agrees that certain areas of the Davisville Site have limited data available in order to render interpretations, the figure produced and provided by the Navy represents a compilation of a significant amount of available data (Nike PR-58, Site 01 to 04, and Site 16) for both potentiometric water levels and groundwater chemistry (total CVOCs in µg/l) in the deep overburden zone. It is not based on a limited data set. However, the modeling effort performed by GF-CDW is based on a limited data set because it only considers a subset of the potentiometric data for Site 03 (many additional Site 03 wells are present but data from these wells were not routinely collected, and only data for 2 wells are considered for Site 16). This limited dataset was used in the modeling to examine the

connection between three different Davisville sites (Nike PR-58, Site 03 and 16). Consequently, there are significant uncertainties attached to the referenced modeling results.

While the contours representing the gradient of the head field are similar in each, it is noteworthy that the CDW model suggests transport in more southeasterly direction beyond NIKE, with flow directions bending to the east up-gradient of site 16. The Navy's figure suggests a more easterly flow direction as inferred by the plume outline which has been contoured from contaminant concentrations measured at particular locations and clean wells. On the Navy figure, it is noteworthy that the plume outline –as drawn - appears to defy the ground water contours. For example, flow directions are shown as distinctly southeastward along the southern periphery of the well network (e.g., ME-4 to MW03-11R/S to MW03-10D to EA-111D/R to PGU Z3-07D, etc.), yet the centroid of mass in the plume is interpreted to be well to the north. The CDW simulation offers a significantly different finding, specifically, that the plume centroid may actually be ***beyond the periphery of the well network to the south****.*

Navy Response: As the Navy outlined at the October 26, 2006 comment review meeting for the Draft Site 16 QAPP, there are areas at Site 03 where the observed CVOC plume is somewhat discordant with the groundwater potentiometric contours. However, the Navy believes that the plume outline is very well defined by chemical data, and that the plume shape clearly indicates a west to east groundwater flow path with the flow veering northeast around Building 224. The Navy is not sure as to why the contours are discordant with the plume; perhaps there are local variations of overburden lithologies, bedrock surface elevation, and/or hydraulic conductivities that are causing the plume to migrate eastward. Presumably, the area-wide, synoptic water level survey to be conducted in spring 2007 will improve the level of detail and understanding in the potentiometric surface maps.

Regarding the CDW model results, it appears that the model was constructed to show that a southerly migration path was possible; however, the Navy does not believe that this modeling effort shows that such a scenario is probable. The Navy speculates that the recharge areas, hydraulic conductivity zonation, and boundary conditions on the eastern side of the model were set to force the plume along the southerly path. Even though the water levels predicted by the CDW model appear to be in good agreement with measured groundwater elevations, the Navy believes that they are not adequately representing flow on the southern side of the modeled area. Based on groundwater elevations measured in wells EA-111D, PGU-Z3-11D, and PGU-Z3-11D, the 18-foot and 19-foot contours presented on the Navy map are oriented northeast-southwest, and indicate that groundwater flow is heading straight toward the ponds (a probable groundwater discharge area). However, the model-predicted contours are oriented north-south in this area. The model was appears to have been constructed with a no-flow boundary that prevents flow into the ponds, which contradicts the Navy belief that groundwater discharge to the ponds does occur to some extent. Perhaps the biggest limitations in the CDW transport model are that:

(1) no mass is left behind in the source area,
(2) the contaminant plume migrating from MW03-14D toward Building 224 is not simulated,
(3) the model-predicted contaminant plume has migrated to Building 41 area, but only relatively low concentrations (i.e., the model does not simulate observed Building 41 plume concentrations even after 50 years of migration, which is about the maximum elapsed time since the Nike PR-58 Site was operated by the USACE).

In both cases, travel times are not well constrained and time-series data are lacking. For example many of the older wells shown on the Navy figure (e.g., PGU-Z3-07D, MW-Z4-01, etc.) have not been sampled in many years. The situation is compounded by the large distances between wells in this area. For example, the presence of a one –time "clean" well in an area with so few wells may be diminished significance if the dimensions of the plume and travel times are not known. Clearly additional hydraulic and geochemical control is needed in the large area between the NIKE site and upgradient areas to site 16. It would appear that such data is most acutely lacking in the areas south of Davisville road where monitoring is extremely limited or non-existent presently. The fact that the two interpretations suggest a difference on the order of 1000 feet in regards to the north to south position of the plume centroid (e.g., PGU-Z3-11D vs. MW-03-07D), clearly indicates that a series of additional explorations will be needed.

<u>Navy Response</u>: A synoptic water level survey covering the Nike PR-58 Site, Site 03, and Site 16 is to be jointly conducted in spring 2007 by the Navy and USACE. This survey should provide ample data to prepare an updated site-wide potentiometric surface map. In addition, all of the wells located north of Davisville Road and west of Site 16 are scheduled to be sampled by the USACE this spring. Therefore, there should be a significant amount of new chemical data generated in the near future (Spring 2007).

For discussion purposes, it is suggested that at least two transects, roughly oriented N-S will be needed to address this data gap. Well spacing should be on the order of 100 feet at most. One transect should be located in the areas just up-gradient of site 16, e.g., in the vicinity of the intersection of Davisville and Thompson roads, and another one should consider a more up-gradient locations, such as the area between PGU-Z3-11D and MW-03-07D. Even without considering the complexities of a bedrock flow component, the foregoing comparison suggests the possibility that the characterizations to date have missed a key flow pathway. It may be possible to use direct push methods to affect a high density characterization of the overburden units in the aforementioned areas. However, given the strong likelihood of bedrock involvement, additional approaches will be needed. In particular, EPA continues to favor an approach based on bedrock drilling targeted to anomalies determined from geophysical methods. This issue is discussed further below.

<u>Navy Response</u>: The Navy has agreed to collect more data in the upgradient area of Site 16 in the vicinity of the intersection of Davisville and Thompson roads. Please see the attached Navy plan for investigations in the upgradient area. With regard specifically to the Site 16 investigation, the Navy does not believe that investigation of further upgradient locations which are clearly located outside of the Site 16 area (but believed by EPA to be downgradient of the Nike PR-58 Site) is warranted for the Site 16 remedial investigation. The objective of the Navy plan for the Site 16 investigation is specifically the characterization of groundwater conditions flowing onto the Site 16 area; not the investigation of areas downgradient of the Nike PR-58 Site. However, the bigger-picture issue of the migration of potential Nike PR-58 Site contamination onto Navy property is worthy of additional discussions between the EPA, RIDEM, the Navy, and the USACE.

<u>Geophysical Considerations</u>; Potential surface geophysical applications were discussed during a BCT conference call on Jan. 27, 2007, particularly in regards for their potential to identify lateral variations in the bedrock potentially indicative of fracture zones. Building on these discussions, after consulting with additional geophysical experts, a number of options are still open for consideration. As with any geophysical survey, a variety of methods will provide the most robust data set, so the possibility of more than one method should be considered.

> ***2-D resitivity profiling**: While it was agreed previously that 2-D resitivity profiling will be difficult at the site, further discussions have corroborated the fact that this method may be useful if alignments are directed so as to intersect buried utilities, fences, etc. at steep angles, while avoiding paralleling such features for significant lengths. For example, 2-D resitivity transects could be run northeast and southwest from the intersection of Davisville and Thompson roads in a manner which minimizes noise from buried utilities. To the west, additional N-S alignments generally normal to Davisville road are possible.*
>
> ***Seismic refraction tomography**: This method may prove to be useful for identifying lateral variations in the bedrock potentially indicative of fracture zones. It may be possible to reprocess previously collected refraction data with additional software. This should be looked into as a first step. Additional new seismic refraction tomography alignments can also be considered, particularly in N-S orientations upgradient to site 16.*
>
> ***Shear wave seismic methods**: These emerging methods may have some advantages at site 16 due to the method's lack of impairment from vehicle noise, etc. However, depth to bedrock may be too great at this site. A 2-3 day pilot test could be attempted to determine the methods suitability for the site. This method is likely beyond the capability of most geophysical service companies, and as such USGS or another intra-governmental group would likely need to be involved.*

Navy Response: Please see the attached Navy plan regarding the collection of more data in the upgradient area of Site 16 in the vicinity of the intersection of Davisville and Thompson roads. The Navy agrees that multiple geophysical methods can complement one another. Several seismic refraction lines have already been completed near Thompson Road, Davisville Road, and Building 39. The Navy is currently planning to have the data reevaluated (using SeisOpt software) in order to generate seismic refraction tomography profiles for the area. These geophysical profiles will be complemented with new DPT borings and permanent monitoring wells.

MW-16-55D/R/R2; A review of the logs provided points out the fact that the inability of the Navy to duplicate the high FID/Filter result at the 46 to 48 foot interval during the drilling of MW-16-55R2 is anything but conclusive. Note that the original FID hit was encountered during the early part of program, i.e., during the drilling of MW-16-55D, the first of three wells to be installed in the same area over a several week period. Drilling commenced on 9/19/02 and ceased on 10/10/02. After the original PID hit was encountered, the drive and wash method was used for many days. Since the static water level in the area was reported at around 28 feet bgs, significant water would have been input into the casing over many days in order to 'wash' the drill cuttings to advance the hole. The lack of significant PID hits during the MW-16-55R2 "redrill" may simply reflect the lingering (dilution) effects of the added water.

Navy Response: The Navy is planning to advance a DPT borehole down to approximately 52 feet (i.e., the intermediate zone). Soil samples will be collected from several locations between 0 and 52 feet bgs, including 46-48 ft bgs or any other intervals that display positive PID readings. These soil samples will be screened for CVOCs using Color-Tec method and at least two of the soil samples will be sent to a fixed-base laboratory (FBL) for VOC analysis. In addition, a temporary well will be installed in this interval and a groundwater sample will be collected and analyzed for VOCs at the FBL. Once all of the data have been presented to the BCT, decisions will be made as to what, if any, additional actions are warranted. A separate attachment outlines the Navy's planned scope of investigation in the "up-gradient area", which includes the MW16-55 well cluster.

Short- and Longer-term Recommendations; In addition to the suggestions made above, it is clear that a number of actions should be taken in the near-term. A large number of existing wells which have not been sampled recently should be sampled and placed on a regular sampling timetable. These wells include the following: Z3-11D, Z4-04, PGU-Z3-07D, PGU-Z3-10D, etc. The condition/integrity of Z4-01 should be evaluated and re-installed if needed. A well screen is needed in the MW-03-55D area (~ 46-48 ft. bgs) as per previous EPA comments. In the longer term, transducers should be deployed in key well pairs in order to clarify vertical gradients and temporal variability of vertical gradients.

Navy Response: The Navy plans to locate and evaluate the integrity of the following wells and piezometers that are west or northwest of Site 16: MW-Z4-01, MW-Z4-02, PGU-Z3-07D, PGU-Z3-08D, PGU-Z3-10D, PGU-Z3-11D, PGU-Z4-02D, RMW-01D, and RMW-02D. If these wells and piezometers still exist and their integrity is deemed adequate, they will be sampled by the Navy or the USACE in 2007. Additional investigative work planned for the "up-gradient area" is contained in a separate attachment. A new monitoring well will be installed in the intermediate zone at the MW16-55 cluster location, if the proposed soil or groundwater samples indicate the presence of CVOCs and the BCT agrees that such a well is necessary.

ENCLOSURE 5

NAVY RESPONSE TO EPA EMAIL DATED 14 FEBRUARY 2007
REGARDING THE GROUNDWATER MODEL

NAVY RESPONSE TO EMAIL RECEIVED WED 2/14/2007 AT 9:13 AM FROM CHRISTINE WILLIAMS

In order to provide comments on the Navy's position on the above referenced document, the Navy has inserted brief comments within key portions of the text. The text of the email message is provided in italics to ease readability. In general, the Navy is confused why EPA would chose to construct a model that uses only a small subset of the monitoring wells and data available for the Nike PR-58 Site, Site 03, and Site 16. The EPA repeatedly has requested that the Navy develop a site-wide conceptual model to assist in understanding and evaluating the potential connection between Site 16 and the Nike PR-58 Site. The model does not simulate the solvent plumes that have been actually mapped at the Nike PR-58 Site, Site 03, and Site 16. Instead, the model predicts a plume for which there is no chemical data that supports it.

Sent: Wed 2/14/2007 9:13 AM

Curt: please forward to those folks from your shop who will be on the call. We took the time to put together a discussion outline of our concerns (in memos from both Conrad and Bill) and a back of the envelope model of contaminants from the NIKE site along overburden flow paths. I cut the following from a couple of e-mails from Conrad concerning the attached model.

While it is not a full blown modeling effort (only took a couple of days) I believe that it does represent the site groundwater flow and potential contaminant transport pathways, at least to illustrate our concerns. This model is not intended to be the final "say so" in terms of how modelers might view what is the appropriate level of modeling i.e. a six month mega dollar effort. Nonetheless, the model is calibrated pretty well to the existing piezometric head data for the deep overburden using the Navy data and with a permeable overburden/bedrock zone along Davisville Road input by myself (the only way to get the groundwater inflections).

Navy Response: The Navy understands that the model as presented is a tool that can be used to portray and to evaluate potential flow and transport scenarios for the site. However, the Navy believes that too many hypothetical conditions have been imposed on the model (e.g., variations in recharge rates, spatial variations in hydraulic conductivity values, no-flow boundary which prevents flow to the ponds, etc.) and not enough real data have been included in the model (i.e., actual chemical data available for the Sites in question). For such a model to be useful, it would need to simulate the actual solvent plume moving across from Nike Site eastward across Site 03 and the actual solvent plume moving from Building 41 to Allen Harbor, in addition to a proposed plume moving south of Davisville Road. Does the EPA believe that all three plumes coexist and are ultimately from the same source?

I [Conrad] used three layers of uniform properties within each layer, without bedrock surface undulations, etc. I used constant head boundaries down gradient and recharge up gradient. There is not enough data in the area to the west of Site 16 to develop a rigorous model at this point. However, I do believe that is a useful tool to visually make the point. The plume depicted is the result of a slug release and the actual position and concentrations may be somewhat different depending upon actual mass released (I assumed one 50 foot cell), time of release, local hydraulic conductivity and effective porosity values, etc. due to stratigraphic heterogeneities.

Navy Response: While the Navy understands the necessity for the simplified model construction, the Navy cannot comment whether the input data are appropriate or not because the input data was not provided for review. The Navy agrees that the only useful aspect of the modeling is for visualization, but is not convinced that the results are a probable scenario. The predicted plume does not correspond to any observed contaminant concentration data available.

The purpose of this simplified model is not to provide all of the answers, but simply to underscore our concerns for releases from Nike PR-58 into the Site 16 area. It is noted that the releases input were only from a 50 by 50 foot cell directly at MW03-14. The actual extent of the past release can be outside these

areas. The Nike pilot showed contamination over a larger area of 100 by 150 feet.

Navy Response: While the Navy appreciates the effort expended and can now visualize the EPA's concerns, the Navy is not convinced that this model is representative of site conditions. No conclusions concerning contaminant migration between Nike Site PR-58 and Site 16 can be drawn from this model.

There are likely variations in actual flow paths due to lenses, variations in conductivity, intermittent minor changes in groundwater flow direction, seasonal changes in gradient, etc. (As such, some CVOC at MW03-08 and MW03-12, for instance could also be from Nike.) Also, because of these variability's, groundwater and CVOC may move more slowly, or more quickly than depicted with this model. (The model uses only general values obtained from the Navy data set).

This model also does not include downward migration into the bedrock, per se, or evaluation of the tendency of CVOC to sink such that in addition to the limited spatial groundwater monitoring network, overburden groundwater contaminated CVOC can move vertically downward (and then upward at Site 16) such that the few deep wells present may not detect CVOC or at concentrations that are actually present. In addition, the few bedrock wells have a low probability of intercepting the highest CVOC, etc.

Navy Response: The fact that this simplified model does not include the EPA's primary pathway of migration from the Nike PR-58 Site to Site 16 (i.e., through the bedrock) underscores the limitations in this modeling effort (beyond the other issues stated in previous responses). In fact, contaminant transport appears to be dominated in the deep overburden, a zone that EPA contends may or may not have contamination present during transport from the Nike PR-58 Site to Site 16.

Nonetheless, while the model is limited, both due to the available data and the simplifications of the model, it does point to likely impacts at Site 16 from Nike.

Navy Response: While the Navy believes that this conclusion is unfounded, the Navy has already committed to characterizing the upgradient portions of Site 16 in order to support the RI/FS. Therefore, this modeling effort was appreciated but unnecessary from the perspective of convincing the Navy to perform an investigation.

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ENCLOSURE 6

NAVY PLAN FOR INVESTIGATIONS IN THE SITE 16 UPGRADIENT AREA

NAVY PLAN FOR INVESTIGATING HYDROGEOLOGIC CONDITIONS UPGRADIENT (WEST) OF BUILDINGS 39 AND 41
SITE 16 – FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Prepared by the Navy, March 23, 2007

1. The existing geophysical data collected in 2002 (seismic lines 2-22, 2-23, 2-24, 2-25, and D) will be re-evaluated and re-processed electronically with newer software (SeisOPT), which will yield the equivalent of seismic refraction tomography data. Synoptic water levels will be collected at selected Site 16 wells in conjunction with USACE (April 2007). New "rough draft" potentiometric surface maps will be prepared based on data collected in April 2007. The results of the re-processed geophysics data and new potentiometric surface maps will be presented to the BCT. Discussions will be held regarding the new information and the selection of locations for DPT borings along Thompson Road (a maximum of five locations will be selected).

2. During Stage 2, Shift 1 of the Phase III field investigation for Site 16, DPT holes (down to bedrock or as deep as possible) will be advanced at the five selected locations along Thompson Road; one DPT boring will also be advanced to the intermediate zone at MW16-55. A temporary PVC monitoring well will be installed in each DPT boring. Soil and groundwater samples will be collected for Color-Tek analysis and fixed-base lab (FBL) analyses (quick-turn; a maximum of two samples per boring). These samples would be part of the Navy's "Pilot Study" for Color-Tek. (These temporary wells may also be used for water level monitoring or re-sampling at a later date, if necessary).

3. "Rough draft" geologic cross-sections, boring logs, field data (PID, Color-Tek), and FBL data will be presented to the BCT. Decisions will be made regarding the placement of three new permanent bedrock monitoring wells in the Thompson Road area.

4. A hollow-stem auger (HSA) rig will be used to install the bedrock monitoring wells at the three locations selected by the BCT. Split-spoon soil samples of the upper overburden will not be collected/examined if the location was already cored by DPT. Split-spoon soil samples of the lower section of overburden will be collected/examined. The bedrock wells will then be completed by coring and reaming 25 to 30 feet into competent rock. Groundwater samples from the new bedrock wells will be analyzed for the presence of CVOCs.

5. All geological information gathered during well installation and raw (unvalidated) analytical results obtained from the FBL will be presented to the BCT as soon as available for discussions of what additional work (if any) is needed to characterize upgradient groundwater conditions at Site 16. (At that point in time, the Navy will have installed 6 new piezometers and three new permanent bedrock wells along Thompson Road.)

The Navy assumes that responses from BCT members will occur in a timely fashion (approximately 10 days after receiving data) to maintain the fieldwork schedule.

ENCLOSURE 7

RESPONSES TO EPA FOLLOW-UP COMMENTS ON NAVY RESPONSES TO EPA RISK AND FORENSICS-RELATED COMMENTS ORIGINALLY RECEIVED ON SEPTEMBER 20, 2006.

EPA FOLLOW-UP COMMENTS WERE RECEIVED FROM EPA IN CORRESPONDENCE DATED FEBRUARY 13, 2007

ENCLOSURE NO. 7
RESPONSES TO EPA FOLLOW-UP COMMENTS ON NAVY RESPONSES TO EPA AND FORENSICS RELATED COMMENTS ORIGINALLY RECEIVED FROM EPA ON SEPTEMBER 20, 2006
(EPA FOLLOW-UP COMMENTS RECEIVED FEBRUARY 13, 2007)
DRAFT PHASE III REMEDIAL INVESTIGATION QAPP FOR IR SITE 16
FORMER NCBC DAVISVILLE

EPA Follow-up Comment on Navy Response to EPA General Comment No. 3:

Please ensure that the Creosote Dip Tank Area and the Fire Fighting Training area are included in the definition of the "site" along with the groundwater contaminant plume, rather than just the extent of the groundwater contaminant plume.

Navy Response to EPA Follow-up Comment on Navy Response to EPA General Comment No. 3:

Agree.

EPA Follow-up Comment on Navy Response to EPA General Comment No. 10:

Concur, provided that subsurface and surface soils are evaluated separately for risk. For instance, risk should not be evaluated for 0-10 ft soil if 0-2 ft soil OR 2-10 ft soil has higher concentrations than 0-10 ft soil.

Navy Response to EPA Follow-up Comment on Navy Response to EPA General Comment No. 10:

Agree.

EPA Follow-up Comment on Navy Response to EPA General Comment No. 15:

It seems that neither the Allen Harbor SLERA nor the upcoming Site 16 soil SLERA will evaluate the wetland adjacent to the Allen Harbor Landfill on the north side of Allen Harbor. The lack of soil data from this wetland may represent a data gap.

Navy Response to EPA Follow-up Comment on Navy Response to EPA General Comment No. 15:

The referenced wetland area is not a part of the Site 16 area of investigation. However, the Navy recommends that the need for any additional soil sampling in the referenced area be discussed/considered during the update to the Long-Term Monitoring Plan for Allen Harbor Landfill anticipated to occur in the near future.

EPA Follow-up to Navy Response to EPA General Comment No. 20:

EPA does not believe that there is a source area in the MW16-55 area, only that contaminated groundwater may be moving past this location at this depth since there was an unusually high FID and FID with filter hit (200/500) noted in the log while drilling the MW16-55D boring. However, EPA welcomes the Navy's offer to take a groundwater sample at the corresponding depth.

Navy Response to EPA Follow-up to Navy Response to EPA General Comment No. 20:

Thank you for the clarification.

EPA Follow-up to Navy Response to EPA Specific Comment No. 40:

The issue whether recreation can occur on land designated "waterfront commercial" is a risk management and legal issue, rather than a risk assessment issue. The marina currently accepts recreational vessels and therefore supports recreational uses such as swimming off the docks or moored vessels. The buildings

currently support recreation and therefore are intrinsically recreational. Recreational risks must be addressed if they are allowed at the site now or in the future.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 40 :

For purposes of completeness, the baseline human health risk assessment ***of soils*** from all Site 16 areas will consider receptor risk assuming a recreational, commercial, or residential land use scenarios. The reviewer is correct that, ultimately, the allowable and designated use of any particular area is a risk management and legal issue (e.g., what does the deed allow??); such decisions are likely to be resolved independently of the actual preparation of the baseline human health risk assessment. Also, as stated in previous response-to-comment documents, the decision to conduct or not conduct a human health risk assessment of Allen Harbor seep-surface waters and sediments will be dependent upon the data collected during the Phase III field investigation, particularly the results and conclusions of the additional forensics studies planned for Site 16 (e.g., are the PAH concentrations observed Allen Harbor sediments related to Site 16 source areas?).

EPA Follow-up to Navy Response to EPA Specific Comment No. 58:

Please be advised that for low level analysis for vinyl chloride in water, the method may require no preservative be added to the sample collection vial, the sample cooled to below 4° C, and that analysis be done within 7 days. The Navy may only need to collect unpreserved groundwater or piezometer samples in the areas where there are known low levels of CVOC and a future indoor air risk scenario may need to be evaluated, such as near Bldg. E-107, in the nearshore, and in the “north central area” or on the western, southern, and eastern outer fringes. EPA believes unpreserved sample collection would not be necessary in areas above the highly contaminated groundwater or in areas where the CVOC has not degraded from parent to significant daughter products. It may be necessary to wait for the next round of groundwater sample results to identify the areas necessary for unpreserved sample collection.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 58:

Per the reviewer’s suggestion, the need for unpreserved sample collection will be deferred until after the Phase III RI groundwater data has been collected and evaluated. Specifically, the need will most likely be determined for post RI groundwater collection programs.

EPA Follow-up to Navy Response to EPA Specific Comment No. 66:

Since this comment, EPA has placed toxicity values for iron and aluminum on the Human Health Provisional Peer Reviewed Toxicity Value database (http://hhpprtv.ornl.gov). EPA will email the printout of these toxicity values separately. Please include iron and aluminum in the risk assessment if the concentrations exceed human health screening levels.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 66:

Agree. The promised information has been received. Thank you.

EPA Follow-up to Navy Response to EPA Specific Comment No. 67:

Since HHPPRTV values for aluminum and iron have been issued, please evaluate these chemicals for risk. Since there is no value for copper, please do not evaluate risk of copper.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 67:

Agree.

EPA Follow-up to Navy Response to EPA Specific Comment No. 71:

Concur, subject to confirmation in final document.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 71:

Agree.

EPA Follow-up to Navy Response to EPA Specific Comment No. 77:

Concur with 4-hour exposure time for construction worker in trench.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 77:

Agree.

EPA Follow-up to Navy Response to EPA Specific Comment No. 79:

EPA would like to achieve consistency among Region I Navy sites for exposure assumptions. EPA is currently waiting for a response to EPA's proposed 5 mg/cm^2 sediment adsorption factor for sediments at Naval Air Station South Weymouth. EPA would like to defer final selection of a sediment adsorption factor so that both sites will have the same factor for sediments. EPA will propose such factors as soon as possible.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 79:

As suggested, the Navy response is deferred until further information is received from the EPA.

EPA Follow-up to Navy Response to EPA Specific Comment No. 80:

EPA would like to achieve consistency among Region I Navy sites for exposure assumptions. EPA is currently waiting for a response to EPA's proposed Fraction Ingested value of 1 in response to Navy's proposal of FI = 0.5 at Naval Air Station South Weymouth. EPA would like to defer final selection of a FI value so that both sites will have the same factor. EPA will propose such factors as soon as possible.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment No. 80:

As suggested, the Navy response is deferred until further information is received from the EPA.

EPA Follow-up to Navy Response to EPA Specific Comment 84:

EPA would like to achieve consistency among Region I Navy sites for exposure assumptions. EPA is currently waiting for a response to EPA's proposed Fraction Ingested value = 1 in response to Navy's proposal of FI = 0.5 at Naval Air Station South Weymouth. EPA would like to defer final selection of a FI value so that both sites will have the same factor. EPA will propose such factors as soon as possible.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment 84:

As suggested, the Navy response is deferred until further information is received from the EPA.

EPA Follow-up to Navy Response to EPA Specific Comment 86:

Although EPA Region I is attempting to update Region I practice to reflect the most recent national guidance as new risk assessments are conducted, EPA Region I withdraws the original comment because use of 1.5 L/day would require cumbersome adjustments of toxicity values per Appendix 1A of EPA (1997). Please use 1 L/day.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment 86:

Agree.

EPA Follow-up to Navy Response to EPA Specific Comment 87:

Although EPA Region I is attempting to update Region I practice to reflect the most recent national guidance as new risk assessments are conducted, EPA Region I withdraws the original comment because use of 2.3 L/day would require cumbersome adjustments of toxicity values per Appendix 1A of EPA (1997). Please use 2 L/day.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment 87:

Agree.

EPA Follow-up to Navy Response to EPA Specific Comment 98:

The food and water ingestion rates in the revised Table C-2 have been better explained with the addition of Table C-3. The ingestion rates are acceptable except as noted below:

* For the northern bobwhite, the food ingestion rate has been multiplied by 0.15 to convert it to a wet-weight basis. It should be noted, however, that the study used to derive the bobwhite ingestion rate used dry commercial game food (5-10% moisture). As the ingestion rates are already based on dry food, there is no need to include the wet to dry-weight conversion. Please confirm the actual values in Koerth and Guthery (1991) and/or remove this factor.

* Please clarify Tables C-2 and C-3 for the invertivorous bird. Table C-2 lists the American Woodcock while Table C-3 and the Draft Table C-2 refers to the robin.

Navy Response to EPA Follow-up to Navy Response to EPA Specific Comment 98:

Section 1.4.2.1.1 (page 1-14) of the Wildlife Exposure Factors Handbook states that "Food ingestion rates are expressed in this Handbook as grams of food (wet weight) per gram of body weight (wet weight) per day (g/g-day)." Therefore, although study used to derive the bobwhite ingestion rate used dry commercial food, those values apparently were converted to a wet-weight in the Handbook. Therefore, they need the conversion factor to convert the values back to a dry weight basis. Please provide any additional information regarding the Koerth and Guthrey paper that indicates the values in the handbook were not converted to wet weight.

The values in Table C-2 for the American Woodcock are correct. Table C-3 will be revised to present the back-up calculations for the woodcock. The American robin will not be used for food chain modeling.

NOTE TO THE READER: Responses to the following forensics-related comments were submitted to the EPA per Navy correspondence dated March 9, 2007. Please see attachment to Enclosure No. 7.

EPA COMMENTS ON THE NAVY'S RESPONSES TO EPA FORENSIC COMMENTS

EPA General Comment 27: In this Comment, EPA has stated the rationale for questioning Navy's conclusions, particularly with regard to impacts from Site 16 creosote operations to near-shore sediments. The second paragraph of this Comment discusses the overall distribution of PAHs in Allen Harbor sediments and suggests that a more uniform distribution would be expected if the dock pilings were the primary contributor of PAHs to harbor sediments. The third paragraph addresses Navy's conclusions regarding the PAH distribution in the southeast corner of the harbor, which Navy attributes to runoff from non-Site 16-related vehicular traffic and storm drain discharge. EPA also noted that the extent, location, and direction of the storm drain is not known. Finally, the fourth paragraph recommends that Navy take additional actions, including:

- Collection of pore water samples via Henry samplers, to supplement the groundwater seep piezometer survey that Navy has already proposed;
- Collection of additional sediment samples, around the docks and shore line, for PAH analysis;
- Development of a more accurate understanding of the storm drain network, including catch basin locations, points of infiltration and discharge, water table depths, etc.

RTC GC 27: Navy's response to this comment states that EPA's conclusion regarding the distribution of PAHs is based on Figure 4-8 of the Phase II SLERA, which shows the predicted total PAH contours in the southern part of Allen Harbor. The Response goes on to state that EPA "…should reconsider the PAH gradients" in the harbor, suggesting that concentrations are higher around the dock pilings than in neighboring open-water areas. Navy's response cites three samples (AH-32, AH-33, and AH-45) in the vicinity of AH-29 and suggests that, because these are lower in EPAPAH concentrations than AH-29, there is a 'concentration gradient' indicating that the marina pilings are the source of PAHs in the sediment. The sample locations cited in this Response are indeed lower in PAH concentration than the implied "source area" (the southern dock), but Navy's argument is not well supported because:

- The number and distribution of samples is too sparse to develop a persuasive picture showing a concentration gradient in the vicinity of the southern dock;
- Two other samples taken immediately adjacent to the docks, AH-23 (EPAPAH = 11.9 mg/kg) and AH-17 (EPAPAH = 6.88 mg/kg), do not show particularly elevated PAH concentrations.

Navy's conclusion regarding the incomplete pathway from the source area to the sediments is not consistent with the plot provided by EPA showing a strong correlation between PAHs in site groundwater (03 28-GW-07S) and Seep 16-01).

Navy's Response concludes with a statement of intent to survey the storm drain system, including known inlets and outlets and any other relevant data. EPA endorses this task, as this information will be critical to an accurate assessment of the contribution that may be transported into the harbor sediments via this pathway.

In addition, the Response indicates that Navy will also conduct "Additional work…for further evaluating PAHs from the marina and storm sewer systems." When will this additional work be performed? What will this involve? Which media will be sampled, where, and how many locations/samples? What type(s) of analysis? Will Navy produce a Work Plan and if so, will all parties have a chance to discuss this? Please provide additional details regarding this additional work in response to this letter.

Comments on Appendix B, Final Report - Environmental Forensic Investigation, Site 16

EFI Comment 1: This comment asked for a more thorough discussion of the weathering of creosote and how various fate and transport processes might be expected to affect the PAH signatures at the source area as

well as in the harbor sediments. Navy's Response briefly explains that 2- and 3-ring PAHs are more susceptible to weathering (e.g., by volatilization, dissolution, biodegradation) and the 4- to 6-ring PAHs are more stable and thus relatively less mobile than the lighter PAHs. However, the response did not discuss how weathering affects individual PAH compounds that are observed in the Site 16 source and study areas, or attenuation during transport, both by overland surface flow (in solution and adsorbed onto particulates and/or colloids) and through groundwater discharging into the Harbor. For example, EPA specifically asked how weathering might have affected the observed anthracene/phenanthrene ratios (A0/P0) in Site 16 soils and harbor sediments. In light of the significance placed on these ratios as a key part of the fingerprint of source-area creosote (e.g., Sec. 4.3, p. 12), please address this question. Please consider the possibility that weathering of source-area soils by relatively low-pH meteoric infiltration, under aerobic conditions, and with a terrestrial microbial population, may yield an A0/P0 ratio in the harbor sediments (a saline and suboxic to anoxic environment, with different microbiota) that may not necessarily reflect the ratio observed at the source area. A more extensive discussion of differences between source-area and harbor sediment samples should also acknowledge that the A0/P0 ratios from source-area samples vary widely, from approximately 2 in the sample from Source 1-2 to 0.14 in soil from Source 2-1. Finally, analytical uncertainty should also be acknowledged, i.e. some duplicate analyses report values varying by as much as a factor of nearly 2. The magnitude of this uncertainty becomes more important for ratios of other constituents, such as benzo(b)fluoranthene/benzo(j,k)fluoranthene; fluoranthene/pyrene; and benzo(e)pyrene/benzo(a)pyrene; as these ratios are generally closer to unity than A0/P0.

EFI Comment 2: This comment requested clarification of the rationale for comparing study area sediments to samples from three reference areas that are "physically dissimilar" to Allen Harbor. The Response assumes that Allen Harbor traps the same suspended particulates and thus the same mix of PAHs as the Reference Areas. The Response states that "…relative abundances of hydrocarbons (e.g. the PAH source signature) is expected to be similar in Reference Area and Allen Harbor sediments" while absolute abundances vary due to localized factors. These factors include dilution due to a higher influx of sand, and increased concentration in areas with higher sedimentation rates. A third factor is "…land use (runoff from more urbanized areas will contain higher levels of PAHs relative to residential or undeveloped areas.)" Given that the contribution from localized runoff will have different proportions of the various PAHs dependent on the localized sources, how can this statement be reconciled with the previous sentence indicating that the PAH source signature should be similar in Reference Area and Allen Harbor sediments?

EPA believes the data presented are inconclusive to agree with the Response, that "[T]he PAH concentration gradients and source signatures both suggest that the marina and storm water runoff represent the most significant sources of PAHs in Allen Harbor." As stated in the discussion of the RTC GC 27, the data do not show a compelling gradient with the (southern) dock as a point source. Rather, a general overview of the distribution of PAHs in Allen Harbor sediments suggests that PAH concentrations in sediments collected in close proximity to the docks are not uniformly high, as might be expected if the docks are the source. Although sampling density is clearly higher at the southern end of the harbor, the number and distribution of forensic samples is not sufficient to demonstrate unequivocally that the docks are the source of PAHs in harbor sediments. The contribution from the storm water discharge point requires further investigation. If storm water runoff is a significant source of PAHs in Allen Harbor, a correlation with lead (Pb) might be expected. However, other than locations AH-50 (storm drain outfall) and AH-28 (southeastern shoreline), no correlation of PAHs with Pb is apparent.

As was discussed in the meeting on Friday additional source area forensic studies should be performed on the "new pavement" and "old pavement" to conclusively tie the pavement at the former NCBC site to the sediment in Allen Harbor.

EFI Comment 3: The Comment questioned the absence of 'weathered creosote' among the reference materials used in the Environmental Forensic study (i.e., those listed in Sec. 2.3). The Response states that samples from the location of the creosote dipping operations (Source 1-1 and 1-2) constitute "weathered creosote" and that no additional reference samples are necessary. Please see the preceding discussion and questions related to creosote weathering (EFI Comment 1); the intent of EFI Comment 3 was to assess the extent to which the reference materials included creosote samples, containing different formulations that had undergone weathering in both terrestrial and marine environments. If Navy feels that additional reference

materials are available in the literature cited in EFI Comment 1 and the Response, those data should be incorporated into the forensic report.

In addition to samples of "weathered creosote" from Source Area 1, please consider taking samples of the pilings at locations corresponding to sediment samples, to demonstrate effects of creosote weathering in the marine environment and also any effects that may be attributed to transport processes in harbor sediments.

EFI Comment 4 and Response address the need for further exploration and delineation of the stormwater outfall pipe. *[The Response to Comment 4 states that the impact of the seeps to the Allen Harbor sediments appears minimal. The plot EPA provided to the Navy in the previous response to comment document showing the strong correlation between individual PAHs in groundwater from 03 28-GW-07S and Seep 16-01 appears to contradict this. This issue was discussed at the December 8th meeting and EPA is satisfied that the Navy will be doing additional investigation to delineate the source of Seep 01.]*

EFI Comment 5: EPA believes that the data are inconclusive with respect to Navy's assertion that PAH concentrations in Allen Harbor are homogeneous. Navy's Response repeats text from RTC GC 27 and EFI Comment 2 stating that the dock pilings and storm water are the "most likely" sources of PAHs in Allen Harbor. Please see (above) discussion of those responses.

[The Response asserts that "EPA incorrectly associated AH-35 with the Seep 16-01" and that this sample location is next to a marina piling. In the "Comments" column in Table 2-3, location AH-35 is characterized as "gradation from seep" even though it is located near a piling.]

EFI Comment 6. The Response is satisfactory.

EFI Comment 7 In this Comment, EPA questioned Navy's statement (p.10, Sec. 4.4, 2nd bullet) regarding the significance of anthracene enrichment. From the Response, it is clear that Navy had intended this term to mean 'enrichment of anthracene *relative to phenanthrene*' as an indicator of chemical refining. EPA appreciates the clarification and continued discussion during the December 8th meeting. As noted in the discussion of the RTC Comment 1, the ratio of anthracene to phenanthrene (A0/P0) in Source Area 1 soil is relatively high (1.46 and 1.97 in Source 1-1 and 1-2, respectively). However, in the remaining source areas, the A0/P0 ratio varies from 0.14 (Source 2-1) to 0.28 (Source 3-2). The accompanying plot shows the distribution of A0/P0 in Allen Harbor sediments. Samples with the lowest A0/P0 (from 0.18 to approximately 0.3, consistent with Source Areas 2, 3, and 4) are located along the southern shoreline and A0/P0 increases to the north, with the exception of the sample adjacent to the pilings at AH-29 (A0/P0 = 0.51).

Recommendations - NCBC Davisville Site 16

1. *Collect additional soil samples from the Site.* The three pairs of samples (from Source Areas 1, 2, and 3) are not sufficient for adequate characterization of the variability of the various PAHs known to be present. Samples should be collected from surface and subsurface soils, and target areas should include the southern part of the site (near the intersection of Westcott and Davisville Roads) as well as the rest of the area within the "extended boundary of potential historical creosote dipping operations."

2. *Collect "new pavement" and "old pavement" source samples.* As was discussed in the December 8th meeting, forensic analysis should be performed on the pavement suspected to be the source for the storm water sediment.

3. *Groundwater sampling.* MW 16-07S, Source Area 2, this well and others downgradient should be sampled and forensic analysis performed to determine if the same material collected in the soils has partitioned into the groundwater, since conventional sampling and analysis had not been conclusive.

4. *Demonstrate variability (if present) in marine-piling creosote and collect additional samples if necessary.* For example, the report and the PowerPoint presentation focus on the sample collected at location AH-29, next to the southern dock, as an example of a 'point source.' Samples were also

taken next to pilings at AH-17 (for quantitative, forensic, and screening analyses) and at AH-23 and AH-35 (quantitative and screening). If these samples show different fingerprints from AH-29, additional samples may be required for adequate characterization of creosote attributed to the marina structures. It is recommended that samples of the pilings be analyzed to determine if these sources are the same as the sediments next to the pilings. While the Navy stated it was not their job to determine the sources of the PAHs in the sediments, analyzing the creosote flaking off the pilings would go a long way in explanation to the public for lack of sediment cleanup and reduce the uncertainty of the current data set.

5. *Develop a flow chart or other schematic that summarizes the forensic evaluation process for the non-specialist*. We acknowledge that this is a highly complex process and that Navy has taken great care both in their execution of the forensic analysis and in their documentation of the results. It would be helpful for those who are not specialists in this field, including the general public, to see the key steps in the evaluation process in summary form, e.g. as a 'bulletized list' or some other abbreviated format. This list would include the principal elements that are used in the forensic process – for example, the ratios of anthracene to phenanthrene, benzo(b)fluoranthene to benzo(j,k)fluoranthene, and benzo(e)pyrene to benzo(a)pyrene; key peaks used in the hydrocarbon fingerprinting; etc. A table showing how the sediment samples do or do not conform to the diagnostics (e.g., if a ratio is used, report the value and the associated uncertainty; if specific chromatogram peaks are diagnostic, indicate presence or absence; etc.) would render the forensic evaluation process more accessible to non-chemists. A more succinct presentation would make it easier for the layman to see how the data do or do not support the Navy's conclusions. Such a chart included in a Proposed Plan for the site may create both an understanding and acceptance of the Navy's position.

ATTACHMENT TO ENCLOSURE 7

NAVY RESPONSES TO EPA COMMENTS DATED DECEMBER 14, 2006
FORENSIC-RELATED ISSUES CONCERNING ALLEN HARBOR MARINA AND IR SITE 16
RESPONSES ORIGINALLY SUBMITTED BY NAVY ON MARCH 9, 2007

DEPARTMENT OF THE NAVY
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE, NORTHEAST
4911 SOUTH BROAD STREET
PHILADELPHIA, PA 19112-1303

5090
Code BPMO NE/DB
Ser 07-049
March 9, 2007

Ms. Christine Williams
U.S. Environmental Protection Agency, Region I
1 Congress Street Suite 1100 (HBT)
Boston, MA 02114-2023

SUBJECT: RESPONSES TO FORENSICS STUDY COMMENTS FROM EPA REGION I CORRESPONDENCE DATED DECEMBER 14, 2007, DRAFT PHASE III QUALITY ASSURANCE PROJECT PLAN FOR INSTALLATION RESTORATION (IR) PROGRAM SITE 16 FORMER NAVAL CONSTRUCTION BATTALION CENTER (NCBC) DAVISVILLE, RI

Dear Ms. Williams:

The Navy's responses to the forensics study comments provided by U.S. EPA Region I in correspondence dated December 14, 2007 are enclosed. Four copies of the response-to-comments (RTC) document are forwarded to U.S. EPA Region I, and one copy of the RTC document is forwarded to RIDEM. As indicated recently, the Navy is proposing to collect additional forensics investigation samples in the Site 16 area to further evaluate the potential contribution of Site 16 source areas to the polycyclic aromatic hydrocarbon (PAH) contamination in the Allen Harbor sediments. The details of the additional forensics evaluations will be incorporated into the next version of the Phase III Quality Assurance Project Plan (QAPP) for Site 16.

If you have any questions, please do not hesitate to contact the Remedial Project Manager, Mr. Curt Frye, at 215-897-4914.

Sincerely,

David Barney
BRAC Environmental Coordinator
By direction of BRAC PMO

Enclosures:

1. Response to EPA Comments Dated 14 December 2006, Forensics Related Issues Concerning Allen Harbor Marina and IR Site 16, Former NCBC Davisville, North Kingstown, Rhode Island

Copy to:

Mr. Curt Frye, NAVFAC Midlant (1 copy)
Mr. Brian Balukonis, RIDEM (1 copy)
Mr. Rich Gottlieb, RIDEM (1 copy)
Dr. Ken Finkelstein, NOAA (1 copy)
Ms. Kathleen Campbell, CDW (2 copies)
Mr. Christopher Modisette, RI RCD (1 copy)
Mr. Steven King, Quonset Development Corporation (1 copy)
Mr. Jon Reiner, Town of North Kingston (1 copy)
Ms. Lee Ann Sinagoga, TtNUS Pittsburgh (1 copy)
Mr. Steve Vetere, TtNUS Boston (1 copy)
Ms. Maryellen Iorio, USACE (1 copy)

RESPONSE TO EPA COMMENTS DATED 14 DECEMBER 2006
FORENSIC RELATED ISSUES CONCERNING ALLEN HARBOR MARINA AND IR SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

BACKGROUND

The Navy held a meeting with EPA and RIDEM on 08 December 2006 at the QDC office in North Kingstown, RI to discuss forensic issues related to the Allen Harbor Marine sediments and IR Site 16. As part of the Screening Level Ecological Risk Assessment (SLERA), which was published by the Navy in 2004, the Navy performed a forensics investigation of the Allen Harbor sediments. Based on this investigation, the Navy concluded that the PAHs detected in the sediments were not likely site related. To date, EPA and RIDEM have not concurred with the Navy's position.

The purpose of the meeting on 08 December 2006 was for the Navy to further explain and support its position to the regulators, enabling a path towards consensus. Following the meeting, EPA submitted comments by letter dated 14 December 2006 and identified aspects of the investigation that it believed would improve the conclusive nature of the study. EPA's comments and Navy's responses are summarized below. Please note that the below EPA comments are not verbatim – rather, they are a summary of each EPA comment, created by the Navy, in order to make the comments and responses more readable and to focus on what the Navy perceived to be the main issues presented by the EPA comment. For the full text of EPA comments, please refer to the EPA's letter of 14 December 2006. Additionally, the comments have been numbered by the Navy to allow a more orderly sequence of comment/response.

EPA General Comment 27a:

EPA believes that the PAH concentration in Allen Harbor should be more uniform if contributions from the dock pilings were the primary PAH source.

Navy response to EPA General Comment 27a:

The PAH concentrations in Allen Harbor are consistent with contributions from three candidate sources that are not associated with Site 16. First, the deposition of fine particulates from Narragansett Bay is expected to begin near the narrow inlet of Allen Harbor and increase with distance away from the Narragansett Bay towards the inner reach of Allen Harbor. The deposition of fines is expected to be lower near the inlet of Allen Harbor and greater in the Inner Harbor as a result of hydrodynamic processes. The settling of fine particulates in Allen Harbor is significant for this study, because the fines contain higher proportions of PAHs than larger particles. The preferential deposition of fines in the Inner Harbor verses the Outer Harbor should create subtle PAH gradients throughout Allen Harbor based on background conditions alone (Forensic Report Figure 9). Consequently, a range of PAH concentrations that are generally lower near the inlet of the Narragansett Bay and higher in the Inner Harbor is consistent with the conceptual site model presented in the SLERA.

Second, localized areas of higher PAH concentrations are expected around marina docks constructed from creosote treated wood (Forensic Report Figure 9). Creosote is a tar product that is often refined based on standards developed by the wood treating industry. Like the creosote leaching studies identified by EPA, creosote leachate and abraded solids from these structures will migrate into the surrounding environment. Due to the high levels of PAHs in creosote, even small amounts of this material can cause elevated PAH concentrations in sediment samples. The complex and variable nature of this migration may not be consistent at every piling location. Furthermore, the composition of each piling is not necessarily identical as these structures have been built and replaced at varying times. For this reason, localized areas of elevated PAHs associated with creosote are expected to be heterogeneous in concentration and composition.

Third, localized areas of higher PAH concentrations are expected near storm sewer outfalls (SLERA Appendix B Figure 9). The storm sewers collect abraded pavement, roadway sealer, vehicular soot, vehicular fuels,

motor oil drippings, and other materials that are known to contain a wide variety of hydrocarbons and PAHs. The variable rates of roadway abrasion, storm water events, and seasonal changes in roadway use (e.g., heavy vehicular traffic in boating season and sanding in winter) will likely introduce variability in the concentration and composition of hydrocarbons conveyed to the Allen Harbor sediments by the storm sewer system. Therefore, some degree of chemical difference is expected between samples collected in the storm sewers and the Allen Harbor sediments. If we assume a normal sedimentation rate of 1 to 4 cm/yr in Allen Harbor, samples collected from sediments several inches thick will contain material deposited over many seasons, if not years. Therefore, sediments near the outfall represent time averaged contributions from the storm sewer and sediments collected within the storm sewer are snapshots of the material flowing through the storm sewer at one specific time. The PAH concentration and compositions are not expected to match perfectly. Rather, they are used together to demonstrate the contribution and variability of roadway materials accumulating in Allen Harbor sediments. Collectively, these samples establish that the storm sewers convey hydrocarbons and PAHs to Allen Harbor sediments. These hydrocarbons mix with and are buried by ambient sediments over time. Additional variability is introduced through this mixing process.

In summary, the PAH concentration gradients are not expected to be perfectly uniform in Allen Harbor. The variation in the settling rate of fine particles supplemented with localized influences of marina structures and roadway runoff sufficiently explain the observed range of PAHs (2 to 28 mg/kg of EPAPAHs) in Allen Harbor. The spatial distribution of the past samples is adequate for associating elevated levels of PAHs with marina structures and storm sewer outfalls. The contribution of PAHs from Site 16 was not evident in the form of a PAH concentration gradient and the lack of compositional similarity among Source Area soil and Allen Harbor sediment samples.

EPA General Comment 27b:

EPA believes that the PAH contributions from the storm drain in the southeast corner of Allen Harbor may include runoff contributions from Site 16. The data presented in the SLERA do not define the areas that are drained by the storm sewer system, some of which might include Site 16.

Navy response to EPA General Comment 27b:

The forensic analysis demonstrates that the hydrocarbons in the Site 16 samples associated with the creosote dip tank operation (Source Areas 1 and 2) and fire fighter training area (Source Area 3) were different than the sediment collected from the storm sewer (Source Area 4) and southeast out fall area in Allen Harbor (AH-49). The distinct source signatures of samples from the creosote and fire fighter training areas were not observed in the storm sewer and Allen Harbor samples; therefore, the difference in compositional features demonstrates that Site 16 was not a significant source of PAHs in Allen Harbor.

In addition, the hydrocarbons from a second roadway runoff area (AH-28) exhibited elevated PAHs (compare 25 mg/kg EPAPAHs in AH-28 with 28 mg/kg EPAPAHs in AH-49). Importantly, the sediment in this outfall area possessed no potential influence from Site 16. In other words, elevated PAHs and hydrocarbons were evident in two areas along Allens Harbor Road regardless of potential influence from Site 16. Therefore, the dominant source of PAHs in Allen Harbor is primarily attributed to the surrounding roads and local land use.

In summary, the likelihood that Site 16 significantly increased PAHs in the surface sediments of the southeast corner of Allen Harbor was unlikely based on two lines of evidence: 1) the compositional differences between the creosote and fire fighter training areas verses Allen Harbor sediments and 2) the similar composition of sediments collected from multiple Allen Harbor sediment locations that received roadway runoff.

Despite these arguments in favor of the conceptual site model presented in the SLERA, Navy will investigate and map the storm sewer system as part of its planned activities in 2007. The details of this supplemental investigation will be included in a work plan under separate cover.

EPA General Comment 27c:

EPA believes that the PAH gradients demonstrated in the SLERA report are too sparse to develop a persuasive picture of the gradient near the southern dock.

Navy response to EPA General Comment 27c:

The sampling intensity was adequate for developing a site model, risk assessment, and forensic analysis of Allen Harbor. In total, more than 20 sediment samples were collected for the SLERA in the Inner Harbor alone. These samples were located with an emphasis on demonstrating the presence of significant concentration gradients radiating from the Seep Areas, Site 16 shoreline, and storm water outfalls. Navy specifically adopted EPA recommendations concerning the collection of two additional non-random samples along transects from the Seep and Storm Sewers when drafting the SLERA work plan (Navy 2003, RTC-EPA Comment 2). Furthermore, EPA stated that, "The random sampling of sediments provides generally good coverage of the three sections in the harbor." (Navy 2003, RTC-EPA Comment 11). Navy perceives a significant incongruity in the decision by EPA to render a criticism at this time about inadequate sampling resolution when the data generated fail to implicate the Site 16 with PAH contributions to Allen Harbor. The data were generated as part of a well reasoned and reviewed work plan. The past data require no additional work.

Despite the adequacy of the previous SLERA investigation, Navy will collect a limited number of additional sediment samples between the Site 16 shoreline and the southern dock to further demonstrate variability in these transects. This work will be included as part of Navy's planned activities in 2007. The details will be included in a work plan under separate cover.

EPA General Comment 27d:

EPA is troubled by the inconsistency of elevated PAHs next to selected dock structures. It questions why some samples collected near marina structures would have elevated PAHs (AH-29 EPAPAH = 24 mg/kg and AH-35 EPAPAH = 22 mg/kg) while others are not particularly elevated (AH-17 EPAPAH = 6.88 mg/kg and AH-23 EPAPAH = 11.9 mg/kg).

Navy response to EPA General Comment 27d:

Some variability in the concentration and composition of sediments around the marina pilings is expected for several reasons. First, the observed PAH concentrations in sediments around the marina pilings require a very large dilution. Recognizing that creosote can contain upwards of 100,000 mg/kg of EPAPAHs, the dilution factor necessary to reach the observed PAH concentrations in Allen Harbor sediments would be three to four orders of magnitude. In other words, the elevated concentrations of PAHs observed near the marina pilings likely reflect the presence of very small fragments of marina pilings mixed at a ratio greater than 1:1000 with ambient sediment. The presence of two or three small fragments in the same mixture will account for the range of concentrations observed around the marina structures.

Second, the pilings are not likely preserved with the same material. The variable nature of the treated wood is common to most dock structures that have experienced repairs or expansions over time. Some marina structures may be treated with creosote alone; some with mixtures of creosote and petroleum; and some with mixtures that contain no creosote at all. Therefore, sediments collected around marina structures treated with creosote will have more PAHs than those treated with creosote blends or no creosote at all.

Third, the age of the marina structures vary. The rate of particle abrasion from older or more weathered pilings will likely be higher than more recently treated structures. The older structures (more splintered and brittle) will be more prone to abrasion. Similarly, the species of wood used to make the marina structures will offer different rates of degradation.

In summary, the release of PAHs from marina structures into proximal sediments should be variable, not uniform. This variability is caused by high dilution rates, changes in the preservative formulation, different

product age, and inconsistent species of wood. As stated previously, the findings presented in the SLERA are consistent with the observed data.

EPA General Comment 27e:

EPA observed that a strong correlation exists between one groundwater sample collected from a temporary monitoring well (03 28-GW-07S) in 1998 and sediment from Seep 16-01. It contends that this compositional similarity is inconsistent with forensic evidence that demonstrate an incomplete pathway between the Source Areas, Seep 16-01, and Allen Harbor sediments.

Navy response to EPA General Comment 27e:

EPA is correct to point out that the observed strong correlation between 03 28-GW-07S and the Seep 16-01 appears incongruous with the Navy's position. However, the Navy believes the observed correlation between 03 28-GW-07S and Seep 16-01 is an anomaly. The Navy previously discussed the reasons for this conclusion. First, Navy noted that the PAHs detected in 03 28-GW-07S were generally measured below conservative screening levels for risk and are not considered hazardous. Second, Navy pointed out that groundwater results from proximal monitoring wells yielded non-detects that supported the discontinuous pathway from the Site 16 Source Areas (creosote and fire fighter training) to Allen Harbor. Third, sample 03 28-GW-07S pathway was situated near Building E107 and an underground storage tank (UST) area. Navy believes that low levels of fuel may have caused the anomalous PAH measurements. Fourth, sample 03 28-GW-07S was collected from a temporary monitoring well that likely contained groundwater whose composition was predominantly influenced by resuspended and otherwise immobile particulate phase hydrocarbons.

Navy recognizes that the correlation coefficient between 03 28-GW-07S and SEEP16-01 is good (R^2 between 0.80 around 0.85). However, Navy also recognizes that the correlation coefficient is likewise very poor when compared to Site 16 Source Area soils, Reference Area sediments, and Allen Harbor sediments (Table 1 – these R^2 values were all less than 0.3). Therefore, the composition of 03 28-GW-07S may resemble SEEP16-01, but these PAHs are not from the creosote or fire fighter training areas and they generate no recognizable impact on Allen Harbor sediments. The notion that sample 03 28-GW-07S demonstrates a potential pathway from the Site 16 Source Areas to Allen Harbor is erroneous.

Despite the above, the Navy will collect additional soil and groundwater samples in the vicinity of sample 03 28-GW-07S to confirm that hydrocarbon migration is not occurring in this area of the site. A particular emphasis will be placed on evaluating potential residues from the UST area formerly located near Building 107. The details will be included in a work plan under separate cover.

Table 1. Statistical comparison of 03 28-GW-07S to proximal groundwater, seep, soils, and sediments.

Sample	Matrix	Description	Correlation Coefficient (R^2)
28-GW07	Groundwater	Temporary Monitoring Well Near Seep	1.000
SEEP16-01	Surface Water	Seep	0.853
SEEP16-01D	Surface Water	Seep	0.805
MW16-03S	Groundwater	Upgradient of 28-GW07	non-detect
MW16-05S	Groundwater	Upgradient of 28-GW07	non-detect
S1-1	Soil	Creosote Area	0.275
S1-2	Soil	Creosote Area	0.298
S2-1	Soil	Creosote Area	0.051
S2-2	Soil	Creosote Area	0.079
S3-1	Soil	Fire Training	0.099
S3-2	Soil	Fire Training	0.143
S4-1	Sediment	Storm Sewer	0.088
R1-1	Sediment	Reference Area	0.143
R1-2	Sediment	Reference Area	0.220
R1-4	Sediment	Reference Area	0.230
R2-1	Sediment	Reference Area	0.244
R2-3	Sediment	Reference Area	0.228
R2-5	Sediment	Reference Area	0.205
R3-1	Sediment	Reference Area	0.184
R3-2	Sediment	Reference Area	0.172
R3-4	Sediment	Reference Area	0.185
AH03	Sediment	Outer Harbor	0.246
AH06	Sediment	Outer Harbor	0.203
AH08	Sediment	Outer Harbor	0.210
AH11	Sediment	Outer Harbor	0.169
AH17	Sediment	Middle Harbor	0.184
AH23	Sediment	Middle Harbor	0.174
AH26	Sediment	Middle Harbor	0.095
AH26D	Sediment	Middle Harbor	0.099
AH28	Sediment	Middle Harbor	0.090
AH29	Sediment	Middle Harbor	0.220
AH32	Sediment	Inner Harbor	0.130
AH33	Sediment	Inner Harbor	0.134
AH35	Sediment	Inner Harbor	0.086
AH40	Sediment	Inner Harbor	0.070
AH42	Sediment	Inner Harbor	0.082
AH45	Sediment	Inner Harbor	0.154
AH47	Sediment	Inner Harbor	0.100
AH49	Sediment	Inner Harbor	0.059
AH51	Sediment	Outer Harbor	0.141

These correlation coefficients were calculated using the PAHs detected in 03 28-GW-07S (naphthalene, 2-methylnaphthalene, acenaphthene, fluorene, anthracene, phenanthrene, fluoranthene, and pyrene) after normalizing each concentration to the total concentration of these 8 PAH analytes in each sample.

Comments on Appendix B, Final Report,
Environmental Forensic Investigation, Site 16

EFI Comment 1a

EPA is concerned that environmental weathering could alter the PAH composition of hydrocarbon migrating from Site 16 to Allen Harbor; especially with respect to ratios used in the forensic investigation to identify refined tar products (i.e., the ratio of anthracene to phenanthrene - A0/P0). EPA emphasized that the conditions under which environmental weathering occurs is different on land than in sediment.

Navy response to EFI Comment 1a

Navy explained the effects of environmental weathering previously. The term environmental weathering refers primarily to the collective effects of volatilization, dissolution, and biodegradation. Researchers have established that 2- and 3-ring PAHs are more susceptible to environmental weathering than 4- to 6-ring PAHs. The molecular changes associated with abiotic weathering (e.g., volatilization and dissolution) will affect isomers, like A0 and P0, in approximately equal measure. In other words, these isomers will be altered at similar rates and the ratio of A0/P0 will not change significantly. The molecular changes associated with biodegradation can result in the preferential reduction of selected hydrocarbons. For example, many species of microbes sequentially degrade:

1. normal linear alkanes (e.g., n-C_{17} and n-C_{18}),
2. isoprenoids (e.g., pristine and phytane),
3. parent aromatic hydrocarbons (e.g., phenanthrene and anthracene), and
4. alkylated aromatic hydrocarbons (e.g., methylphenanthrenes).

This sequential biodegradation is largely governed enzymes known as mono- and di-oxygenases that add one or two oxygen atoms, respectively, to the hydrocarbon molecule. Once oxygenated, the compound can be more readily metabolized. Aromatic hydrocarbons are more difficult to initially oxygenate than aliphatic hydrocarbons, because of the high degree of molecular stability offered by the benzene ring structure. Many of the enzymes capable of oxygenating aromatic compounds exhibit broad specificity within each class of hydrocarbon compounds and are not isomer specific for parent PAHs. For example, dioxygenases capable of degrading aromatic hydrocarbons are also capable of degrading heterocyclic aromatics, saturated rings, and linear alkenes. The evolutionary rationale for broad specificity within hydrocarbon classes is an interesting topic, but beyond the scope of this discussion. What is important about the biodegradation process is that hydrocarbon degrading bacteria generally specialize in classes of compounds (e.g., normal alkanes, isoprenoids, parent PAHs, and alkylated PAHs). Within a class of hydrocarbons, lighter molecular weight compounds are degraded before heavier constituents. When the class of hydrocarbons is reduced (but rarely eliminated entirely), a different population(s) of bacteria will begin to degrade the next class of more bioresistant hydrocarbons. The rate of biodegradation is a function of terminal electron acceptors, nutrients, microbial species, water, temperature, hydrocarbon types, and lack of biocides. The rate will be higher in oxygen containing and lower in saline environments.

The bottom line is that diagnostic compounds such as A0 and P0 are expected to degrade in the environment. The biotic and abiotic processes of degradation are expected to reduce both compounds at approximately equal rates. The available literature provided in the SLERA and Navy's initial response to comments supports this conclusion. At present, the only known process for generating a high A0/P0 ratio is through specialized industrial refining. Published accounts of anthracene enrichment are complemented by numerous environmental investigations at tar refineries and wood treating plants in which creosote residues in surficial tar deposits and subsurface soils forensically match PAH enriched sediments in proximal waterways. Despite long residence time in terrestrial and sediment environments, the A0/P0 ratio consistently identified fugitive creosote. Collectively, these lines of evidence support the use of the A0/P0 ratio as presented in the SLERA report. If EPA possesses any specific evidence to refute the use of this ratio as presented, it is requested that the EPA provide this information to Navy before April 2, 2007.

EFI Comment 1b

EPA requests a more extensive discussion about the variability in the A0/P0 ratio among Source Area samples.

Navy response to EFI Comment 1b

The forensics report and December 2006 presentation provide the multiple lines of evidence used to differentiate the Source Area samples from the pyrogenic PAHs observed in Allen Harbor in detail. Navy acknowledges that the A0/P0 ratio varies among the Source Area samples. Source Area samples with low A0/P0 ratios (e.g., Source 2-1) are distinguished from Allen Harbor sediments based on separate lines of evidence. Source 2-1 contained weathered middle distillate that is likely kerosene. Kerosene was not observed in Allen Harbor sediments. Source 2-2 also contained weathered middle distillate that is likely biodegraded diesel fuel. The PAHs in Allen Harbor (mostly pyrogenic 4- to 6-ring PAHs) are clearly not derived from a plume of biodegraded diesel (petrogenic 2- to 3-ring PAHs). Source samples 3-1 and 3-2 contain residual petroleum with biomarker patterns that do not match the Allen Harbor sediments. The only Source Area samples for which the A0/P0 is important are the samples with creosote. Source 1-1 and 1-2 possess high A0/P0 ratios (1.5 to 2). None of the Allen Harbor sediments along the Site 16 shoreline exhibit this characteristic feature; therefore, the migration pathway is incomplete.

EFI Comment 1c

EPA requests a more extensive discussion about the analytical uncertainty of diagnostic PAH compounds. EPA is concerned because the concentrations of PAH in some of the duplicates vary by a factor of 2.

Navy response to EFI Comment 1c

The assessment of variability in the PAH results is centered on duplicate measurements of the same parameter. Table 2 summarizes the duplicate measurements among the two batches of samples collected from Allen Harbor that were measured for PAHs. The relative percent difference (RPD) is calculated for each set of duplicate results that are associated with the A0/P0 ratio. The performance standard for the RPD is less than 30% as stated in the work plan. The primary corrective action for RPDs greater than 30% is a review of the data for evidence of matrix heterogeneity.

A comparison of the laboratory control (LCS) samples demonstrates variability within the analytical method in the absence of variability associated with the matrix. In this case, the measured amount of A0, P0, and P0d10 (the surrogate) yielded RPDs of 20% which satisfied the 30% performance criteria. The proportional nature of this shift did not affect the A0/P0 ratio (RPD = 1%).

The laboratory duplicates consist of aliquots of the field sample withdrawn from the same sample container. One laboratory duplicate was created as part of the batch QC for each sample delivery group. The duplicate from the first batch of samples (i.e., AH-26 and AH-26 Duplicate) demonstrate the variability of the analytical method plus the variability of this particular field sample matrix. These data demonstrate a consistent RPD among PAH analytes (A0 = 10% RPD and P0 = 11% RPD) and the associated surrogate (P0d10 = 8% RPD) that satisfied the performance criteria. Again, the laboratory and matrix precision did not alter the A0/P0 ratio (RPD = 0%).

The second batch of samples was associated with the duplicate set including Core 1-Bottom and Core 1-Bottom Duplicate. In this case, the precision of the A0 and P0 measurements exceeded the performance criteria (RPD A0 = 116% and P0 = 41%) and prompted a review of the data. These results did affect the A0/P0 ratio (RPD = 85%). This review of the data indicated numerous source signature differences between the sample and its laboratory duplicate. The surrogate RPD was 7% which indicated that the analytical method performed well, but the matrix heterogeneity was high. In practical terms, the first sample was very clean (EPAPAHs = 2.8 mg/kg) and the second sample contained a few small fragments of pyrogenic material not present in the first sample (EPAPAHs = 12.5 mg/kg). In summary, this sample simply contained heterogeneous sources of PAHs.

Three sets of blind field duplicates were also associated with the PAH samples. In this case, the sample was homogenized in the field and split samples were submitted to the laboratory in separate sample containers with distinct field identities (i.e., DUP 01, DUP 03, and DUP 07). The exact associations of the "DUP" and field samples were not revealed until after the data were reported and independently validated.

The first two blind duplicate sets (AH-06 & DUP03 and AH-11 & DUP01) satisfied the performance criteria. The laboratory precision (P0d10 RPD = 1% to 3%) was about 13% better than field matrix precision (A0 and P0 RPD = 12% to 18%). The A0/P0 source signature for these samples was not distorted by the different degrees of laboratory and matrix variability. In summary, the RPD differences in these samples indicated that a few extra fragments of pyrogenic PAH material were present in one of the samples, but the origin of this material was likely the same based on the consistent A0/P0 ratio. The third blind duplicate set (AH-33 & DUP07) also exhibited better laboratory precision (P0d10 RPD = 20%) than the matrix precision (A0 RPD = 38% and P0 = 43%). The collective difference in measured PAH concentrations exceeded performance criteria. However, the difference was consistent and did not affect the source signature (A0/P0 = 5%). Again, this finding demonstrates the likely presence of a few extra fragments of pyrogenic PAH material in one of the samples, but the origin of this material was likely the same based on the consistent A0/P0 ratio.

Table 2. Duplicate measurements among Allen Harbor sediment samples.

Sample ID	Sample Type	Batch	Relative Percent Difference (RPD)			
			A0 %	P0 %	A0/P0 %	P0d10 %
BE162LCS-P	LCS	S04-0117MS	20%	20%	1%	20%
BE165LCS-P	LCS	S04-0118MS				
AH-26	Sample	S04-0117MS	10%	11%	0%	8%
AH-26	Lab Duplicate	S04-0117MS				
Core 1-Bot	Sample	S04-0118MS	116%	41%	85%	7%
Core 1-Bot	Lab Duplicate	S04-0118MS				
AH-06	Sample	S04-0117MS	17%	12%	5%	3%
DUP 03	Blind Duplicate	S04-0117MS				
AH-11	Sample	S04-0118MS	12%	18%	6%	1%
DUP 01	Blind Duplicate	S04-0118MS				
AH-33	Sample	S04-0118MS	38%	43%	5%	20%
DUP 07	Blind Duplicate	S04-0118MS				

A0 Anthracene
P0 Phenanthrene
P0d10 Phenanthrene-d10 (Surrogate)

$$RPD = \frac{|\text{Difference}|}{\text{Average}} * 100$$

In summary, this study experienced some degree of matrix heterogeneity and laboratory variability. However, the source signatures of diagnostic PAH ratios, like A0/P0, were unaffected.

EFI Comment 2a

EPA requested clarification as to how regional background, marina, and storm sewer releases can be recognized.

Navy response to EFI Comment 2a

The primary forensic objective of Navy was the determination of Site 16 contributions to Allen Harbor. None were observed.

Based on the available data, Allen Harbor sediments are compositionally most similar to the Reference Areas (SLERA Appendix B Figure 11a for PAHs and Table 6 for heavy petroleum). As discussed previously, the absolute hydrocarbon concentrations in Allen Harbor are higher than the Reference Areas, but the difference

is attributed to the preferential deposition of fine grain particles in Allen Harbor. See Navy response to EPA General Comment 27a for more detailed discussion of fine particles. Except where noted below, the Narragansett Bay is a likely and significant source of EPAPAHs below about 15 mg/kg in Allen Harbor.

Localized influences of residual petroleum from roadway runoff are evident at AH-28 and AH-49 (SLERA Appendix B Table 6 Triterpane Pattern E). The somewhat elevated concentrations of PAHs at these locations more closely resemble regional background (SLERA Appendix B Figure 11a), perhaps the result of concentrating terrestrial runoff in the storm sewer system. Localized influences of creosote from marina structures are evident in samples AH-03 and AH-29 (SLERA Appendix B Figure 11a). The full extent of these contributions in Allen Harbor is unknown, but likely significant in sediments with more than 15 mg/kg EPAPAHs.

EFI Comment 2b

EPA stated that the number and distribution of forensic samples is not sufficient to demonstrate unequivocally that the docks are the source of PAHs in harbor sediments.

Navy response to EFI Comment 2b

The primary forensic objective of Navy was the determination of Site 16 contributions to Allen Harbor. The objective has never been to unequivocally reconcile the full magnitude of non-Site 16 sources of PAHs in Allen Harbor. The data were used to construct a conceptual site model to reconcile the available data in accordance with interrelationships that are more likely than not correct. EPA's expressed interest in an unequivocal source apportionment for non-Site 16 sources is well beyond the scope of Navy obligations. (Please note that, if the contaminants in Allen Harbor <u>were</u> determined to be site related, then, per Navy policy, a Watershed Contaminated Source Document [WCSD] would in fact be required. The purpose of this document would be to identify all of the potential sources of contamination to the harbor, site related and non-site related, in order to determine the extent of the Navy's responsibility, as well as the estimated effectiveness of any potential remedy dealing only with the site related contribution. For a copy of the Navy policy: see *http://enviro.nfesc.navy.mil/erb/erb_a/regs_and_policy/don_policy_sediment.pdf*).

Despite the absence of a requirement that Navy reconcile the impact of storm sewer effluent in Allen Harbor, it will collect several additional samples of roadway materials to further evaluate the types of hydrocarbons present in storm sewer drainage area. An emphasis will be placed on collecting samples of new and old paving materials. The details of this supplemental investigation will be included in a work plan under separate cover.

EFI Comment 3

EPA expressed an interest in incorporating examples of weathered creosotes with different formulations into the report.

Navy response to EFI Comment 3

Navy is planning to collect a limited number of additional soil samples from the creosote treating area on Site 16. It is also planning to collect several samples from the marina pilings themselves. Collectively, these will serve as the primary basis for demonstrating a more broad range of creosote formulations associated with potential impacts to Allen Harbor sediments. Sediment samples will be collected near the pilings sampled previously. The details of this additional work will be included in a work plan under separate cover.

EFI Comment 4a

EPA expressed a need to further explore and delineate the storm sewer system.

Navy response to EFI Comment 4a

Navy intends to further explore and delineate the storm sewer system. The details of this additional work will be included in a work plan under separate cover.

EFI Comment 4b

EPA noted a high correlation between the groundwater sample 03 28-GW-07S and SEEP 16-01. It expressed a need to further investigate the source of SEEP 16-01.

Navy response to EFI Comment 4b

Navy contends that the PAH contribution of SEEP 16-01 is not associated with the PAHs in the creosote treating area, fire fighter training area, or Allen Harbor sediments (see Navy response to EPA General Comment 27e). However, Navy intends to further explore the soil and groundwater constituents at and upgradient of SEEP 16-01 with an emphasis on potential residues from a nearby former UST area and former septic tank area.

EFI Comment 5a

EPA believes the data are inconclusive with respect to Navy's assertion that the PAH concentrations in Allen Harbor are homogeneous. EPA is also not convinced that the dock piling and storm sewers are the "most likely" sources of PAHs in Allen Harbor.

Navy response to EFI Comment 5a

In general, Navy believes that the sediments within Allen Harbor are relatively homogeneous. The PAHs fall within a low and narrow concentration range (EPAPAHs from 2 to 28 mg/kg). Most sediment throughout the Inner, Middle, and Outer Harbor contain ∑EPAPAHs below 15 mg/kg with slight elevations near the marina pilings and storm sewer outfalls. Most Allen Harbor sediments are dominated by plant waxes mixed with heavy residual petroleum and low levels of PAHs. These are the same hydrocarbon features observed in the Reference Area sediments. With the exception of samples near the marina pilings and storm sewer outfalls, the sediment samples in the Inner, Middle, and Outer Harbors possess very similar chemical fingerprints. It is on the basis of these findings that Navy describes the Allen Harbor sediments as homogeneous.

The origins of PAHs in Allen Harbor are mixed. Against the background hydrocarbon features described above, the most significant source of PAHs in Allen Harbor is most likely the marina pilings and storm sewer effluent. Samples of these features will be collected as part of Navy sampling activities in 2007. The details of this additional work will be included in a work plan under separate cover.

EFI Comment 5b

EPA adopted language for associating AH-35 with Seep 16-01 from the comments column in Table 2-3 which describe this location as "gradational from seep."

Navy response to EFI Comment 5b

Navy has clarified that sample location AH-35 is best described as "proximal to piling." All parties agree. No further action is required.

EFI Comment 6

No further action is required.

EFI Comment 7

EPA questions the use of A0/P0 to identify PAH impacts from Site 16 to Allen Harbor.

Navy response to EFI Comment 7

The A0/P0 ratio is only used to help determine that Site 16 creosote did not impact Allen Harbor sediments. Its use was appropriate. See Navy response to EFI Comment 1b for further details on the multiple lines of evidence approach used to demonstrate the absence of impacts from other Site 16 Source Areas.

Navy Response to EPA Recommendations

As presented at our meeting in December, Navy is planning to conduct addition work at Allen Harbor in accordance with the tasks summarized in this section. This additional work is complex and beyond the scope of this document. The details of this supplemental investigation will be included in a work plan under separate cover. If these data support the conceptual site model proposed in the SLERA report, regulatory concurrence with the results is anticipated.

ENCLOSURE 8

RESPONSES TO EPA FOLLOW-UP COMMENTS ON NAVY RESPONSES TO EPA HYDROGEOLOGICAL COMMENTS ORIGINALLY RECEIVED ON SEPTEMBER 20, 2006

EPA FOLLOW-UP COMMENTS WERE RECEIVED IN CORRESPONDENCE DATED FEBRUARY 20, 2007

ENCLOSURE NO. 8
RESPONSES TO EPA-FOLLOW-UP COMMENTS ON NAVY RESPONSES TO EPA HYDROGEOLOGICAL COMMENTS ORIGINALLY RECEIVED FROM EPA ON SEPTEMBER 20, 2006
(EPA FOLLOW-UP COMMENTS RECEIVED FEBRUARY 20, 2007)
DRAFT PHASE III REMEDIAL INVESTIGATION QAPP FOR IR SITE 16
NCBC DAVISVILLE

EPA GENERAL OVERVIEW COMMENTS:

Three major comments are germane to the responses to comments. First, it is noted that while some work elements proposed are clearly outlined and specific, other work elements are less so. In particular, until the conference call on February 14, 2007, it was not entirely clear that the Navy has committed to at least evaluating the re-processing of the existing geophysical data, if not actually performing additional geophysical investigation of the hypothesized preferential pathway up gradient of Site 16. The approach outlined in the Work Plan for installation of additional monitoring well(s) for up gradient data gap assessment is contingent upon the findings resulting from the geophysical survey, if performed, and additional soil borings, temporary well installation, and sampling and analyses, either with field methods such as Color Trac testing, or laboratory analyses. As discussed during the conference call, economical placement (reduced numbers) of permanent up gradient wells without further geophysical evaluation is not acceptable. Further, text in the Work Plan describes use of the field information for *possible* well installation. There is no firm commitment in this response to comment document that a minimum number of wells will be installed up gradient. As was discussed during the conference call, EPA believes that it is absolutely imperative that a thorough and robust evaluation of this up gradient potential pathway be performed. If a geophysical survey is not performed, additional groundwater monitoring well clusters may be necessary depending on the data collected during this next field season. The Stage I field screening methods alone may not be sufficient to minimize the number of up gradient monitoring wells required. We agreed for cost estimating purposes, that a maximum of 3 well clusters would be put forward in the QAPP, however, this number is entirely dependent on the evaluation of the geophyisical data, the chemical screening data, the lithogic information gathered through borings in the overburden and bedrock, the evaluation of this data and integration of the old and new data sets.

The second comment is that many of the Navy responses to comments are still not supported by the data. In some cases such as groundwater flow directions, upward vertical gradients from the bedrock to the deep overburden, and distribution and concentrations of contaminants, the Navy either disregards their own data or has provided incorrect data. Some of the responses to comments simply suggest that "the EPA revisit the data" because the Navy does not agree with the comments made by the EPA. These are not adequate responses. It should be noted that the EPA has reviewed the data thoroughly and in depth in order to arrive at is comments in the first place.

In fact, the tone of many of the responses is combative with the use of **bold type** for certain statements, conveying a sense of shouting the response. EPA requests the Navy refrain from such tactics in the future. It is also noted that many of the Navy responses to EPA comments are accompanied by the qualifier that additional work is proposed to address EPA concerns. However, also as noted in the previous comment, though, the adequacy to address EPA concerns was uncertain when reading the reviewed text. Thus, while the Navy purports to want to be cooperative and work jointly at this site, this is not what comes across from review of at least portions of the responses to comments. We are optimistic that this artifact from reading the text has been changed based on the outcome of the February 14, 2007 conference call.

The third comment is that the Navy continues to suggest that the EPA "prove" its theory or "provide information" that substantiates its comments. This response suggests an inverted understanding of how the process works. That is, it is the Navy that is charged with performing the site investigation, as the Navy is the lead agency under CERCLA. The Navy is providing tremendous financial resources to it contractor to perform investigative work at this site. It is the role of the EPA to provide peer review comment of data and interpretations that are provided to it, not "prove" or "provide information" to support

its comments. If the Navy presentation makes a sound case supported by sufficient data, then the EPA comments will be commensurately brief or non-existent. However, where EPA believes there are obvious data gaps, inconsistencies, or unsupported statements, the EPA is compelled to point those out. The EPA has no vested interest in one outcome or another, per se, other than to ensure that the public is served by efforts of all. The onus is on the Navy to scientifically support its interpretation and not just say that it disagrees with the comments. Nonetheless, the EPA has provided cogent lines of evidence supporting its "hypotheses" and has provided them previously to the Navy and again in these responses and again in figures and memos provided prior to the February 14, 2007 conference call. These figures and memos are attached to this document.

NAVY RESPONSE TO EPA GENERAL OVERVIEW FOLLOW-UP COMMENTS:

Response to paragraph 1: Please see enclosed plan for the upgradient groundwater investigation (Enclosure No. 6)

Response to paragraph 2: This comment emphasizes the fact that data interpretation can be very subjective, particularly when there is limited information. There are clearly alternative positions on the items listed in the comment. The Navy believes that the data collected during the Phase III field investigation will provide the technical basis to adequately address concerns raised by the EPA.

Response to paragraph 3: The referenced bold type was added to simply emphasize information or a question of concern that the Navy needed clarification from EPA; it was not intended otherwise.

Response to paragraph 4: Navy appreciates the insight on how EPA views its role in this process. It is helpful in furthering our comprehension of the comments received. However, Navy asserts the onus is actually on all parties contributing to remedial investigation activities (the Navy and its regulatory reviewers [EPA Region I, and RIDEM]) to provide technically sound and scientifically defensible interpretations of the available environmental data. Notes summarizing the EPA and Navy discussions regarding the conceptual site models for Site 16 and the investigative efforts necessary to complete the Phase III remedial investigation were prepared in response to the technical teleconference held on February 14, 2007 (see Enclosures No. 1 through No. 5). The Navy believes that further debate regarding which conceptual model (Navy or EPA) is correct for Site 16 would be non-productive and that the BRAC Clean-up Team (BCT) should focus its efforts on reaching consensus regarding the hydrogeological investigation of the up gradient area so the Phase III field work may proceed.

RESPONSES TO EPA GENERAL COMMENTS

Responses to EPA Follow-up Comments on the Phase II Data Gap Report

EPA Follow-up Comment No. 1:

Comment not addressed The Navy still has not provided a cogent rational or data to support the contention that photo ionization detector/flame ionization detector (PID/FID data cannot be used to evaluate areas of likely elevated or non presence of chlorinated volatile organic compounds (CVOC). (It should be remembered that the EPA never stated that PID/FID data could be used as the final determinant of contamination. It was the Navy's contention that employment of PID/FID with filter was essentially worthless that generated the recent comment). The Navy also states that PID/FID data cannot be used for volume calculations and that Color Trac screening will provide this capability. However, it is yet to be established that the Color Trac screening procedures are superior to rigorous PID/FID screening. EPA is looking forward to the field screening pilot study in advance of the field work at site 16. It is assumed that PID/FID results will continue to be used as outlined in the Work Plan. Please see attached memos dated 2-13-07 sent previously to the Navy.

Navy Response to EPA Follow-up Comment No. 1:

The Phase III QAPP for Site 16 does incorporate the use of both the PID and Color-Tec screening for the

selection of soil samples for fixed-base laboratory (FBL) analysis.

Responses to General Comments on the Phase III QAPP

EPA Follow-up Comment No. 17:

Comment appears to be addressed. However, some of the written responses to comments that follow suggest this may not be a whole hearted consensus within the Navy team. While the results of the conference call indicate that the Navy does not agree with the EPA's interpretation, at least Navy is willing to perform additional investigations in the up gradient area. There is the need for more investigations in the appropriate areas. It is encouraging that additional work is being proposed and it is hoped that a cooperative effort can truly be implemented in order to eliminate data gaps to the extent practicable.

Navy Response to EPA Follow-up Comment No. 17:

Comment acknowledged.

EPA Follow-up Comment No. 18:

Comment may be addressed. The response implies that sufficient data and information will be collected. However, what constitutes sufficient remains to be seen. This concern is generated based upon the Stage I, II, and III approach where substantial discretionary power is proposed for the Triad Professional. The responses to comments contained herein note that consultation with the regulatory agencies will be made. However, there is still uncertainty whether certain activities such as the geophysical survey will actually be implemented, and how many and at what locations permanent groundwater monitoring wells will be installed. EPA proposes occasional oversight of the Triad Professional to ensure EPA's interests are being addressed real time in the field.

Navy Response to EPA Follow-up Comment No. 18:

The Navy is suggesting that, for the duration of the Phase III field investigation, a weekly technical teleconference be held with the EPA, RIDEM, and other interested parties (as necessary) to share environmental data (e.g., screening data [Color Tec, PID, etc]) generated in the field and to discuss the progression of the investigation based on such data. Please note that resumes of the two project hydrogeologeologists (Mr. Scott Anderson [the Field Operations Leader [FOL] and Mr. Jeff Schubert) and the Triad Coordinator (Mr. John Wright) who will be responsible for the work in the field have been attached. Please note that these individuals will be in frequent (if not daily) contact with the Navy project manager (Mr. Curt Frye) and the TtNUS project manager (Ms. Lee Ann Sinagoga) regarding field investigation decisions. EPA and RIDEM representatives are welcome to visit in the field at any time. However, for health and safety reasons, please advise Mr. Curt Frye when EPA and RIDEM representatives will be conducting field visits. Also, please see the attached proposal for the upgradient groundwater investigation.

EPA Follow-up Comment No. 19:

Comment not addressed. The response to this EPA comment is argumentative (including use of **bold type**), is not supported by the data, and appears to be counter to the cooperative approach outlined in response to Comment 17.

First Paragraph: EPA believes that there is a severe scarcity of groundwater monitoring points in the up gradient area. Thus, there is virtually no data to show, that there is no link between Nike PR-58 (which is hydraulically up gradient) and Site 16. The Navy's demand that EPA "prove" its interpretations with limited available data is somewhat incongruous given that it has stated that it is certain that a CVOC source is present at the former Building 41 area, yet, none has been found with an order of magnitude

greater number of wells being installed and sampled in that area with no detection of any substantial source in the shallow or intermediate zones.

Between the Nike PR-58/Site 03 boundary and Site 16 is a distance of approximately 3,500 feet. An average width of this up gradient flow zone is approximately 750 feet (centered on monitoring well EA-111D/R). This is an area of approximately 60 acres. Yet, there are no more than a handful of monitoring wells in this pathway (MW03-08D/R, MW03-10D/R, EA-111-D/R, and if considering wells at the fringe, MW03-11R, MW16-55D/R, and EA-110D/R). This is a monitoring well density of one well location per 10 acres. At the northeast end of former Building 41 footprint there are over 20 wells within an area of approximately 10,000 square feet for a density of 80 wells per acre.

As its proof that the EPA is ignoring the data, the Navy provides data for two wells, MW03-11R and EA-111D. As noted above, MW03-11R is at the likely fringe of the potential pathway and may be expected to have low concentrations of CVOC. Further, as with any bedrock well, a single well, let alone a virtual absence of wells, cannot be used as proof of the presence or absence of contamination. Nonetheless, the Navy is incorrect in its statement that monitoring well EA-111D has shown 1.35 µg/L of CVOC in 2000 and non-detect in 2005. The Navy is invited to review their "*Interim Groundwater Sampling Event 04 – June 2005 Results Repot for Site 03*". Figure 7 of that report shows CVOC present in this well in June 2005 at 7 µg/L. The bedrock well at this location has also shown CVOC at 4 µg/L in June 2005. Furthermore, the concentrations have been increasing from less than 1 µg/L in 1998. Further, up gradient from this location (according to the groundwater contours and flow directions depicted by the Navy on Figures 3A and B of that same report, monitoring wells MW03-8D/R, MW03-10 D/R, MW03-12D/R, and MW03-14D/R have exhibited higher concentrations of CVOC. Further, these figures clearly show flow from what appears to be the Site 03 Study Area 1 toward Building 224. Therefore, the Navy's statement that EPA has rejected or ignored the chemical data is totally without basis.

It should also be noted that in subsequent response to Comment 22, the Navy goes to great length to discuss the hydraulic conductivity values of four well locations (MW03-08R, MW03-10R, MW03-12R, and EA-106R) to establish the average hydraulic conductivity for the up gradient (and down gradient) areas. First, the concentrated locations of these wells do not provide data of geostatistical significance. Second, the Navy should provide the raw data to support why they opted to change the hydraulic conductivity value for one well that was prepared by another consultant to the Navy. Third, the log for MW03-12R shows a different picture than might be assessed from the slug test result. Rock (described as phyllite and quartzite) is present from 21 feet to 55 feet with rock quality designation at 21 to 37 feet being given a 0%, while from 37 to 42 feet it was 60%, from 41 to 46 feet at 80%, and from 46 to 51 feet being 92%. The screen for MW03-12R was set at 46 to 51 feet. Thus, the result presented does not appear to be a representative value for the bedrock at this location.

Further, when considering potential bedrock hydraulic conductivity, the log for EA-111R (which does not have a slug/packer test value) shows low rock quality designator (RQD) values over its entire length ranging from 65 to 90 feet below ground surface at a geometric mean of 39%. Standard geotechnical engineering procedures interpret RQD values of 50% or less as rock that is highly fractured. Thus, while there has not been a hydraulic conductivity test conducted at EA-111R, the Navy's interpretation that bedrock hydraulic conductivity is low in bedrock overall is not supported. Transport rates may be high along fractured rock zones that can provide preferential pathways for groundwater flow and contaminant migration. Additional comment regarding bedrock permeability is provided in following responses to comments. (See also response to Comment 20 below regarding geophysical surveys at Site 16).

Second Paragraph: This comment appears to ignore the overall data for Site 16 that clearly shows that the Site 16 area is a groundwater discharge zone from shallow bedrock to the deep overburden. Contrary to what is protested in the first portion of this paragraph, while the Navy may claim to have documented them extensively in their various reports, they clearly made the point that bedrock groundwater does not discharge at Site 16 area near the former Building 41 footprint in their reports on Site 16. Bold face type aside, the data clearly shows to EPA that groundwater discharges from bedrock to the deep overburden within the Site 16 area, contrary to what is stated by the Navy. As previously commented by EPA, due to heterogeneous conditions including bedrock fracture zones, degree of inter

connectedness, times of the year, etc. not all locations will show upward flow from the bedrock to the deep overburden. Inspection of the 23 well locations shown on Figure 3-15 of the Supplemental Phase II Remedial Investigation Data Package for IR Program Site 16 shows that 12 exhibit at least intermittent upward vertical gradients from the bedrock.

It is also noted that many of these upward vertical gradients from the bedrock to the deep overburden lie along the CVOC "plume" area as depicted by the Navy. In the immediate location of the former Building 41 area, MW16-15 and MW16-60 have also shown intermittent upward gradient from the bedrock to the deep overburden in addition to MW16-68 and MW16-70 within the footprint. Also, along the "plume" extending from the location of the northeast corner of the former Building 41, upward gradients are observed at MW16-59, MW16-02, and MW16-05. MW16-44 has also shown intermittent upward gradients as well as MW16-03, MW16-27, and MW16-56. These upward vertical gradients are also coincident with highly fractured (highly permeable rock) as discussed in subsequent responses to comments.

Third Paragraph: In this paragraph, the Navy purports to provide further evidence contaminants do not migrate upward in the Building 41 area. (It should be noted that EPA has always considered the entire Site 16 area and not just Building 41 when viewing the conceptual site model). The Navy notes that CVOC concentrations are "much" higher in the deep overburden than in the bedrock and dismisses the influence of well screen length or open borehole interval. First, inspection of the data clearly did not support this. At best, the deep overburden wells show slightly or somewhat higher CVOC concentrations, not "much higher concentrations". Other well pairs are either equal in concentration or show that the bedrock is slightly higher in CVOC.

Second, this ignores standard site investigation practices where it is imperative to compare equal intervals when assessing vertical distribution of CVOC. As an example, if the well screen for a deep overburden well is extended 15 feet upward into the less contaminated intermediate zone to create a comparable 25 foot screened interval to the bedrock open hole, the average CVOC concentrations for that (now 25 foot well screen – comparable to the bedrock open borehole interval) will decline. The following table illustrates this concern, showing recorded concentrations in micrograms per liter for a few wells. There is no clear overwhelming pattern of "much" higher CVOC in deep groundwater compared to bedrock.

Well Identification	**Intermediate**	**Deep**	**Bedrock**
MW16-02	63	1200	1200
MW16-67	11	980	600
MW16-68	11	790	620
MW16-71	12	790	1100
MW16-60	NA	1600	1800

The last portion of the response states that CVOC discharging from bedrock cannot account for the CVOC detected in the shallow and intermediate intervals is not understood. While the Navy requests that the EPA explain how CVOC from the bedrock can migrate to the shallow and intermediate intervals, the Navy should first revisit the comments made by EPA.

First, EPA never stated that CVOC contamination at this site was solely due from CVOC contaminated groundwater discharging from the bedrock. (For that matter, EPA never stated that CVOC contaminated groundwater discharges from the bedrock to the deep overburden. This pathway was put forth as a "hypothesis" that should be investigated in lieu of the fact that extensive investigations by the Navy have not documented a source for the continuing dissolved phase CVOC at Site 16 that is present near the former Building 41 footprint).

Second, EPA has also suggested that based upon the data, there is the potential for CVOC to have migrated to this location from the North Central area, or that there may be other isolated releases in the Railroad Yard area or possibly from the Building 319 area where solvent recovery operations were

reported to have been relocated in the 1950's. In particular, the "hypothesis" put forth by EPA that contamination from the North Central area could have migrated into this area contaminating all intervals was summarily dismissed by the Navy. It was never stated that CVOC from bedrock contributed to the shallow or intermediate CVOC contamination.

Summary: Therefore, while the Navy states that it will conduct a comprehensive groundwater flow analysis and following that develop a robust, comprehensive conceptual site model, it is not clear given the tone and comments provided in this RTC document that this will be an unbiased effort. The Navy already appears to have drawn conclusions about the conceptual site model at Site 16. It should also be noted, this analysis cannot be limited to the Building 41 area only as is implied in this response to comment. A comprehensive assessment needs to be developed for the entire area of concern from the former Nike PR-58 site, Site 03, and Site 16.

Navy Response to EPA Follow-up Comment No. 19:

Please see the attached plan for the upgradient groundwater investigation (Enclosure No. 6). Also, note that the Navy agrees that an understanding of the conditions *immediately* upgradient of Site 16 is important to the Site 16 remedial investigation. However, a comprehensive, hydrogeological characterization of all areas downgradient of the NIKE Site (and up gradient of Site 16) is beyond the scope of the Site 16 investigation. The Navy does agree that the bigger-picture issue of the migration of potential NIKE PR-58 Site contamination onto Navy property is worthy of additional discussions between EPA, RIDEM, the Navy, and the USACE. Additionally, the Navy has recommended that 17 shallow bedrock and 4 deep bedrock wells be tested for determination of hydraulic conductivity (per the Phase III QAPP, packer tests will also be performed and will include sampling for a 10 foot packered section of bedrock) to better understand the bedrock system and the potential for contaminant transport in that system. Finally, the Phase III QAPP for Site 16 includes several additional borings in the "North Central" area of Site 16 to further understand contaminant sources and the potential for contaminant migration in this area.

EPA Follow-up Comment No. 20:

Comment not addressed. There are virtually no up gradient monitoring wells for Site 16 in order to adequately evaluate potential impacts from up gradient. The "hypothesized" groundwater flow path is between MW16-30 and MW16-33, a distance of approximately 300 feet. There is only one monitoring well, MW16-10D/R in this location. Additional monitoring wells are needed. The Navy states that an electrical resistivity survey is only being considered. While placement of wells may be performed subsequent to conduct and analysis of that survey, if it is not conducted, wells are still needed. The text that "Once these data have been collected, decisions can be made regarding the numbers and locations of *possible* up gradient wells that should be installed" is unacceptable. The numbers and locations of wells may be yet to be decided, but not the *possibility* of (permanent) wells. As a result of the conference call on February 14, 2007, EPA agrees that the numbers and locations of additional wells will be based on data from the re- processed geophysical data or new geophysical investigative data, the chemical screening of direct push borings (if it can be shown that the direct push gets to the top of rock), and split spoon lithological data as appropriate. EPA also agreed that for cost estimating purposes only, a maximum of 3 well clusters of (intermediate, deep, and rock) will be installed in locations satisfactory to RIDEM, EPA, and the Navy.

Further, the response to comment discusses FID readings for MW16-55D and states that it could be methane and that the Navy will not intend to place a well at a location with an FID detection indicating methane. It is not clear what the Navy intends by this statement. The Navy is referred to the drilling log for MW16-55D. The FID reading was 500 parts per million with a filter (2,000 without). Therefore, the detection was from a non-methane volatile organic compound. While this detection was at an intermediate interval, it is also noted that this detection lies close to the inferred preferential flow axis with ultimate flow to intermediate wells MW16-37I and MW-38I with elevated CVOC. There are no other intermediate wells along this axis. Please also see discussion on this issue in the Memo from Bill Brandon dated 2-13-07 and the figures and technical memo from Conrad Leszkiewicz dated 2-13-07.

Note: Past Geophysical Surveys

As part of developing its "hypothesis" the EPA reviewed the four seismic refraction geophysical investigations at Site 16 conducted by Geophysical Applications, Inc. The `results of these surveys are less than optimal in that standard refraction was employed and rigorous rock coring calibration control with the seismic surveys were not performed. Nonetheless, Geophysical Applications stated that traverses with seismic velocities less than 13,000 feet per second can be interpreted as fractured or weathered bedrock. Seismic velocities above 13,000 feet per second can be viewed as more competent rock.

Inspection of the data provided showed that a number of seismic traverses had seismic velocities of 14,400 to 16,000 feet per second indicative of competent bedrock. However, several traverses yielded seismic velocities of 11,500 to 12,700 feet per second. These lower seismic velocities are interpreted to be indicative of bedrock with moderate fractures. It should not noted, though, that there is potential for zones of even greater fracturing, but, the method of seismic refraction surveying provides only general, average velocities across the traverse, such that those smaller or narrower zones may not be specifically identified. Several seismic refraction traverses that exhibited the lower seismic velocities included the following.

Traverse 3:	(adjacent, just west of Building 41) = 12,600 feet per second.
Traverse 02-22:	(along Thompson Road) = 12,600 feet per second.
Traverse 02-23:	(between Building 39 and 41) = 12,600 feet per second.
Traverse 02-06:	(north segment just south of Building 41 = 11,500 feet per second.
Traverse 02-07:	(just south of Building 41 = 12,700 feet per second.
Traverse 02-1:	(western segment northeast of Building 319) = 12,600 feet per second.
Traverse 02-3:	(western segment southwest of Building 319) = 12,600 feet per second.

The pattern of lower seismic velocities corresponds to the unmonitored "hypothesized' groundwater preferential flow pathway (shown by groundwater inflections on Navy and USACOE deep groundwater contour maps). This pathway is centered west to east between Building 39 and 41 to the east side of Building 41. This pathway leads into Site 16 from up gradient Site 03 and the former Nike PR-58 site according to the Navy and USACOE published groundwater contour maps. See attached figures. The approximately 2,000 feet per second velocity differential between traverses with higher seismic velocities provides ample reason to interpret this zone as more fractured than surrounding bedrock and likely to provide preferential flow of groundwater in bedrock at Site 16.

Navy Response to EPA Follow-up Comment No. 20:

Please see the attached plan (Enclosure No. 6) for the upgradient groundwater investigation.

EPA Follow-up Comment No. 21:

Comment not addressed. Again, the tone of this response is argumentative and the statements made not supported by the data. The Navy asks the EPA to provide specific data that supports groundwater inflections and a preferential pathway. The Navy only has to look at its own data that clearly shows inflections in the groundwater contours supporting the pathway inferred. Further, the Navy is referred to groundwater contours developed by the US Army Corps of Engineers in the report "USACE NED Characterization of CVOC Contamination Report Former PR-58 Nike Site North Kingstown, Rhode Island". These contours by another party also clearly depict a sharp, focus of groundwater in the deep overburden pointing from the former Nike PR-58 Site through and including Site 03 to an area between Building 41 and 39. These anomalous contours indicate subsurface groundwater control (in addition to the direction of groundwater flow to the Site 16 area). (See also geophysical note in Comment 20).

Further, the second portion of the response is totally unsupported and contrary to the data. As noted above and in the Navy's own groundwater maps, groundwater flows from the former Nike PR-58 site through Site 03 to Site 16. While there may be radial flow from the former Nike PR-58 site that

contributes CVOC to the northeast and east as well, their interpretation that the primary groundwater flow is to Building 224 is not correct. The Navy is also referred to the groundwater contours the Navy developed for its *Interim Groundwater Sampling Event 04 – June 2005 Results Report for Site 03.* As noted in Comment 19 above, these contours clearly show flow to the southeast to be a major, if not the predominant groundwater flow pathway. Further, they show flow to Building 224 to be from Study Area 1within Site 03.
The interpretation that groundwater and/or CVOC have not moved very far is not supported. There is ample evidence that the bedrock is highly fractured in places that provides rapid movement of groundwater. There are also downward vertical gradients in the up gradient location and upward gradients in the Site 16 area. The Navy is referred to the response to Navy response to Comment 19 and 20 above as well as Comment 22 below.

Navy Response to EPA Follow-up Comment No. 21:

Please see the attached plan (Enclosure No. 6) for the up gradient groundwater investigation.

EPA Follow-up Comment No. 22:

Comment not addressed. The response to this comment is unsupported and contradictory. The Navy states that no hydraulic conductivity tests have been conducted in bedrock at Site 16. If there is no slug test data at Site 16, how can the Navy state that it knows the hydraulic conductivity of the bedrock at Site 16, and the area in between Site 03 and Site 16 based on four wells in one small location some distance away at the furthest boundary of Site 03? It states that four slug tests at Site 03 (one adjusted by the Navy) had values less than three feet per day. Even this data is uncertain (see response to Comment 19).

However, slug tests are not the only means of interpreting relative hydraulic conductivity and preferential pathways in bedrock. Standard geotechnical engineering practice interprets rock cores with RQD values of 50% or less to be highly fractured, and as a result, of relatively high hydraulic conductivity. Examination of the RQD values for the site is summarized on Figure 3-7 of the Supplemental Phase II Remedial Investigation Data Package. Rock cores with RQD values below 50% are extensive throughout Site 16 and follow a pattern similar to the CVOC “plume” and the upward vertical gradients from the bedrock to the deep overburden. That is, rock in areas surrounding this zone exhibits RQD values of relatively competent rock with values around 90%. This pattern strongly indicates zones of high hydraulic conductivity in the bedrock.

In any location where there is glacial outwash material, the highest groundwater yield is from the overburden. That is because due to overall bulk effective porosity, greater yield is obtained from a comparable unit mass. That is not to say that segments of rock can have effective porosities much higher than that for glacial outwash materials. The issue here is preferential fracture zone, not whether sand has a higher yield than rock. The EPA has continually stressed that there is a potential for flow in localized, highly permeably rock zones as created by faulting, etc. EPA has never stated or implied that bedrock as a whole is more permeable than sand as the Navy comment implies.

The third factor has been addressed in response to Comment 19 above. There Navy has not shown that the CVOC concentrations in the deep overburden are much higher, or for that matter, higher when considering equal sample intervals than the bedrock. Nonetheless, even if there is more widespread contamination in the deep overburden, this does not discount contribution from discrete, preferential bedrock fracture zones discharging to the deep overburden.

The Navy states that because of the above three reasons, the hydraulic conductivity in the deep overburden can be assumed to be greater than the shallow bedrock. The Navy is missing the point. It is common knowledge that the overall bulk hydraulic conductivity for glacial outwash sand is greater than the overall bulk hydraulic conductivity for rock. The issue at hand as described by the EPA is that there is potential for faster groundwater movement and hence contaminant transport along preferential bedrock fractures and fracture zones.

The comment by the Navy in regard to the 750 gallons of water lost in MW16-14R is perhaps indicative of the overall argumentative, yet unsupported by data, approach being taken by the Navy in these responses to comments. EPA also carefully reviewed the logs for MW16-14. MW16-14D (overburden) was completed over the time frame of January 29 to 30 of 2001. There is no mention of water lost on that log. MW16-14R (bedrock) was completed over the time frame of August 2 to 5 of 2004. The water lost is annotated on that drilling log. This is clear evidence that the water was lost during coring of MW16-14R and not from drive and wash of MW16-14D which occurred two and one half years earlier.

Navy Response to EPA Follow-up Comment No. 22:

The Navy has proposed the installation of bedrock wells in the up gradient area west of Bldg 39/the former Bldg 41 (see Enclosure No. 6) and has also recommended that 17 shallow bedrock and 4 deep bedrock wells be tested for determination of hydraulic conductivity (per the Phase III QAPP, packer tests will also be performed). (The EPA has specifically indicated that investigations of the bedrock system are needed in these two areas.) Thus, data collected during the Phase III field investigation will allow for a more complete understanding of the potential for contaminant transport in the bedrock system at Site 16.

EPA Follow-up Comment 23:

Comment not concurred with. The Navy does not concur that bedrock provides a major pathway for contaminant transport and has strenuously argued that it does not (not just that there is insufficient data). The available evidence suggests otherwise (see Comments 19, 20 and 22). The additional work proposed is minimal, at best and does not commit to a geophysical survey. If the geophysical survey is not performed, more than one well cluster will be necessary. This was discussed on the February 14, 2007 conference call and an understanding of the Navy's reliance on direct push was obtained. EPA does agree that the re-processing of the existing data set, if possible, along with information evaluated from the direct push chemical screening and lithologic information evaluated from drilling, may indeed address our issues without an another geophysical investigation. However, this issue may need to be revisited if the reprocessing and direct push technologies do not address EPA concerns of possible bedrock fracture flow in the up gradient area.

Navy Response to EPA Follow-up Comment No. 23:

Please see attached plan (Enclosure No. 6) for the upgradient groundwater investigation.

EPA Follow-up Comment No. 24:

Comment noted. However, there is significant uncertainty in this response. It suggests that the geophysical survey may not be performed and that installation of any wells will be based upon the field screening only. Further, while a synoptic round of groundwater elevation measurements are planned, it is not clear that there are sufficient wells since there is only 1 well per 10 acres up gradient and it is noted that some of those existing wells may not be serviceable.

Navy Response to EPA Follow-up Comment No. 24:

Please see attached plan (Enclosure No. 6) for the upgradient groundwater investigation. It is anticipated that most of the proposed downgradient wells listed on Table 4-3 will be installed. However, the actual locations of the wells will be based on screening level data and "raw" (unvalidated) FBL data from DPT soil samples and groundwater samples from temporary wells/Hydro-Punch. Also, please note that the Navy agrees that an understanding of the conditions *immediately* upgradient of Site 16 is important to the Site 16 remedial investigation. However, a comprehensive, hydrogeological characterization of all areas downgradient of the NIKE Site (and upgradient of Site 16) is not an objective of the Site 16 investigation. The Navy does agree that the bigger-picture issue of the migration of potential NIKE PR-58 Site contamination onto Navy property is worthy of additional discussions between EPA, RIDEM, the Navy, and the USACE.

EPA Follow-up Comment No. 26:

Comment not addressed. The response to the 3rd paragraph is ambiguous as to whether an additional well cluster will be placed near Building 319 or at any other up gradient locations. Results of the, February 14, conference call indicate otherwise.
In their response to the 4th paragraph the Navy states that EPA has discounted spills to storm drains as being potential contributors of CVOC to the subsurface. In fact, the EPA in its comments on Work Plans for Site 16 has suggested this as a possible explanation for a source area as no overburden source has been identified near Building 41. The Navy comment relative to TCE being observed primarily in the deep overburden and bedrock indicating that this area is not a current source misses the point. First, the conceptual site model needs to include consideration of all potential significant sources including past releases. For instance, the Navy has challenged the EPA to explain CVOC in the shallow groundwater. CVOC (solvents) released to sediment in storm drains will adhere to organic matter in the sediment (including hydrocarbons adsorbed to silt) as well as migrate vertically downward through breaks in the storm drain piping and catch basins. This residual in catch basins and storm drain sediment will continue to bleed unless the sediment is removed.

Navy Response to EPA Follow-up Comment No. 26:

Please see the attached plan (Enclosure No. 6) for the upgradient groundwater investigation. Also, specifically with regard to a potential well nest south of Bldg 319, a well nest would be installed south of this area (VOC Screening Area No. 1) if screening level or FBL data for the soils and/or temporary wells in this area (and hydrogeological data for the area) suggest a potential for contaminant migration south from VOC Screening Area No. 1. Also note that a storm water system investigation is a component of the Phase III field investigation. This will include sampling of sediments in catch basins and the collection of soil samples from areas immediately adjoining storm system features once the Navy acquires a better understanding of the past and current configuration of the storm water system.

EPA Follow-up Comment No. 28:

Comment noted. However, the conclusions of the Navy are, to date, not supported by sufficient data. Additional data collection described is welcomed to help resolve this issue.

Navy Response to EPA Follow-up Comment No. 28:

Comment noted.

SPECIFIC COMMENTS

Specific Comments on the Draft Phase III QAPP

EPA Follow-up Comment No. 35:

Comment noted. The Navy notes that RQD values less than 50% are indicative of “comparatively high permeability”. This is a correct statement. As noted in Comment 19, 20 and 22 above, there is substantial information for the EPA (and the Navy) to interpret that there are zones of highly fractured bedrock capable of transmitting groundwater and potentially CVOC. Rock with RQD less than 25% is of very poor quality (extremely fractured), less than 50% is of poor quality (highly fractured), and less than 75% is of fair quality (contains significant fractures).

Further, the 50% RQD values is not “arbitrary”. In standard geotechnical engineering practice, rock cores with less than 50% RQD are considered to be highly fractured and therefore, likely to have very high hydraulic conductivities. It is noted that the zones depicted on the various Navy investigation report figures shows that elevated CVOC concentrations in the deep overburden and bedrock occur along the areas where the bedrock exhibits low RQD values and also typically upward vertical gradients from the bedrock to the deep overburden. This confluence of site characteristics may or may not indicate that

CVOC migrates with groundwater from the bedrock to the overburden. There is, however, distinct data to support EPA interpretation of bedrock being a potential contaminant migration pathway (among others) that needs to be investigated.

Navy Response to EPA Follow-up Comment No. 35:

Comment noted.

EPA Follow-up Comment No. 41:

Comment noted. The Navy response is somewhat incomplete. While it states that CVOC vapor concentrations beneath the pavement, etc. would only be at the solubility of the source present, it omits the potential buildup from lateral migration in soil from areas where the source(s) is not in the immediate vicinity. This migration can be due to heterogeneities in the soil including silt and clay lenses present at Site 16 that can impede downward vertical flow of groundwater and DNAPL and also upward vertical flow of gases. Therefore, an assumed source area concentration may not be sufficient.

Navy Follow-up to EPA Comment No. 41:

Comment noted. While the soil gas sampling proposed for the Site 16 will contribute to our collective understanding of a potential for a soil gas issue at Site 16, it is likely that any buildings or structures constructed in the areas of concern in the future will be constructed assuming there is a potential for vapor intrusion and appropriate precautions taken.

EPA Follow-up Comment No. 43:

Comment noted. The Navy is inconsistent in its responses to comments. While in this response it notes that hydraulic conductivity data at Site 16 is limited, in previous responses to comments it rigorously argues (based on four slug tests at the far western edge of Site 03) that bedrock hydraulic conductivity is low. On the other hand, the statement implies that there is no data at Site 16 to estimate relative hydraulic conductivity in bedrock. This ignores the extensive RQD data, which the Navy itself notes is indicative of “relatively high permeability” as well as seismic survey data. It is important that any slug/packer testing of bedrock wells must include a proportionate number of wells with low RQD values.

Navy Response to EPA Follow-up Comment No. 43:

Comment noted. The Navy has identified slug and packer testing for a proportionate number of wells with various RQD values, vertical gradients, etc., in order to provide a comprehensive understanding of the hydrogeological flow system at Site 16 and adjacent areas.

EPA Follow-up Comment No 57:

Comment noted. The Navy response provided does not provide robust confidence in the screening procedures. The comment that personnel are available to train or be part of the field crew suggests that there is high potential for subjective operator interpretations and therefore, errors. Also the statement that the Navy has become familiar with all advantages and “limitations” of the test does not provide confidence, even with vendor support to overcome those limitations. As far as the chloride versus chlorine interference concern there is a concern for chlorine interference since chlorinated water is/has been used at Site 16. That is, unless the Navy has documentation that potable water has not been chlorinated, there is a concern that interferences from chlorine residual can be present in site groundwater. This is from routine wash down operations, past fire fighting operations, and leaking water mains as well as the large underground water supply reservoir that had existed up gradient from Site 16. Therefore, careful evaluation of potential chlorine interference is warranted. EPA will be providing occasional oversight during the Triad investigation. Please provide advance notice as to when the pilot test will be performed and when the Triad professional will be out in the field.

Navy Response to EPA Follow-up Comment No. 57:

Please note Navy response to EPA Follow-up Comment No. 18 regarding field personnel qualifications. The Navy will consult with the QDC (and the water utility in the area) regarding the potential for recent releases of large quantities of chlorinated, potable water in the area of investigation. However, unless the release is recent and substantial, it is unlikely that there would be significant free chlorine residual in the groundwater of the area of investigation.

Additional EPA Follow-up Comments after the February 14, 2007 conference call:

The Navy's statement that there is no contamination found at NCBC in the bedrock if none is found in the overburden misses the point of bedrock fracture flow. Fractures are sometimes only hydraulically connected within the bedrock for a distance and then become connected to the overburden quite a distance down gradient and then loose that connection. The Navy's reliance on direct push overburden investigation without bedrock investigation (reprocessing the previous seismic data, conducting additional geophysical investigations both horizontally and vertically, or performing bedrock coring) may not provide adequate characterization of the up gradient fracture flow.

EPA does not agree that a direct push point near the MW 16-55 FID hit will be adequate. EPA requests a permanent well be placed at that depth.

We did agree to wait for the Navy's overburden investigation prior to placement of the, only for cost estimating purposes, up to three intermediate, deep, and rock well clusters.

Navy Response to EPA Follow-up Comments after the February 14, 2007 conference call:

Please see attached plan (Enclosure No. 6) for the upgradient groundwater investigation.

ATTACHMENT TO ENCLOSURE 8

RESUMES OF SCOTT ANDERSON, JEFF SCHUBERT, AND JOHN WRIGHT

SCOTT R. ANDERSON
EARTH SCIENTIST III / HYDROGEOLOGIST
PITTSBURGH, PENNSYLVANIA

EDUCATION: B.S., Geosciences, The Pennsylvania State University, University Park, PA, 1995 with Honors and High Distinction with emphases in Geophysics and Paleontology, Department Marshall (Valedictorian).

CERTIFICATIONS/ REGISTRATIONS: None (Qualified to take Professional Geologist Exam in PA and VA)

TRAINING:
OSHA 1910.120 40-Hour HAZWOPER Training; April 1996
OSHA 1910.120 8-Hour Annual Refresher Training; June 2006
OSHA 1910.120 8-Hour Supervisory Training; Fall 1998
OSHA 1910.120 8-Hour Supervisory Refresher Training; January 2004
OSHA 29 CFR 1910.146(g) thru (k) Permit Required Confined Space – Authorized Attendant and Entrant; July 2006
RCRA Hazardous/Toxic Waste Management; January 2003
American Red Cross CPR; April 2001
American Red Cross First Aid Training; April 2001

EXPERIENCE SUMMARY:

Mr. Scott Anderson has a total of 11 years of professional experience in hydrogeologic investigations and design, implementation and management of site characterization investigations; environmental site assessments; soil, groundwater and surface water sampling; long-term and short-term pumping tests; Field Portable X-Ray Fluorescence (FPXRF) – both sample preparation and analysis; underground storage tank investigations and closures; LNAPL site characterization and advanced evaluations of free product thickness' and volume (consistent with API methodologies); evaluation and comparison of LNAPL remedial designs; 3-D LNAPL modeling in both unconfined and semi-confined systems; design, implement, oversight and quality assurance of field programs; interpret, review, and assist permitting and compliance issues at local, state, and federal level; prepare reports, graphics and figures including data analysis and interpretation; database construction, implementation, and management; computer applications including pre- and post-processing of DOS based and GUI based data sets; Geographic Information Systems (GIS); statistical analyses (including standard EPA techniques); transport and fate modeling (analytical and 3-D finite difference methods); and structural geology, mineralogy, petrology, paleontology and hydrogeology.

Mr. Anderson has environmental experience for government and industrial clients and has performed multimedia environmental sampling including: surface water, groundwater, sediment, surface soil, subsurface soil, lagoon/sludge, drums, waste piles, landfills, ecological, biological (Anthrax) and air sampling. Mr. Anderson has served as both Field Operations Leader as well as Site Safety Officer on numerous field efforts. He has also provided oversight of subcontractor personnel during the removal of underground storage tanks (USTs). Experienced in National Pollutant Discharge Elimination System (NPDES) sampling methods, permit renewal, stormwater sampling and discharge monitoring reports (DMR). Experienced in the use of automated samplers, flow measurement devices, multi-parameter water quality meters,

FPXRF, Radiological monitors and flow-level recorders as well as equipment calibration and maintenance.

Mr. Anderson has served as field geoscientist while supervising subcontractors during drilling activities. He has also assisted in installation of monitoring wells using various drilling methodologies as well as various hydraulic conductivity test methods. He is experienced in the use of direct push technology (DPT) system for subsurface soil investigation and temporary monitoring well installation. He has also trained as well as had field experience in the collection and analysis of field geochemical and geotechnical parameters.

Mr. Anderson was formerly responsible for field equipment and field vehicles used by office personnel while at GeoTrans, Inc. in Sterling, VA. Duties included: effectively organizing for short-term and long-term storage of equipment, maintenance of both vehicles and equipment, and coordination of use of this equipment for both the Sterling, VA and other GeoTrans offices. Also, was the designated office representative to rental and other environmental field equipment related companies.

Mr. Anderson was the Health and Safety Officer for the GeoTrans, Inc. office in Sterling, VA for 3 years. Responsibilities included aiding in the preparation, reviewing and approving of health and safety plans for all field activities coordinated through the Sterling Office. He provided health and safety materials and training to all employees at Sterling Office, which included non-technical staff. He maintained MSDS sheets on all appropriate on-site materials. Additional duties included: coordination of yearly 8-Hour HAZWOPER/Health and Safety refresher class, coordination of various American Red Cross programs, tracking of yearly medical exams for all field employees, and trouble shooting individual health and safety concerns for field projects.

PROJECT EXPERIENCE:

Project Geologist/Hydrogeologist; CERCLA RI/FS; U.S. Navy; Naval Support Activity (NSA), Mechanicsburg, PA; March 2005 to Present. Project geologist/hydrogeologist responsible for the characterization and remedial process evaluation of multiple waste disposal sites. The sites include two landfills, two bulk storage areas and a drainage ditch that is the primary storm water drainage feature for the base. Activities included oversite of geophysical survey, collection of extensive soil and groundwater samples (multiple rounds of waste/soil sampling (including several DPT investigations – one over 400 locations) and three rounds of low-flow groundwater sampling), RI and performance monitoring report preparation for various sites, remedial activity monitoring for a soils bioremediation pilot study and a groundwater remediation (chemical oxidation) pilot study, and supporting program/project manager for meetings and negotiations with regulatory agencies. Other responsibilities included procurement of materials and subcontractors and oversight of subcontractor work performed.

Lead Project Geologist/Hydrogeologist; CERCLA Investigation for Site 16 and Site 7 at the Naval Construction Battalion Center Davisville; U.S. Navy, EFANE/CLEAN; North Kingstown, Rhode Island; September 2005 to Present. Lead project geologist/hydrogeologist for a task order contracted with the Navy for at the Naval Construction Battalion Center at Davisville. A significant trichloroethene plume underlies two sites (Site 16 and Site 7) which are

being investigated under a Federal Facilities Agreement (a ROD was written for Site 7). Groundwater is the primary media of concern for both sites; approximately 200 monitoring wells at Site 16 were installed to evaluate the vertical and lateral extent of contamination at the site. The existing data was evaluated to identify data gaps for the completion of the remedial investigation for the site as well as the preparation of quality assurance project plan (QAPP) for the resolution of those data gaps. A significant Phase III RI field investigation including numerous DPT borings, in-field chemical analyses by Color-Tec and immuno-assay methods, hydrogeological testing, as well as an integrated Triad approach will be used. Coordination with other government parties and both federal and state agencies will also be done.

Project Hydrogeologist; U.S. Department of the Navy, Portsmouth Naval Shipyard; U.S. Navy CLEAN Northern Division; Kittery, ME; March 2003 to Present. Evaluate the geological and hydrogeological conditions of an island facility located in an estuary in various stages of RCRA Investigations, in various site areas. Also analyzed the tidal influence on groundwater flow in unconsolidated materials and fractured bedrock to assess groundwater quality and changes in flow directions at different portions of site under different geometric and physical shapes. Analyzed initial results and wrote work plans for further investigative actions. Specific tasks included: FOL and SSO for Ash Delineation/Extent Investigation at Site 34 (over 100 DPT holes drilled, logged and examined for presence of ash), wrote QAPP Addendum for Site 10 detailing investigation of lead in both subsurface soils and groundwater (oversaw all technical aspects and was primary lead writer - also prepared site summary of hydrogeology and geology for technical meeting), FOL and SSO for Site 10 Addendum work (DPT and hand-collection of soils and analyzed by FPXRF); evaluated geology and hydrogeology of OU2 and prepared technical sections of Remedial Design report. Assist program manager for presentations to RAB meetings.

Various Clients, September 2003 to Present. Project hydrogeologist responsible for evaluation and design of injection/extraction systems for delivery of bimetallic nanoscale particles (BNP) or other bioaugmentation systems to promote *in-situ* abiotic degradation of chlorinated solvents. Either existing or new MODFLOW models are created and calibrated and utilized for project needs. Emphasis is placed on matching site conditions and ensuring future injection/extraction systems achieve full capture of target groundwater zones reducing contaminant mass. Project hydrogeologist responsible for use of BIOCHLOR to estimate degradation of TCE in assistance of Pilot Study designs (when site data is not available for construction of MODFLOW models).

Lead Geologist; Geotechnical/Environmental Site Investigation; Confidential Industrial Client; Pittsburgh, PA; January 2005 to Present. Lead geologist responsible for the geotechnical and environmental site investigation of a parcel within an operating chemical plant for possible use in a planned plant expansion. The project entails a geotechnical drilling and testing program, engineering evaluation and preparation of foundation recommendations for proposed chemical processing line structures, and identification/evaluation of potential soil excavation handling issues related to the presence of soil contamination from historic plant operations. Responsibilities included collection and logging of geotechnical borings, collection of subsurface soil samples for VOCs and surface soil samples for asbestos, and preparation of a site map and summary report characterizing both the geotechnical and environmental issues.

Support Geologist; Emergency Response Action, Major Insurer, Altoona, Pennsylvania; September 2005 to October 2005. Served as a support geologist for expedited response of a home heating oil spill. A heating oil delivery service inadvertently pumped 750 gallons of heating oil into a septic tank. The property owner discovered oil flowing along a ditch located an adjacent agricultural field. Performed preliminary site visit to assess appropriate remedial actions to be taken. Oversaw collection of several soil samples along the excavated areas to confirm adequate soil removal. All work was performed to comply with the Pennsylvania Department of Environmental Protection Land Recycling Program (Act 2) with the intent of obtaining liability protection. Assisted in preparation of a data report for client submittal.

Project Hydrogeologist/Lead Modeler: USEPA, RAC III; Boyertown, PA; CERCLA; November 2003 to Present. Lead modeler responsible for the site conceptualization, development, and calibration of a three-dimensional computer model (MODFLOW) to evaluate current and future pumping conditions on- and off-site. Geology is a fractured bedrock system, having three distinct geologic regimes governing groundwater flow in the area. Assist the project manager in evaluation of long term remedial activities associated with the chlorinated solvent groundwater plume with respect to geology and hydrogeology. Assist the project manager consider remedial activities including: changes to the operation of a groundwater treatment plant, operation of residential well treatment systems, and groundwater monitoring to monitor plume cleanup.

Technical Specialist/Project Hydrogeologist; Corrective Action Plan (CAP) Addendum; NASA Wallops Island; Wallops Island, Virginia; July 2004 to Present. Technical specialist/project hydrogeologist responsible for the evaluation of geological and hyrdrogeological data for two sites within the Wallops Island facility. Data included information from multiple sources over a large time frame. Lead project hydrogeologist responsible for the construction and evaluation of previous, current, and future site conditions (chemical, geological and hydrogeological) utilizing the screening models BioChlor and BioScreen. Assisted program engineers with evaluation of remedial options and designs based on modeling results.

Technical Specialist/Project Hydrogeologist; Corrective Action Plan (CAP) Addendum; Former Fuel Farm; United States Coast Guard, Support Center Elizabeth City, North Carolina; March 2004 to Present. Technical specialist requested to evaluate a JP-4/JP-5 LNAPL and a dissolved plume greater than 200,000 gallons encompassing a 3 acre site. Evaluation of all investigations, technologies employed, and LNAPL thickness' and recoveries versus time considered. Re-evaluated previous estimates of free-product plume consistent with API calculations taking into account soil properties, LNAPL properties, and current site conditions. Recommendations to the CAP Addendum made to achieve closure goals consistent with Coast Guard and state regulatory agencies.

Project Geologist; U.S. DOD, Department of the Navy, Southern Division, Naval Facilities Engineering Command/CLEAN; Naval Training Center Great Lakes; Great Lakes, Illinois; October 2000 to Present. Project geologist responsible for evaluating geology and hydrogeology at several sites. Prepared cross-sections, potentiometric maps, and determined hydraulic conductivity based on all site-specific, collected data. Wrote sections covering geology and hydrogeology for Remedial Investigation Report and evaluated and edited entire report. Assisted

with the overall understanding of initial release, current conditions, and future transport and fate mechanisms present at the site. FOL and SSO for Landfill Delineation and Radiological Investigation at Site 1. Installed over 100 DPT borings and 3 temporary monitoring wells. Collected soil and water environmental samples and monitored for radiological parameters (alpha and beta counts).

Project Hydrogeologist; U.S. Navy; Naval Industrial Reserve Ordnance Plant, Fridley, MN; December 2004 to Present. Project hydrogeologist responsible for over-site of installation of two temporary monitoring wells using Rotosonic techniques and collection of groundwater samples screened at discrete vertical zones. Constructed geological cross-sections utilizing newly installed wells and previously installed wells to evaluate contaminant migration pathways. Assisted program managers with response to comments involving geology.

Geologist; Site 13 Remedial Investigation and Feasibility Study; Naval Weapons Station, Earle, Navy Installation Restoration Program, Northern Division; Earle, New Jersey; February 2005 to Present. Collected composite soil and sediment samples in a wetland to delineate the extent of PCB and metal contamination in the area and assist with soil volume removal estimations. Sample locations were determined using Magellan GPS unit and sampling was done with hand augers.

Field Geologist; U.S. DOD/CLEAN; Bethpage NWIRP; Bethpage, NY; U.S. EPA Region II; CERCLA; Bethpage RI/FS/RD/RA; November 2004 to Present. Field geologist responsible for the over-site of well abandonment activities and well restorations at on-site and off-site monitoring wells. Used magnetic locator to find several wells buried by several feet of overburden. All wells were abandoned in accordance with CERCLA and the NY State Health Department.

Project Geologist; Butz Landfill Site Long-Term Operations and Maintenance; U.S. EPA Region 3; Tannersville, Pennsylvania; November 2002 to February 2004. Assisted with the geologic and hydrogeologic understanding for a groundwater extraction and treatment system at an NPL site. The groundwater remedy includes three extraction wells pumping contaminated groundwater at nearly 80 gpm. Responsibilities included preparing figures (cross-sections, chemical and potentiometric maps, and vertical flow nets) based on geology and hydrogeology for semi-annual groundwater monitoring reports and assisted in Response to Comments letter for geologic and hydrogeologic content.

Field Technician; White Oak Naval Facility; US Navy Northern Division; White Oak, MD; November 2003 to January 2004. Performed PCB sampling in surface soils at two SWMUs. Composite sampling was performed, based on a grid established in the field. Determined extent of PCBs at one SWMU to assist in excavation activities utilizing SDI Immunoassay test kits.

Project Hydrogeologist; Interim Remedial Measure; NAS Jacksonville; U.S. Navy, Southern Division CLEAN and Naval Facilities Engineering Command (NAVFAC); Jacksonville, Florida, September 2003 to October 2004. Project hydrogeologist responsible for evaluation and design of injection/extraction system for delivery of bimetallic nanoscale particles (BNP) to promote in-situ abiotic degradation of chlorinated solvents. An existing MODFLOW model created and calibrated by the USGS was utilized and modified for project needs. Additional layering was

added and hydraulic conductivities matched to site-specific data to further calibrate and evaluate results.

GeoTrans, Inc.:

Transport and Fate Modeling and Multi-phase Modeling

Senior Geologist/Earth Scientist III; Confidential Site; ExxonMobil; Baltimore, Maryland; July 2003 to October 2003. Lead modeler responsible for the site conceptualization, development, and calibration of a complex computer model involving multi-phase flow of water, LNAPL, and air. Model program used was SWANFLOW, and included a newly installed LNAPL only removal option. Primary goals were: to determine a radius of influence of LNAPL pumping under varying conditions in complex lithologies; to determine the current LNAPL migration rates and directions; and determine the most time efficient LNAPL recovery methods. Site specific data was utilized and included capillary pressure curves, saturation profiles and lithologic analyses. Geology was complex, being a former seashore subject to multiple transgressions and regressions, resulting in dome-like structures that act as stratigraphic traps. The calibrated modeling showed that LNAPL recovery is dependent upon successful identification and location of the stratigraphic traps. Modeling results are currently under review by both the client and state agency.

Senior Geologist; W.R. Grace Superfund Site; W.R. Grace; Acton, Massachusetts; Fall 2001 to Summer 2003. Team/Lead modeler responsible for the development, site conceptualization and calibration of a three-dimensional flow and transport model to verify current and assess future remedial remedies at a current industrial site. Tasks included refinement of original model grid, re-interpretation of layering based on lithologies from well logs completed by multiple parties, and re-evaluation and designation of boundary conditions. Primary calibration was completed to current conditions, and included verification to water levels at on- and off-site wells, stage elevations of several surface water bodies, pumping rates to 16 wells, recharge observed, fluxes to surface water bodies, and vertical gradients. The calibrated model was verified under steady-state conditions to historical site conditions, and verified under transient conditions to long term, high rate pumping test. The model was used under historical operating conditions to evaluate and verify contaminant migration as currently observed. The model will be used to evaluate possible remedial remedies, minimizing costly field work to achieve the same goal. The model is being reviewed by federal, state, and local agencies, as well as other consulting firms. A full modeling report was prepared and submitted for their use.

Project Geologist; BASF Riverview Flow Model; BASF; Riverview, Michigan; March 2001 to August 2001. Modeler responsible for aiding in the development, site conceptualization and calibration of a three-dimensional flow and transport model to verify current and assess future remedial remedies at a former industrial site. Tasks included construction and calibration of current model conditions, and construction and calibration of future remedial designs including effects of evapotranspiration and a groundwater extraction system. Model layering was designed based on available geologic records to accurately represent the subsurface flow regime, and evapotranspiration rates and extinction depths were estimated based on type, size, and coverage of tree groves present now and in the future at the site. Results of the future

remedial design show that inward hydraulic gradients can be maintained (as mandated by the Michigan Department of Environmental Quality) with evapotranspiration playing a key role in "cleaning" the site.

Project Geologist; Rockwell Automation; Rockwell; San Juan, Puerto Rico; Spring 2000 to Summer 2001. Primary Modeler/Modeling Task Manager responsible for the development, site conceptualization and calibration of a three-dimensional flow and transport model to assess the nature of impacted groundwater and determine length of time pump-and-treat remediation is necessary before utilizing monitored natural attenuation as a viable remedial action. Particle tracking was performed to determine migration pathways, utilized for determining compliance monitoring program. Model was calibrated to three distinct times assumed at steady-state conditions, with the final model being transient for both pumping and parameter concentrations. Results of the transport model are consistent with subsequent multi-species transport analyses, which have guided the changes to the remedial action plan.

Project Geologist; Melbourne Deep Well Injection Modeling; L.S. Sims & Associates; Melbourne, Florida; Summer 2000 to Summer 2001. Primary Modeler to simulate a high rate effluent injection into a deep well, to determine if a Class I Nonhazardous injection well permit can be obtained. The three-dimensional, transient groundwater modeling program SWIFT98 was used to determine the maximum vertical and lateral distances that the injected fluid would migrate. The model was constructed from available geologic data including geologic cross-section, field data, and laboratory results, which resulted in a 93 layer, radial model grid that also accounted for several casing leaks. The SWIFT98 model was calibrated to observed pressure and geochemical data in both the deep injection well and three monitoring wells screened at various depths above the injection interval. Effects of variable fluid properties were represented. Visual Basic modules were written to aid with the pre- and post-processing of the data. Results show that the injected fluid does not migrate into the lowermost Underground Source Drinking Water aquifer, allowing for pursuit of a miner aquifer exemption.

Project Geologist; GE Morrison; General Electric; Morrison, Illinois; Spring 2000 to Fall 2000. Modeler/Modeling Task Manager responsible for the development and calibration of a three-dimensional flow and transport model to assess the nature of impacted groundwater and determine if monitored natural attenuation is viable remedial action. Performed particle tracking to determine migration pathways to assist in recommendations of new monitoring wells to the existing modeling network. Also primary database/GIS Specialist responsible for construction and maintenance of database, used for both the modeling and reporting aspects.

Staff Geologist to Project Geologist; FREPRES Development; ICF Kaiser under USEPA Contract; Washington, D.C.; Fall 1999 to Summer 2002. Primary Modeler to simulate several LNAPL recovery techniques for a combination of soil types, NAPL types, residual NAPL saturations, and NAPL thicknesses. The three-dimensional, numerical multi-phase transport model SWANFLOW was used to obtain the results for each of the 288 simulations established. Simulations were determined from idealized treatment technology conditions for each of the varying parameters. Visual Basic modules were written to aid with the pre- and post-processing of the data. Results were simulated from steady state conditions, which were determined from initial model runs in SWANFLOW. Results of the modeling effort were compiled into a Free

Product Recovery Evaluation System program that allows the user to quickly evaluate whether free-product recovery is practicable.

Staff Geologist; CDM Puente Valley Modeling; Litigation support for Jim Mercer; Southern California; Fall 1998 to Spring 1999. Primary Modeler for computer modeling of particle tracking using three-dimensional finite element groundwater flow model. Duties included: installing and running three programs needed to perform the particle tracking; modifying data source files to run scenarios for both facility pumping and no pumping; and perform particle tracking for two specific source locations in two different three-dimensional steady-state flow fields. Results of particle tracking were used to show that facility pumping adequately captures impacted groundwater at and near the facility.

Site Characterizations and Environmental Assessments

Senior Geologist; Site Confidential; ExxonMobil; Manassas, Virginia; June 2002 to December 2003. Primary field geologist responsible for coordinating, overseeing, and performing quarterly corrective action plan action items, as outlined by the Virginia Department of Environmental Quality. Work includes headspace analysis of all wells, collecting water levels, determining product thicknesses at selected wells, low-flow sampling at all wells for multiple groundwater analyses, trend analyses, and report preparation (including text and figures). Trouble shoot unique field conditions such as low water levels, site access (active ASTs), etc. Additional duties include acting as site contact between client, current owner, state DEQ, and subcontractors. Was field geologist coordinating installation of four new monitoring wells, ensuring that all subcontractors adhere to clients strict protocol procedure and current owner is properly notified and informed of activities.

Senior Geologist/Earth Scientist III; Sites Confidential; ExxonMobil; Chesapeake and Norfolk, Virginia; June 2002 to October 2003. Primary field geologist responsible for coordinating and overseeing monthly and quarterly corrective action plan action items, as outlined by the Virginia Department of Environmental Quality for each site. Work includes headspace analysis of all wells, collecting water levels, determining product thicknesses at selected wells, manual bailing of free product, trend analyses, and report preparation (including text and figures). Trouble shoot unique field conditions such as low water levels, site access (active ASTs), etc. Additional duties include acting as site contact between client, current owner, state DEQ, and subcontractors. General duties to ExxonMobil also include remedial process operations and evaluations. Assist in determining appropriate remedial actions to modify existing remedial action plans to save client time and money.

Senior Geologist; AirBP Dulles Airport; AirBP Global; Loudoun County, Virginia; April 2002 to October 2003. Primary field geologist responsible for coordinating, overseeing, and performing monthly and quarterly action plan items, as outlined by the Virginia Department of Environmental Quality at the Dulles International Airport. Monthly work includes collecting water levels from all wells and headspace analysis at drain points by each AST. Quarterly work includes all monthly work, as well as headspace and visual inspection of the groundwater at all monitoring wells, and preparation of quarterly summary letters. Yearly activities include sampling all wells and preparation of report analyzing results and trends. Additional duties

include acting as site contact between client, airport officials, state DEQ, and subcontractors. Will be field geologist coordinating installation of at least eight new monitoring wells, ensuring that all subcontractors adhere to clients strict protocol procedure and airport security. All holes will be logged, measuring points surveyed, slug tested, and sampled, with a subsequent report written and submitted to client, airport authority, and DEQ.

Staff to Senior Geologist; Reston Fire Station #31; Fairfax County Department of Vehicle Services; Reston Fire Station #31, Reston, Virginia; Fall 1998 to Present. Project Manager of Operation and Maintenance staff for pump-and-treat system. Duties include: quarterly sampling of eight wells for Diesel Range Organics, monthly groundwater elevation survey and subsequent bailing of free product in wells, as well as monthly maintenance of the pump-and-treat system, submission of monthly discharge monitoring reports, and submission of quarterly monitoring reports. Coordinate and prepare all compliance issues for State on behalf of client (monthly compliance monitoring of discharge parameters, quarterly reporting, yearly effectiveness evaluation, and multi-yearly general discharge permitting). Seek reimbursement for field activities through the state UST fund, managing and assembling necessary paperwork for submission. Additional duties are contractor liaison for product/sludge/water removal. Effectively negotiated cost effective solution to existing Corrective Action Plan to reduce time of operation of pump-and-treat system.

Project Geologist; NVHomes Springfield; NVHomes and Sac and Harris Attorneys; Springfield, Virginia; June 2001 to September 2001. Principal project manager/Task leader responsible for site characterization and remedial actions at a housing development with elevated methane levels in basements of homes and in the subsurface of people's yards. Tasks included coordination of site characterization and remedial actions with the Fairfax County Fire Marshall, Client, Client's lawyers and homeowners. Responsibility of acting as environmental engineer to address homeowner's concerns and test their sumps and yards was given by the client. Much time was spent discussing physical and health properties of methane to ease homeowners concerns, resulting in the client avoiding an over-hyped situation concerning a non-issue (and lawsuits). Results showed that methane observed in sumps and yards were of natural occurrence and at insignificant levels to cause concern from both homeowners and the Fairfax County Fire Marshall.

Staff to Senior Geologist; Fairfax County UST Program; Fairfax County Department of Vehicle Services; Fairfax, Virginia; Summer 1999 to Present. Primary Field Operations Staff responsible for coordination and supervision of various Site Characterization activities at County Properties. Tasks include: coordination with Northern Virginia Regional Department of Environmental Quality office on style and content of Site Characterizations, working within VA DEQ Underground Storage Tank Fund specifications, and presentation of results to appropriate Fairfax County personnel. Work with DEQ to determine most cost effective approach for site characterization that still complies with all VA DEQ requirements. Oversee and coordinate VA DEQ compliance issues on behalf of Fairfax County. Seek reimbursement from the state UST fund on behalf of Fairfax County through regional VA DEQ office, managing and assembling necessary paperwork for submission. Duties also include supervision of field staff and subcontractors. Effectively investigated and closed four UST sites and recovered over $400,000 from the VA UST fund for Fairfax County.

Project Geologist; Mayfield Site; Howard County, Maryland; Howard County, Maryland, Summer 2001. Primary geologist responsible for oversite of installation of 12 shallow injection wells and two observation wells. Duties included logging of soil borings, screening of soil for elevated levels of VOCs, and completion of soil boring logs/well completion forms. Duties also included deciding on final depths of wells to be in saturated zone, but also in transmissive layer conducive to chemical injection.

Staff to Senior Geologist; Loudoun County Pump Tests; Loudoun County, Virginia; Summer 1997 to July 2003. Field Operations Staff and Field Operations Coordinator for 8-hour aquifer pump tests for several developers in Loudoun County. Duties included: setting up appropriate submersible pump and discharge assemblies to achieve desired pumping rate vs. drawdown; trouble shoot these set ups for both mechanical and electrical breakdowns; monitor drawdown and plot results in Aqtesolve; complete geologic section for well; and sample for VOCs, metals, etc.

Staff Geologist; GE Lighting Systems; General Electric; Asheville, North Carolina; Summer 1997 to Summer 1998. Field Operations Staff and Field Sampling Coordinator for groundwater and soil investigations at a manufacturing facility. Duties included: establishing sampling location points for soil sampling events, performing groundwater elevation surveys, and groundwater sampling. Soil was sampled for PCBs using hand augers. Groundwater was sampled with both bailers and QED low-flow bladder pumps and included sampling parameters.

Staff Geologist; GE Columbia; General Electric; Columbia, Maryland; Spring 1997 to Spring 2000. Field Operations staff and Field Sampling Coordinator for site characterization activities. Duties include supervision of daily site activities and contractor liaison. This project has included performing a VLF survey to identify a linear fracture trace, installation and development of five bedrock and four saprolite wells, VOC sampling of these nine new wells and existing wells, site-wide aquifer testing, and subsequent treatment of the waste water produced during previous operations.

WasteWater Treatment Supervisor; Hilton Davis Chemical Plant; Cincinnati, Ohio; Summer to Fall 1996. Field Technician at the Lagoon Closure Hazardous Worksite. Performed decontamination of site vehicles and equipment. Operated fork lift (certified), bobcat, and dump trucks. Operated multi-stage inorganic water treatment facility which included inclined, parallel plate clarifier, sand filter, bag filters, and Calgon Activated Carbon cells. Supervised and trained other employees to operate the water treatment facility. Maintained daily journal of operations for water treatment division.

Database Analysis, Construction, Management and GIS

Staff to Project Geologist; Rochelle and Winnebago Landfills, Winnebago Reclamation; Rochelle and Winnebago, Illinois; Spring 1997 to Fall 2001. Primary Database/GIS Specialist for managing GIS, database, permitting, remediation, and reporting requirements for two landfills in Illinois. Tasks included implementation of new data into current database; evaluation of water quality data through: comparison to previous monitoring events, comparison

to regulatory standards, comparison to statistical variations; presentation of water quality data in both tabular and areal styles, prepare quarterly and annual monitoring reports for both client and state. Designed Visual Basic macros to efficiently handle and present data - such as: produce standardized time series plots for multiple wells for many parameters, calculate new regulatory standards using EPA accepted statistical approaches (Upper Prediction Limit, Cohen's Adjustment, etc.) for multiple wells and varying sample populations, manipulate vast data sets in Excel to meet GIS and Access 97 formats. Additional tasks for these landfills included: submittals for permit modifications, coordination of compatible electronic data formats with laboratories, interpretation and construction of geologic cross-sections, and coordination with client for need specific queries and maps. Also part of modeling team responsible for re-calibration of three-dimensional flow and transport model to assess potential migration pathways of releases at landfill liner. Goals of modeling effort was to show effectiveness of landfill design, show migratory pathways to be beyond permit minimum requirements, and suitability of monitoring well network.

Staff Geologist; GE Plastics; General Electric; Parkersburg, West Virginia; Winter 1996 to Summer 1998. Staff Geologist for database management of field investigation results. Responsibilities included coordination, construction, and maintenance of the database. Duties included verification of changes made to laboratory results by Validator, and proper interpretation of these changes. Additional duties included screening of the data against several screening standards such as: soil screening transfers for groundwater and air, soil ingestion for both industrial and residential, and permit specified screening levels.

Various Clients; Spring 1997 to July 2004. Performed analytical computer modeling of two-dimensional groundwater flow. Examined technical reports for both accuracy and precision of geology and grammar. Database management and report preparation for annual reports. Also use Visual Basic to write modules for processing of large quantities of data in short periods of time.

CHRONOLOGICAL WORK HISTORY:

Earth Scientist III; Tetra Tech NUS, Inc.; Pittsburgh, Pennsylvania; July 2003 to Present.
Transferred from GeoTrans, Inc. in Sterling, VA to equivalent position. Position effective on July 26, 2003.

Senior Geologist; GeoTrans, Inc.; Sterling, VA; December 1996 to July 2003.
Actively managed several ongoing projects of varying amounts (ranged from $5000 to >$50,000) and staff employees for project support. Responsible for training and mentoring new geologists. See Project Experience Section for more information.

WasteWater Treatment Supervisor; O.H. Materials Corporation; Cincinnati, OH; July 1996 to November 1996. Temporary position through Virtual Workplace of Pittsburgh, PA.

Upgrade Sales Associate; Computer City; Monroeville, PA; September 1995 to April 1996.

Temporary Project Geologist; Earth Sciences Consultants; Export, PA; July 1995 to September 1995. Performed analytical computer modeling and reviewed technical reports.

Technical Editor; Ore Deposits Research; Department of Geosciences, The Pennsylvania State University, University Park, PA; February 1995 to April 1995. Scanned, prepared, and reviewed technical papers for International GeoChemistry conference publication.

PROFESSIONAL AFFILIATIONS: The Geological Society of America

HONORS AND AWARDS:
Marquis's Who's Who for 2006-2007 in Science and Engineering
Marquis's Who's Who in America for 2006-2007
Marquis's Who's Who in the World for 2006-2007
Marquis's Who's Who of Emerging Leaders for 2007
Appearing in the 60th Edition of Marquis's Who's Who in America, February 2005
Geosciences Department Marshall (Valedictorian), 1995
University Scholar's Medal, 1995 (completion of University Scholar's Program and Thesis)
Undergraduate Research Award, 1995 (poster-board presentation of Thesis work)
A.P. Honess Award in Geosciences, 1995
Evan Pugh Scholar Award (ranked in upper ½ percentile of respective graduating class), 1994
Golden Key National Honor's Society, 1993-1995
Daniel E. Weber Award for Mathematics, 1993
University Scholar's Program, 1992-1995
American Chemical Association Sophomore Award (Received as Freshman), 1992
Presidential Academic Fitness Award (only one of 3 students in school system), 1983

PUBLICATIONS:

Anderson, S.R., 1995. A Reconnaissance Study of the Local Earthquakes in Northern Tanzania, B.S. Geosciences Department and Honors Department Thesis, The Pennsylvania State University, 84 pp.

Anderson, Scott, Michael Knapp, Larry Sims, Daniel Burnell and Patricia Fleming, 2001. "Application of SWIFT Model to Simulate Deep Well Injection in Melbourne, Florida" MODFLOW '01 Conference, IGWMC, Golden, Colorado.

Burnell, Daniel, Mary J. Thurman, Jeffrey Benegar, Scott Anderson, Robert Fuhrer and Richard Gnat, 2001. "Application of MT3D99 to Simulate 1,1,1-TCA and its Degradation Product 1,1-DCE During Recovery Well Pumping" MODFLOW '01 Conference, IGWMC, Golden, Colorado.

Anderson, Scott R., Patrick Craig, and Jorge A. Santiago-Blay, 2002. "A minute fungus beetle larva (Coleoptera: Corylophidae) from Dominican Amber: A striking example of morphological convergence" Geological Society of America '02 Conference, Denver, Colorado.

Anderson, Scott R., Patrick Craig, and Jorge A. Santiago-Blay, 2003. "An exquisitely preserved frog tongue with last insect meal and other exceptional frozen behaviors in Dominican Amber" Geological Society of America '03 Conference, Seattle, Washington.

Benegar, Jeffrey, Thomas Hilbert, Daniel Burnell, Mark Shupe, and Scott R. Anderson, 2003. "Three-Dimensional Groundwater Modeling of a Complex Glaciated Aquifer System at the Rochelle, IL Municipal Landfill" Geological Society of America '03 Conference, Seattle, Washington.

Anderson, Scott R. and Jorge A. Santiago-Blay, 2004. "New Representatives of Predators in Burmite: A Tiny Mantid, A Damsel Bug, and a Larval Megalopteran" Geological Society of America '04 Conference, Denver, Colorado.

Anderson, Scott R., January and February 2004. "Insect Meals from a Leptodactylid Frog (Amphibia: Leptodactyidae) in Dominican Amber (Miocene, 23 MA)" Entomological News, Vol. 115, No.1, pages 52-54.

Santiago-Blay, Jorge A., Anderson, Scott R. and Ronald T. Buckley, November and December 2005. "Possible Implications of Two New Angiosperm Flowers from Burmese Amber (Lower Cretaceous) for Well-Established and Diversified Insect-Plant Associations" Entomological News, Vol. 116, No.5, pages 341-346.

JEFFREY P. SCHUBERT
SENIOR HYDROGEOLOGIST
PITTSBURGH, PENNSYLVANIA

EDUCATION: B.S., Geology, University of Illinois, Champaign, 1972
M.S., Earth Sciences, Pennsylvania State University, 1978

TRAINING: OSHA 1910.120 40-Hour HAZWOPER Training; 1990
OSHA 1910.120 8-Hour Supervisory Training; 1992
OSHA 1910.120 8-Hour Annual Refresher Training; 1991-2007

EXPERIENCE SUMMARY:

Mr. Schubert is a hydrogeologist with 32 years of experience in hydrogeology, geochemistry, radiochemistry, groundwater modeling, and remediation of sites containing hazardous, radioactive, and mining wastes. Expertise includes the design of environmental monitoring programs, hydraulic testing of geologic media, evaluation of contaminant transport processes, groundwater impact analysis, groundwater-surface water interactions, multivariate statistical analysis of geological and hydrogeological data, limnology, groundwater and soil remediation techniques, infiltration and water movement through engineered landfill covers, permitting assistance, and negotiations with regulatory agencies. Experienced in all phases of field investigations and site characterization. Strong technical background in project planning, preparation of work plans, quality assurance, supervision and execution of work plans, data analysis, and report preparation.

Mr. Schubert has had a lead technical or project management role on over 80 RCRA, CERCLA, UST, Brownfields, and other types of environmental and civil engineering projects. Has been manager of private and government environmental investigations ranging up to $500,000 in size. Experienced in coordinating multidisciplinary teams of professionals, meeting schedules, staying on budget, and dealing with adverse weather and logistical conditions. Has participated in projects in 33 states in diverse geological environments, including volcanic, granite, metamorphic, and sedimentary rocks, karstic limestone, valley-fill glacial outwash, and glacial tills.

Mr. Schubert is the technical lead for groundwater modeling within the company. Groundwater and soil gas modeling experience includes the use of MODFLOW, MODPATH, GMS, RT3D, MT3D, PEST, SWIFT/486, PLASM, HELP, SESOIL, AT123D, VLEACH, VS2DT, MULTIMED, MULTIMED_DP, BIOSCREEN, BIOCHLOR, BIOPLUME III, AIR2D, AIR3D, SEQUENCE, WATEQ, MINTEQ, PHREEQCI, CHEMFLO-2000, and others. These models are used to simulate and graphically present results for groundwater flow, well capture efficiency and other hydraulic controls, solute transport, leaching, brine or density-dependent flow, contaminant biodegradation, adsorption/desorption, other transport-related reactions, chemical equilibrium reactions, and soil gas migration. Works constantly with risk assessors, civil engineers, project managers, clients, and regulators to ensure that modeling results are understandable, defensible, and useful in attaining the project goals and satisfying regulatory requirements.

Mr. Schubert has authored more than 20 published technical papers and book chapters related to geochemistry, hydrogeology, and groundwater modeling, and has presented more than 25 other papers at technical symposia. He is currently a member of the American Geophysical Union, the Association of Ground Water Scientists and Engineers, and the Pittsburgh Geological Society.

PROJECT EXPERIENCE:

Senior Hydrogeologist and Groundwater Modeler; Groundwater Modeling and Natural Attenuation Studies for Feasibility Study, Kennedy Athletic Recreation and Social Park I; National Aeronautics and Space Administration (NASA), Kennedy Space Center, Florida (2007). Modeling the migration and attenuation of lead and arsenic in shallow groundwater at two different sites. Groundwater system complicated by tidal action and large component of evapotranspiration which causes unusual water-table surfaces and flow directions. Draft FS nearly completed.

Senior Hydrogeologist; Remedial Investigations (RI), Former Naval Construction Battalion Center Davisville, North Kingstown, Rhode Island (2006-present). Senior hydrogeologist conducting RIs and preparing Long-Term Monitoring plans for four different sites. Site consists of numerous plumes of chlorinated solvents and BTEX migrating through complex glacial overburden and fractured metamorphic rock. Plumes are migrating into Harbor and monitoring of offshore sediments and groundwater are being performed.

Senior Hydrogeologist; RCRA Facility Investigations (RFI), Naval Surface Warfare Center Crane, Indiana (2000-present). Lead geologist and hydrogeologist conducting RCRA Facility Investigations (RFIs) and Corrective Measure Studies (CMS) at twelve different SWMUs. At the Mustard Gas Burial Ground (SWMU 1), the nature and extent of contamination in soil, groundwater, and streams that formerly contained mustard nerve agent, radioactive thorium nitrate, and lab chemicals has been evaluated and the CMS has been completed. The bedrock consists of fractured shales, sandstone, and coal seams overlying karstic limestone. Shallow groundwater contains chlorinated solvents. Monitored natural attenuation has been accepted by the regulatory agencies to address TCE and 1,1,2,2-tetrachloroethane contamination.

Evaluated geologic and hydrogeologic data for Dye Burial Grounds (SWMU 2), which is situated on a ridge of Pennsylvanian-age sandstones and shale. Groundwater was not contaminated with dyes, but an assessment of impacts (elevated metals concentrations) was necessary. One well was acidic and contained the highest metals concentrations. Anomalous groundwater conditions were attributed to localized surface recharge and pyrite oxidation.

Ammunition Burning Grounds/Jeep Trail area (SWMU 3) data were evaluated to determine groundwater flow directions and contaminant transport mechanisms in a karstic limestone aquifer intersected an alluvial aquifer. The RFI report and CMS have been completed. A CM Implementation Plan and a RCRA Groundwater Monitoring Plan are currently being prepared. Interacted with the USEPA and USACE on their joint study of the natural attenuation of HMX, RDX, TNT, and other explosive compounds (energetic compounds) at the sites. RDX contamination of soils and groundwater are also being investigated at SWMUs 12, 13, and 16.

Senior Hydrogeologist and Groundwater Modeler; Groundwater Modeling and Natural Attenuation Studies, Naval Air Station (NAS) Dallas; U.S. Navy; Dallas, Texas (1999-present). Hydraulic characteristics and groundwater flow system at the site are complex. Data from more than 400 wells have been evaluated. Groundwater modeling for three different areas of the facility has been performed, using BIOCHLOR, MODFLOW, and RT3D. The models were used to evaluate migration potential of chlorinated solvents and benzene, and to assess remedial options. The models were calibrated using PEST software. Extensive evidence was accumulated and presented to the regulatory agencies regarding natural attenuation and the potential attenuation rates occurring at 11 different SWMUs. These models have been used to support enhanced monitored natural attenuation as the preferred alternative for groundwater quality remediation.

Senior Hydrogeologist and Groundwater Modeler; Keystone Sanitary Landfill Superfund Site, U.S. Environmental Protection Agency (USEPA); Adams County, Pennsylvania (1999-2004). Migration of chlorinated solvents from a landfill through saprolite and fractured schist was evaluated using three different one-dimensional solute transport codes (MODFLOW-RT3D, BIOCHLOR, and a proprietary spreadsheet model). The models were used to calculate dilution-attenuation factors (DAFs) and develop leachate performance standards for the landfill remediation. The leachate performance standards are to be achieved at the source, so that groundwater downgradient will meet the ROD-specified groundwater performance standards. AIR2D model was used to evaluate the performance and capture efficiency of soil venting system installed in the landfill. The spacing of venting wells is being evaluated to determine if spacing interval is reasonable.

Groundwater Modeler and Senior Hydrogeologist; Groundwater Model Update, Taiwan Nuclear Power Plant, Taiwan (2003). Performed major revisions of MODFLOW groundwater model for radioactive waste storage facility and recalibrated flow model using GMS 3.1 and PEST. MT3D model was built and run to simulate hypothetical strontium-90 release and evaluate possible impacts. Groundwater model training course was presented to employees of Tai Power.

Groundwater Modeler; Bayer Manufacturing Plant; New Martinsville, West Virginia (2002-2004). Senior hydrogeologist for a groundwater modeling effort using MODFLOW, MODPATH, and GMS codes. The transient flow model was calibrated using PEST and a month-long series of production well pumping schemes that stressed the sand and gravel aquifer in several locations. Five different pumping and hydrologic scenarios were simulated to ensure that plume capture was attained under extreme hydrologic conditions. Model was modified to include rerouting of stream, infilling of lagoon, and capping of landfill. Well capture system was then optimized to account for the altered hydrologic conditions.

Senior Hydrogeologist and Groundwater Modeler; SWMU 12 Corrective Measure Studies (CMS), Naval Weapons Station Charleston, South Carolina (2000-2002). Constructed and calibrated a three-dimensional MODFLOW-RT3D model for a chlorinated solvent plume that is migrating through a shallow aquifer toward wetlands. The model was used to evaluate several remedial options.

Senior Hydrogeologist and Lead Groundwater Modeler; Groundwater Investigations, NIROP Fridley; U.S. Navy; Fridley, Minnesota (1999-2002). Six-layer groundwater flow model was constructed for the site using MODFLOW and GMS modeling shell. Data from over 200 wells were used to construct the model. Model was calibration using PEST software. Using MODPATH, the model was used to evaluate the capture of migrating contaminants (trichloroethene) by the existing seven-well extraction system. Calibration was performed using PEST software. The locations and pumping rates of alternative capture well scenarios have also been evaluated and optimized using particle-tracking analysis.

Senior Hydrogeologist and Lead Groundwater Modeler; Remedial Investigation, Operable Unit (OU) 1; Marine Corps Air Station Cherry Point; U.S. Navy; Havelock, North Carolina (1999-2001). Eight-layer groundwater flow model was constructed for the site using MODFLOW and GMS modeling shell. Data from over 250 wells were used to construct the model, which included four different aquifer units and major production wells. Calibration was performed using PEST software.

Groundwater Modeler; Site 17 1400 Area Landfill Remedial Design, Naval Surface Warfare Center Dahlgren, Virginia (1999-2000). Constructed a three-dimensional MODFLOW model to evaluate how well the installation of a landfill cap and planting of phreatophytes (e.g., hybrid poplars) will control contaminant migration from the landfill area into two wetlands. The remedial design will meet ROD requirements.

Manager and Lead Hydrogeologist; Groundwater and Soils Investigation of Aluminum Rolling Mill; Alcoa, Inc.; Lebanon, Pennsylvania (1998-1999). Performed investigations to determine the nature and extent of soil and groundwater contamination in a karst terrain. Groundwater contamination was shown to be very minor. As a result of the investigation, the Pennsylvania Department of Environmental Protection allowed the groundwater monitoring program to be shut down and monitoring wells to be abandoned, with no further action required.

Manager and Lead Hydrogeologist; Groundwater and Soils Investigation, Ross Garage; Port Authority of Allegheny County; Pittsburgh, Pennsylvania (1998-1999). Managed the subsurface investigation of a bus terminal facility to determine the nature and extent of contamination by fuels, oils, and ethylene glycol. Soil and groundwater contamination was found to be very minor and further actions were not necessary.

Senior Modeler; Area D Feasibility Study, Picatinny Arsenal; U.S. Army Corps of Engineers (USACE); New Jersey (1998-1999). Prepared Work Plan and conceptual model for groundwater fate and transport modeling of the large solvent plume in Area D.

Senior Hydrogeologist; Remediation of Ashland 2 and Colonie Radioactive Waste (FUSRAP) Sites; USACE; Tonowanda and Albany, New York (1998-1999). Assisted in the preparation of sampling and analysis plans, dewatering plans, Quality Assurance Project Plan, and project cost estimates for two radioactive waste sites being remediated under the USACE FUSRAP program. Cleanup Verification Work Plan was the first in the country to be written according to the federal “MARSSIM” guidelines.

Groundwater Modeler; RFI; Chemical Manufacturing Plant; New Martinsville, West Virginia (1998-1999). Managed the groundwater modeling effort using MODFLOW, MODPATH, and GMS codes. The flow model was calibrated using PEST. Numerous pumping and hydrologic scenarios were simulated to ensure that plume capture was attained under extreme hydrologic conditions.

Senior Hydrogeologist and Task Manager; Pohatcong Valley Superfund Remedial Investigation/Feasibility Study (RI/FS) Project; USEPA; Warren County, New Jersey (1997-1998). Prepared Work Plans and designed groundwater monitoring/testing program for a large RI/FS of the Pohatcong Valley area, including the drilling, sampling, pumping tests, dye tracer tests, and groundwater flow and the transport modeling activities. The karstic limestone aquifer in a 5-mi^2 area is contaminated with chlorinated solvents, gasoline, and oil. Over 60 gas stations, auto repair shops, and industries in the area were evaluated as possible sources of the contaminants.

Groundwater Modeler; Support of O-Field Remedial Action; USACE; Aberdeen Proving Ground, Maryland (1997-1998). Constructed a groundwater flow model for the O-Field area of Aberdeen Proving Ground using MODFLOW and GMS codes. Was responsible for construction of the model using site geologic, hydrogeologic, and water quality data; preparing portions of the modeling report; and reviewing the final deliverable. The three-dimensional model included spatially-variable recharge rates to accommodate a permeable recharge cap installed over a waste disposal area, groundwater discharge to tidally-affected rivers and wetlands, and 12 extraction wells to capture the contaminant plume in upper aquifer. The model simulations were transient to simulate the seasonal changes in recharge rates, temporal changes in tidal elevations, and short-term changes in pumping rates for each extraction well. PEST software was used to automatically calibrate the transient model and minimize the mean absolute residual error in hydraulic head target data.

Senior Hydrogeologist; RI of Phase II Areas; USACE; Picatinny Arsenal, New Jersey (1997-1998). Interpreted the nature and extent of contamination, directions and rates of groundwater flow, and probable migration pathways for contaminants in the Phase 2 areas. Wrote the “Nature and Extent” portions of two RI reports and made recommendations for additional data collection.

Senior Hydrogeologist and Groundwater Modeler; Pennsylvania Act 2 Remedial Investigation and Risk Assessment; ARCO Chemical Company; Monaca, Pennsylvania (1997-1998). Performed hydrogeologic studies for a chemical manufacturing facility undergoing cleanup and regulatory release under the Pennsylvania Act 2 standards. Studies included: a review of the geological, hydrogeological, and chemical data for each of the six operable units; characterization of the nature and extent of contamination and the most likely contaminant migration pathways; and identification of the physical, chemical, and biodegradation processes that were affecting subsurface migration rates. A groundwater flow and chemical transport model was constructed and calibrated for one area containing benzene waste residues. Results of groundwater flow and solute transport modeling, using MODFLOW and MT3D, showed that migration to the receiving stream is minimal. As a result, capping of the waste residues was not required, thus saving the client over $500,000.

Lead Geologist; Phase II Site Investigations of Properties; USACE; Houston, Pennsylvania (1996). Technical Manager and Field Leader for a Phase 2 investigation of numerous properties located along Little Chartiers Creek in Washington County. Evaluated a wide variety of potential environmental problems by drilling, soil sampling, and soil gas studies. Performed gamma radiation surveys in areas suspected of containing radium-contaminated fill material. Previously unknown leaking pipelines were detected during the investigation.

Senior Technical Reviewer; Remedial Investigations, Operable Units III and V; Brookhaven National Laboratory; Upton, New York (1996). Provided senior review for the interpretation of the groundwater flow system and groundwater modeling results for several RI reports. Areas being investigated contained groundwater contaminated with solvents, tritium, and strontium-90.

Lead Geologist; Phase II Property Transfer Investigation; Private Client; Rockaway, New Jersey (1996). Project Manager and Field Team Leader for the site investigation of a large trucking depot. Leaking USTs and repair shop floor drains were the cause of significant contamination of shallow groundwater. Conducted soil sampling and analyses to determine if prior remediation of the site was complete and verify that residual contamination was below NJDEP cleanup standards.

Senior Modeler and Task Manager; Passaic River Flood Protection Feasibility Project; USACE; New Jersey (1994-1995). Developed conceptual model of groundwater flow system for the region, prepared the modeling Work Plan, and managed the modeling of six areas within the region. Six models were developed to estimate potential groundwater seepage into 24 miles of proposed underground tunnel through fractured rock using MODFLOW code. Different geological/hydrological conditions were encountered in each of the six areas. Performed an extensive sensitivity analysis for each model. Also evaluated different tunnel liners as to their effect on tunnel seepage rates and impacts to groundwater resources.

Senior Hydrogeologist; **RCRA Facility Investigation (RFI), Chemical Manufacturing Plant, Barberton, Ohio (1993-1996).** Interpreted groundwater and geology data collected at a large industrial site contaminated with chlorinated solvents and brine. Prepared RFI reports on sitewide groundwater conditions, background soil and water chemistry, and groundwater flow and solute transport modeling (using SWIFT/486 code). Solute transport modeling showed that no off-site migration of contaminants should occur and that most of the organic solvents are being naturally biodegraded on-site. Modeling of brine migration was performed using density-dependent functions of SWIFT/486.

Senior Hydrogeologist; Remedial Investigations of OU-4 and OU-5; U.S. Department of Energy (DOE); Fernald, Ohio (1993-1995). Assisted in the preparation of geology and hydrology portions of the RIs conducted for the DOE uranium processing plant. Performed a statistical analysis of background water quality data, assembled and interpreted hydraulic characteristics of geologic media, and determined hydraulic gradients and flow directions for the facility. Was the author or co-author for numerous RI/FS reports, including *Sitewide*

Characterization Report, *Initial Screening of Alternatives*, *Characterization of Background Water Quality*, and *OU-5 Remedial Investigation Report*.

Project Manager; Radiation Surveys; Molycorp, Inc.; Washington, Pennsylvania (1992-1996). Managed alpha, beta, and gamma radiation surveys of buildings and thorium waste pile over a four-year period. Buildings were released from the U.S. Nuclear Regulatory Commission (USNRC) "affected" classification.

Project Manager and Principal Investigator; Hydrogeologic Investigations of Plot M; Argonne National Laboratory; Argonne, Illinois (1992-1994). Performed a statistical evaluation of tritium distribution in glacial till and fractured limestone bedrock. The migration of tritium in the complex, multiaquifer system was simulated using the MODFLOW/MT3D and the VS2DT groundwater transport codes. Through this study, tritium concentrations were shown to decline into the future in downgradient wells, and no health criteria were exceeded.

Senior Technical Reviewer; Remedial Action, NAS Whidbey Island; U.S. Navy; Oak Harbor, Washington (1992-1993). Reviewed geologic and hydrologic data and prepared initial plans for a pump-and-treat plume containment system.

Senior Hydrogeologist; Site Investigations; Joliet Army Ammunition Plant, Joliet, Illinois (1900-1992). Evaluated surface water and groundwater hydrology of large ammunition plant. Helped design and install stream gaging stations, collect groundwater elevation data, evaluate pumping test data, and construct groundwater flow model for the entire facility. Soils and shallow groundwater have been contaminated with energetic compounds (e.g., RDX, TNT, and DNT) and migration and attenuation of these compounds were major focus of the studies. Groundwater and surface water flow systems were influenced by agricultural drainage tiles installed in the late 1800s.

Senior Hydrogeologist; Site Investigations; U.S. Navy; Oahu and Kauai, Hawaii (1990-1992). Performed on-site investigations at three U.S. Navy bases in Hawaii. These sites were contaminated with polychlorinated biphenyls (PCBs), fuels, and a variety of volatile organic compounds. Wrote site investigation reports.

Lead Hydrologist; Remedial Investigation; National Science Foundation; McMurdo Station, Antarctica (1990-1991). Assisted in the RI of contaminated sites and streams at McMurdo Station. These contaminated sites included two landfills, a small nuclear reactor site, and large-scale fuel spills. Wrote the majority of the RI report for the facility.

Project Manager and Principal Investigator; Remedial Investigation of Uranium Mine Sites; U.S. Forest Service; Lakeview, Oregon (1988-1991). Managed remedial investigation (RI) of two abandoned uranium mines in volcanic terrain. Characterized hydrogeology, geochemistry, and radiochemistry of the sites, evaluated a new disposal site for geotechnical competence, and wrote majority of the environmental impact statement (EIS) and RI/FS reports.

Lead Geologist; Environmental Impact Statement, Thorium Processing Plant; USNRC; West Chicago, Illinois (1988-1989). Performed year-long study to investigate alternative

disposal sites for thorium mill tailings. Evaluated six different sites in Illinois and disposal options, wrote majority of an EIS, and provided expert testimony to the USNRC Licensing Board.

Project Manager and Principal Investigator; Coal Refuse Reclamation Investigations; U.S. Bureau of Mines; Illinois (1984-1987). Managed research project related to the effects of various soil cover thicknesses and treatments on the oxidation and leaching of pyritic coal mine waste piles. Monitored hydrogeologic and geochemical characteristics of six reclaimed waste piles over a two-year time period. Determined statistical relations between reclamation factors and success in controlling water quality. Performed sampling and analysis of iron-oxidizing bacterial populations to determine the effects of surface treatments on bacterial activity.

Project Manager and Senior Hydrologist; Impacts to Streams by Gas Pipeline Construction; Gas Research Institute; Ohio and Michigan (1985-1987). Managed a research project on the effects of different gas pipeline construction techniques on sediment transport in streams. Investigated in detail the hydrology, sediment transport, and substrate characteristics of two construction sites.

Lead Geologist and Hydrogeologist; Greater Confinement Disposal Program at Argonne National Laboratory; DOE; Argonne, Illinois (1984-1986). Evaluated geologic, hydrologic, and engineering aspects of alternatives for disposal of low-level and medium-level radioactive waste that provide greater confinement disposal (GCD) than shallow land burial. Co-authored several reports for DOE related to GCD, including waste streams that may require GCD.

Project Manager and Senior Modeler; Potential Seepage into Two Proposed Underground Coal Mines; AMAX Coal Company; Indiana (1985). Geologic and well testing data were collected and used to construct two different MODFLOW models, which simulated groundwater seepage into two proposed underground coal mine sites. Evaluated seepage rates into the mines under varying mining scenarios and performed a sensitivity analysis of the models.

Project Manager and Principal Investigator; Hydrology and Geochemistry of Surface Coal Mine Lakes; U.S. Office of Surface Mining (1984-1987). Managed a hydrogeologic, limnologic, and geochemical research project on surface coal mine lakes over a three-year period. The water quality of 24 lakes throughout the eastern and central U.S. was compared to numerous geochemical and hydrologic characteristics of the mine spoils to determine which factors had the greatest influence over lake water quality.

Principal Hydrologist; Chemistry and Treatment Technology of Coal Mine Drainage; DOE (1975-1984). Investigated water chemistry, treatment technology, and environmental impacts caused by coal mine drainage throughout the eastern and midwestern U.S. Evaluated processes which affected runoff, infiltration, leaching, and resulting impacts to streams and groundwater. Documented effectiveness and costs of technologies that were most successful in the control of mine drainage quality.

Principal Hydrologist, Evaluation of Underground Mine Pools as a Source of Groundwater for Heat Pump Systems; Dept. of Energy (1980-1982). Managed the drilling, geotechnical, and hydrogeological aspects of a demonstration project to use underground mine

pools as an exchange medium for low-temperature geothermal heat pump systems for residential and commercial purposes. A site in the northern anthracite coal field of Pennsylvania was drilled, tested, and evaluated for feasibility and cost-effectiveness prior to construction of a full-scale system.

CHRONOLOGICAL WORK HISTORY:

Tetra Tech NUS, Inc.; Senior Hydrogeologist; 1999 to Present.

ICF Kaiser Engineers, Inc.; Senior Hydrogeologist; 1997 to 1999. Performed groundwater investigations and groundwater modeling at sites contaminated with hazardous chemicals (primarily chlorinated solvents and BTEX) and radioactive wastes. Groundwater modeling included use of MODFLOW, GMS, MODPATH, MT3D, and PEST. One facility investigated was the first major Brownfield site in Pennsylvania remediated under PA Act 2.

AWK Consulting Engineers, Inc.; Senior Hydrogeologist; 1996 to 1997. Wrote work plans and managed field investigation of Phase 2 site investigations for potential soil contamination along flood control embankments. Investigations included soil gas sampling, radiation surveys, and evaluation of extensive fill materials.

IT Corporation; Senior Hydrogeologist; 1992 to 1996. Managed the hydrogeology and geochemistry group (15 professional staff). Managed projects, conducted groundwater investigations, and performed groundwater modeling for numerous government and private clients. Groundwater modeling included the use of MODFLOW, MODPATH, MT3D, VS2DT, and SWIFT/486. Reviewed the technical quality and completeness of reports prepared by hydrogeology staff.

Argonne National Laboratory; Hydrogeologist; 1975 to 1992. Conducted research on the hydrogeology, geochemistry, and water quality impacts related to surface and underground coal mining sites across the U.S. Managed programs looking at surface water-groundwater interactions at surface mine lakes, geochemical indicators of acid mine drainage, and evaluation of reclamation efforts to control oxidation and leaching of pyritic coal refuse. Also investigated thorium tailings disposal options in Illinois, uranium mining wastes in Oregon, and copper tailings in Washington. Performed hydrogeologic investigations of Navy sites in Hawaii and Antarctica.

PROFESSIONAL AFFILIATIONS:

American Geophysical Union
Association of Ground Water Scientists and Engineers
Pittsburgh Geological Society

PUBLICATIONS:

R. Chuang, E. Harmsen, and J. Schubert, 1998, "Transient Calibration of a Groundwater Flow Model for the O-Field Area, Aberdeen Proving Ground, Maryland," *MODFLOW '98*, pp. 19-26, Proceedings of Conference held in Golden, Colorado, October 4-8, 1998.

Schubert, J.P., 1997, "Calibration of a 3D Groundwater Transport Model, Including Dispersion, Reversible Sorption, and Biodegradation," EOS, *Transactions American Geophysical Union.*

Schubert, J.P., 1996, "Storage and Diffusive Release of Tritium in Fractured Glacial Tills Beneath a Low-Level Radioactive Waste Disposal Site," EOS, *Transactions American Geophysical Union*.

Schubert, J.P., 1995, "Temporal and Spatial Variation of Tritium Concentrations in Variably Saturated Glacial Tills Beneath a Low-Level Radioactive Waste Disposal Site," EOS, *Transactions American Geophysical Union*.

Schubert, J.P., 1990, "Groundwater-Surface Water Interchange in Surface-Mined Lands," EOS, *Transactions American Geophysical Union*, 61(48):1193.

Trevorrow, L.E. and J.P. Schubert, 1989, "Chapter VII. Greater-Confinement Disposal," *Near-Surface Land Disposal*, Vol. 1, Nuclear Waste Management Technology Series, Harwood Publication, pp. 169-235.

Durham, L.A., J.P. Schubert, D.I. Leap, and S.J. Fritz, 1988, "Hydrologic and Geochemical Factors Affecting the Chemistry of Groundwater in the Vicinity of a Reclaimed Strip Mine Lake," Abstracts with Programs, Geological Society Annual Meeting, Denver, Colorado, 20(7):A173.

Schubert, J.P., 1988, "Hydrology and Geochemistry of Surface Coal Mine Lakes," *Mine Drainage and Surface Mine Reclamation, Volume I: Mine Water and Mine Waste, Proceedings, American Society for Surface Mining and Reclamation Annual Meeting*, Pittsburgh, Pennsylvania, U.S. Bureau of Mines Information Circular 9183, p. 402.

Schubert, J.P. and W.S. Vinikour, 1987, "Effects on Suspended and Substrate Sediments in Two Streams Resulting from Different Gas-Pipeline Installation Techniques," *Proceedings Fourth Symposium on Environmental Concerns in Right-of-Way Management*, Indianapolis, Indiana, pp. 491-502.

Tsai, S.Y., J.P. Schubert, et al., 1987, "Draft Supplement to the Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois," prepared by Argonne National Laboratory for the U.S. Nuclear Regulatory Commission, *NUREG-0904 Supplement No. 1*.

Vinikour, W.S. and J.P. Schubert, 1987, "Effects of Gas-Pipeline Construction on the Aquatic Ecosystem of Canada Creek, Presque Isle County, Michigan," Final Report to the Gas Research Institute, *GRI-87/0027*.

Gilbert, T.L., N.K. Meshkov, J.P. Schubert, et al., 1986, "Planning for Greater-Confinement Disposal," Volume I, Alternatives and Methods*, U.S. DOE, Low-Level Radioactive Waste Management Handbook Series, DOE/LLW-53T*.

Gilbert, T.L., N.K. Meshkov, J.P. Schubert, et al., 1986, "Planning for Greater-Confinement Disposal," Volume II, Appendices, *U.S. DOE, Low-Level Radioactive Waste Management Handbook Series, DOE/LLW-58T*.

Schubert, J.P., W.S. Vinikour, and D. K. Gartman, 1985, "Effects of Gas-Pipeline Construction on the Little Miami River Aquatic Ecosystem," Final Report to the Gas Research Institute, *GRI-86/0024*.

Fenster, D.F., J.P. Schubert, S.D. Zellmer, W. Harrison, D.G. Simpson, and J.S. Busch, 1984, "Radioactive Waste Isolation in Salt: Peer Review of the Office of Nuclear Waste Isolation's Plan to Decommission and Reclaim Exploratory Shafts and Related Facilities," *Argonne National Laboratory ANL/EES-TM-258*.

Jastrow, J.D., J.P. Schubert, et al., 1984, "Amelioration of Acidic Waste Materials Resulting from Energy Mineral Extraction," Chapter 4, "*Ecological Studies of Disturbed Landscapes: A Compendium of the Results of Five Years of Research Aimed at the Restoration of Disturbed Ecosystems*," U.S. Dept. of Energy, DOE/NBM-50093722.

Olsen, R.D., J.P. Schubert, et al., 1984, "Effects of Coal Mining on Watershed Hydrology, Water Quality, and Aquatic Ecosystems of a Western Perennial Stream," Chapter 5, *Ecological Studies of Disturbed Landscapes: A Compendium of the Results of Five Years of Research Aimed at the Restoration of Disturbed Ecosystems*," U.S. Dept. of Energy, DOE/NBM-50093722.

Mele, L.M., P.F. Prodan, and J.P. Schubert, 1982, "Characterization of Runoff Water from Coal-Waste Disposal Sites in Southern Illinois," *International Journal Mine Water*, 1 (2):1-14.

Prodan, P.F., L.M. Mele, and J.P. Schubert, 1982, "Runoff Water Quality and Hydrology at Coal Refuse Disposal Sites in Southern Illinois," *Proceedings 1982 Symposium on Surface Mining, Hydrology, Sedimentology, and Reclamation*, University of Kentucky, Lexington, pp. 57-63.

Schubert, J.P. and M.J. McDaniel, 1982, "Using Mine Waters for Heating and Cooling," *Proceedings First Congress International Mine Water Association*, Budapest, Hungary, Vol. D, pp. 63-82.

Schubert, J.P. and R.M. Miller, 1982, "Subsurface Oxidation of Pyritic Coal-Cleaning Wastes by Chemoautotrophic Bacteria," *Proceedings 1982 Symposium on Surface Mining, Hydrology, Sedimentology, and Reclamation*, University of Kentucky, Lexington, pp. 623-634.

Bogner, J.E., J.P. Schubert, and G.M. Kaszynski, 1981, "Control Technology, Environmental Control Technology," Survey of Selected U.S. Strip Mining Sites, *Argonne National Laboratory Report ANL/EMR-2*, Vol. 3.

Schubert, J.P. and P.F. Prodan, 1981, "Groundwater Pollution Resulting from Disposal of Pyritic Coal Wastes," *Proceedings International Symposium on Quality of Groundwater*, National Institute for Water Supply, Noordwijkerhout, Netherlands, pp. 319-327.

Krothe, N.C., J.E. Edkins, and J.P. Schubert, 1980, "Leaching of Metals and Trace Elements from Sulfide-Bearing Coal Waste in Southwestern Illinois," *Proceedings 1980 Symposium on Surface Mining, Hydrology, Sedimentology, and Reclamation,*, University of Kentucky, Lexington, pp. 63-73.

Schubert, J.P., 1980, "Comparison of Laboratory and Field Measurements of Hydraulic Conductivity for Coal-Bearing Strata," EOS, *Transactions American Geophysical Union*, 61 (17).

Schubert, J.P., 1979, "Groundwater Contamination Problems Resulting from Coal Refuse Disposal," Chapter 35, "Mine Drainage," *Proceedings First International Mine Drainage Symposium*, Denver, Colorado, Miller Freeman Publications, pp. 757-780.

Schubert, J.P., 1978, "Reducing Water Leakage into Underground Coal Mines by Aquifer Dewatering," *Proceedings International Symposium on Water in Mining and Underground Works*, Asociacion Nacional de Ingenieros de Minas, Granada, Spain, Vol. 2, pp. 911-932.

SELECTED CONSULTING REPORTS

Schubert, J.P., and D. Cercone, 1999, "Groundwater Flow Modeling Report, Naval Industrial Reserve Ordnance Plant (NIROP), Fridley, Minnesota," Draft Report prepared for the U.S. Navy, Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina.

Schubert, J.P., 1999, "Groundwater Flow Model Report for Operable Unit 1, Marine Corps Air Station Cherry Point, North Carolina," Report prepared for the U.S. Navy, Atlantic Division Naval Facilities Engineering Command, Norfolk, Virginia.

Schubert, J.P., et al., 1997, "Groundwater Flow Model for the O-Field Area, Aberdeen Proving Ground, MD," Report prepared for the U.S. Army Corps of Engineers, Baltimore, MD.

Schubert, J.P., 1995, "Background Chemical Characteristics of Environmental Media, RCRA Facility Investigation Report, Barberton Facility," Report prepared for PPG Industries, Inc.

Schubert, J.P., 1994, "Tritium Migration and Hydrogeological Studies in the Vicinity of Plot M, Palos Forest Preserve," Report prepared for Argonne National Laboratory, Argonne, IL.

Schubert, J.P., et al., 1994, “Characterization of Background Water Quality for Streams and Groundwater,” Report prepared for Fernald Environmental Management Project (DOE), Fernald, Ohio.

Schubert, J.P., et al., 1994, “Initial Screening of Alternatives” Report prepared for Fernald Environmental Management Project (DOE), Fernald, Ohio.

Schubert, J.P., 1992, “Sitewide Groundwater Evaluation, Barberton Facility,” Report prepared for PPG Industries, Inc.

Fenster, D.F., J.P. Schubert, and R. V. Colangelo, 1985, “Groundwater Quality Assessment Plan for Louisiana Army Ammunition Plant,” Report prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, 48 pp.

Schubert, J.P., 1984, “Subsurface Leaching of Pyritic Coal Mine Spoils and Contaminant Migration,” Final Report to U.S. Bureau of Mines, Grant No. G1115173, *Open-File Report 10-85*, 122 pp.

Shackelford, M., J.P. Schubert, and C. Luner, 1982, “Proposed Drilling and Testing Program to Assess the Use of Underground Mine Water for Heat Pumps in Scranton, Pennsylvania,” unpublished report to U.S. DOE, Office of Federal and Community Programs, 41 pp.

JOHN S. WRIGHT, EIT
TECHNICAL SPECIALIST
PITTSBURGH, PENNSYLVANIA

EDUCATION: B.S. Civil Engineering; University of Pittsburgh; April 1990

CERTIFICATIONS/ REGISTRATIONS: Engineer-In-Training, Pennsylvania (Civil), 2005

TRAINING:
OSHA 1910.120 40-Hour HAZWOPER Training; July/1991
OSHA 1910.120 8-Hour Annual Refresher Training; February/2007
OSHA 1910.120 8-Hour Supervisory Training; March/1993
OSHA 1910.120 8-Hour Supervisory Refresher Training; February/2007
U. S. Army Corps of Engineers Construction Quality Management for Contractors
Troxler Nuclear Density Gauge Operation and Radiological Safety Certification
Industrial Power Distribution, Duquesne Light, Pittsburgh, Pennsylvania

EXPERIENCE SUMMARY:

Mr. Wright has 17 total years of professional experience in the civil and environmental remediation industry. As a Project Manager and technical specialist, he has been responsible for project engineering, project management, site engineering, and technical support for both commercial and government clients. Mr. Wright is currently part of the technical team within the NAVFAC Southeast Program Management Office and functions as a Technical Lead for developing and implementing innovative technologies, processes, and cost estimating.

PROJECT EXPERIENCE:

Technical Specialist; Department of the Navy, NAVFAC Southeast, Comprehensive Long-Term Environmental Action Navy (CLEAN) Program; Multiple Facilities; Multiple EPA Regions; $250 MM (CLEAN III) and $125 MM (CLEAN IV); February 2002 to present. Responsibilities include serving as technical specialist and project engineer on investigation and innovative remediation projects; stress and communicate innovation in thinking, technologies, and processes; maintain working knowledge of all SOUTHDIV contract projects; support the mission of others within the group; communicate policy and technical standards to the Task Order Managers; ensure that projects follow policy and technical standards; assist with the development of policies and standards; troubleshoot project technical issues and provide support as needed; document/communicate project successes within and outside TtNUS; interface with network of clients, regulators, competitors and other Tetra Tech divisions; and coordinate special initiatives, as requested, to correct problems or provide program direction.

Specific initiatives spearheaded include the continued development of the Brown Bag University training program and Internal Growth webcasts within the TetraTech organization, development and testing of the collection of field data using electronic and wireless devices; streamlining of the CLEAN Program proposal process and developing technical tools for the evaluation of past projects for use in the proposals; enhancing the evaluation of the Technical and Financial Monthly

Reports with an audit function as well as electronic reviewing and comment process; and development of subcontractor cost history and technical evaluation for use at each facility.

eData Initiative – Implementation with Various Projects; January 2005 to present. Leads initiative development, implementation, and training for the collection of field data via electronic methods. Initiative includes the development of custom application software as well as the evaluation and integration of various hardware systems for use in the field. Implemented beta and full-scale testing and use of the eData system at various facilities and projects; including key projects at NSWC Crane, IN and NAS Key West, FL. Formulated the innovative approach to the inspection and inventory of over 600 monitoring wells at NSWC Crane, IN using the eData system for both field acquisition of data and the evaluation and use of the data in the office and by the client. Conceptualized and implemented the use of the eData approach for the location, evaluation, and documentation of Land Use Control signage related to regulatory stipulations at NAS Key West, FL. Integration of other methods and technologies such as real-time data transfer, Global Positioning System; geophysics investigations; and unexploded ordnance delineation and acquisition. Supports on-site and office training for the full-scale implementation of the eData application.

Monitoring Well Inspection – Basewide; NWIRP Dallas, TX; March 2007. Performed both eData inventory management and GPS support of the inspection and inventory of more than 390 monitoring wells. Served as lead author of the results and recommendation evaluation report.

Monitoring Well Inspection – Basewide; NSB New London, CT; February 2007. Performed both eData inventory management and GPS support of the inspection and inventory of more than 300 monitoring wells. Served as lead author of the results and recommendation evaluation report.

Monitoring Well Inspection – Basewide; NWS Charleston, SC; January 2007. Performed both eData inventory management and GPS support of the inspection and inventory of more than 300 monitoring wells. Served as lead author of the results and recommendation evaluation report.

Landfill Delineation – Site 1; NTC Great Lakes, IL; December 2006. Served as on-site eData/Triad data coordinator during the delineation of a large landfill currently covered by an active golf coarse. Tasks included the advancement of over 100 Direct-Push Technology borings with multiple field geologists; processing of lithology, field screening data, and related boring log data; surface water and sediment sample collection; and the installation and sampling of temporary wells for leachate and groundwater analyses. Facilitated Triad-type decisions for location of stepout borings, movement of planned locations based on conditions and data collected, and location and intervals for the permanent monitoring wells. Performed daily GPS location stakeout, real-time modifications and figure updates, and final as-built positions of all features.

Storm Surge Sampling – Phase I – SWMUs 1, 2, 4, and 5; NAS Key West, FL; November 2006. Conducted Phase I delineation with real-time field data use to assess the impact of hurricanes and storm surges on the horizontal distribution of various contaminates in surface water, sediment, and soil. Coordinated on-site decisions for placement of sample locations and provided technical consultant services for both the rationale as well as the graphical depiction of the work plan/QAPP decisions from the field. Performed GIS layout and GPS navigation to planned sample locations; including locations in dense swamps and large open water bodies. Collected soil, sediment, and surface water samples and trained additional field team for eData use.

Delineation Sampling – Disposal Area; US Coast Guard Baltimore, MD; October 2006. Provided GPS support and training for multi-event soil sampling and characterization project.

Wetland Delineation – Pistol Range and Various Wetlands; Solomons Island Complex, MD; October 2006. Performed GPS data gathering during wetland delineation project. Employed a variety of techniques for difficult vegetation conditions and produced real-time mapping for discussion with the client and approval of the wetland specialist to assure data quality before leaving the site.

Groundwater Investigation – OU4; NTC Orlando, FL; June-July 2006. Served as on-site eData/Triad data coordinator during the investigation of CVOCs in both soil and groundwater in complex geology at a former dry cleaning facility. The project involved the advancement of sonic drilling to depths of 245 feet, continuous lithology data collection, extensive soil and groundwater profile sample collection with rapid result on-site screening, and the installation of multi-channel/level permanent monitoring wells. Developed electronic boring and well completion logs for the incorporation of data collection to the eData application. Facilitated Triad-type decisions for location of the borings, vacuum utility clearance coordination, determination of groundwater and soil sample profile intervals, and location of each multi-level permanent well screen location. Performed GPS location stakeout and as-built location gathering and real-time graphical presentation of boring locations.

GPS Tasks and Groundwater/Soil Sampling – Site 22; NWIRP Toledo, OH; June 2006. Performed layout and as-built GPS position tasks for delineation and investigation project, including collection of precise vertical data for all temporary monitoring wells. Collected both groundwater and soil boring data using the eData application and related tools.

Bathymetry Survey – SWMU8; NSWC Crane, IN; April 2006. Developed the methodology and performed the surveying via total station for gathering of bathymetry data at the B-108 pond prior to remediation. The data collected and processed was used for the design of the remedial action related volume calculations. Data collected for pond water surface elevation; detailed edge of water delineation; elevation data for underwater features including top of soft sediment, top of overburden soils, and top of bedrock; topography of surrounding land, and physical features within the project area.

Monitoring Well Inspection – Basewide; NAS Key West, FL; March 2006. Performed both eData collection and GPS support of the inspection and inventory of more than 300 monitoring wells. Coordinated the data management with eData, GIS updates, and recommendations required for client-specific needs.

GPS Data Collection – NOVA Chemical, PA; February 2006. Performed GPS data collection with innovative system components for completed soil borings for client reporting.

Site Characterization – Site 18; NAS Pensacola, FL; February 2006. Served as on-site eData/Triad data coordinator during the horizontal and vertical delineation of a multi-plume hydrocarbon site. Tasks included the advancement of over 80 Direct-Push Technology borings; vertical groundwater sampling and profiling with on-site mobile laboratory; and the installation of temporary wells for sampling of groundwater and free product assessment. Facilitated Triad-type decisions for location of step-out borings, movement of planned locations based on conditions and data collected, and location and intervals for the permanent monitoring wells. Performed daily GPS location stakeout, real-time modifications and figure updates, and final as-built positions of all features.

UXO Prove-Out and Test Plot Project – Oak Ridge, TN; January 2006. Provided technical consultant services, equipment configuration, and on-site training for advanced RTK GPS methods for the TtNUS geophysics prove-out project. Also performed variety of alternate surveying methods for the technical comparison, correlation, and verification of the methods planned for future UXO projects.

LUC Sign Replacement and Inventory – NAS Key West, FL; July 2005 to January 2006. Performed sign replacement and installation services in conjunction with eData inspection and inventory updates. Field services included GPS data navigation, position collection, and GIS data management.

Monitoring Well Inspection – Basewide; NSWC Crane, IN; November 2005 to January 2006. Performed both eData collection and GPS support of the inspection and inventory of more than 600 monitoring wells. Coordinated the data management with eData, GIS updates, and recommendations required for client-specific needs.

Sampling Support and GPS Services – Sites 5, 8, and 11; NS Mechanicsburg, PA; April 2005 to May 2006. Provided GPS layout and as-built collection services for multi-phase sampling and delineation events. Devised layout method for planned limits of excavation with pre-remediation sidewall and vertical extent limits of waste with accuracy specifications for locations to meet project requirements. Specific tasks included the immediate post-processing of data with advanced techniques and equipment for same-day modification to sample locations.

eData Services and Sampling Support – SWMUs 12, 13, and 16; NSWC Crane, IN; May 2005 to November 2006. Provided sampling support for routine MNA sampling of groundwater over multiple rounds of sampling. Developed, tested, and deployed eData techniques for use by all sampling team members and automated Chain-of-Custody generation.

GPS Layout Support – Various Sites; MCB Quantico, VA; April 2005. Provided on-site technical services and personnel training for the defining the limits of isolated "surgical" excavation areas with GPS techniques.

Guaranteed Fixed Price Remediation Projects – Various Projects; May 2004 to present. Involved with the preparation of multiple GFPR and performance-based contracts for various sites, projects, and clients. Projects involve the review of extensive background records, the formulation of innovative and effective technical approaches, the formulation of management approaches, projection of project milestones and payment structures, development of costing data and estimating information, and the management of technical and administration personnel during the development of proposals.

Treatability Study Evaluation – Site 18; NAS Pensacola, FL; August 2004 to March 2005. Involved the evaluation of monitoring data associated with the injection of PermeOx® Plus conducted to determine the effectiveness of the material for the degradation of petroleum hydrocarbons at a former fire training area.

Treatability Study – Martin State Airport, MD; December 2004. Involved the injection of three innovative materials to determine the effectiveness of the material for the degradation of chlorinated solvents. Performed field coordination and implementation functions for the extraction, injection, and recirculation of nanoscale iron, vegetable oil, and lactate solutions. Completed calculations for injection quantities, flow rates, mixing volumes, and other work plan procedures.

Optimization Study – Operable Unit 1; NAS Pensacola, FL; February 2003 to March 2005. Involved with the evaluation of existing remedial actions at OU1 and the determination of the optimization strategy for a groundwater interceptor trench system and site-wide groundwater attenuation and monitoring to reflect data trends, technical considerations, and other guidance criteria. Emphasis was placed on evaluation of the Site Conceptual Model and an evaluation of data for the determination of appropriate regulatory criteria. Recommendations and a plan for implementation are included with the project. The document and technical evaluation is used by the Navy as an example of the optimization process.

Mike Singletary, with the Navy Technical Support Branch (2004), noted that "I am very pleased with (the report). You guys did a very thorough review of the existing site data and researched and presented common-sense regulatory and technical alternatives to improve remedy performance."

Technology Demonstration – Hanger 1000; NAS Jacksonville, FL; February 2002 to February 2005. Involved with a technology demonstration for the in-situ abiotic reductive dechlorination of chlorinated organics in groundwater using Bi-metallic Nanoparticles (BNPs). The technology demonstration addresses the Navy requirement to improved remediation of groundwater contaminated with halogenated hydrocarbons and other organics. The project involves the initial technology evaluation and implementation, bench scale test, field scale demonstration, and preparation of the conclusions of the study.

Corrective Action Plan – Former Fuel Farm; US Coast Guard Support Center, Elizabeth City, NC; February 2002 to March 2004. Author of the Corrective Action Plan addendum for the modification to existing removal of free phase fuel contamination at the facility. Innovative technologies and applications involving bioslurping and the evaluation of recoverability of free product were some challenges presented with this project.

Feasibility Study – Site 42; Indian Head, MD; February 2001 to March 2002. Authored Feasibility Study for the remediation of a rubble landfill area at Site 42.

Operation and Maintenance Plan – Sites 2, 6, and 8; New London, CT; February 2002 to April 2002. Preparation of Operation and Maintenance Plan for three sites at New London Submarine Base. O&M Plans for the long-term monitoring and maintenance of asphalt cap systems implemented as a remedial action.

Engineering Evaluation/Cost Assessment – Building 184/Site 30; Portsmouth Naval Shipyard, Kittery, ME; February 2002 to March 2004. Performed evaluation and preparation of Engineering Evaluation and Cost Analysis (EE/CA) for the Building 184 former acid pit remedial action.

Construction Oversight – Site 25; NSWC - Dahlgren, Dahlgren, VA; March 2001 to November 2001. Consultation and site inspection services for pond outlet structure construction.

Design and Oversight – Tranguch Gasoline Site; U. S. Army Corps of Engineers; Hazleton, PA; February 2001 to April 2002. Design of sanitary and storm sewer replacement systems; including the replacement of sewer pipe sections with HDPE materials, groundwater collection piping, and soil vapor extraction systems. The project also involved site consultation inspections, contractor oversight, and specification for QC methods for system acceptance. *"This project [Tranguch] is an excellent and innovative solution to a difficult environmental problem. It is a truly collaborative effort that demonstrates the synergy that can be developed between Government and private companies" - 2002 Civil Works and Environmental Design Awards Jury Comments.*

Investigation Planning – Jamaica Island Landfill/OU3; Portsmouth Naval Shipyard, Kittery, ME; January 2001 to April 2002. Prepared project documents for a field investigation; including scope of work and specifications for cone penetration testing, piezometer installation, land and hydrographic surveying, landfill gas surveying, and wetland assessment activities.

Engineering Evaluation/Cost Assessment – Site 31; NSWC Dahlgren, VA; December 2000 to April 2001. Performed evaluation and preparation of Engineering Evaluation and Cost Analysis (EE/CA) for Site 31.

Corrective Measures Study – Site 7; NSWC White Oak, MD; November 2000 to March 2001. Performed evaluation and preparation of a Corrective Measures Study (CMS) for Site 7.

CHRONOLOGICAL WORK HISTORY:

Technical Specialist; Tetra Tech NUS, Inc.; Pittsburgh, Pennsylvania; November 2000 to Present.

Engineer/Scientist III; IT/OHM Corporation; Monroeville, Pennsylvania; February 1993 to October 2000.
Experience includes task management and project engineering responsibilities for projects related to the development of remedial strategies and the implementation of selected remedies. Projects involved site investigations and assessments; development of remediation objectives; development and evaluation of remedial technologies and alternatives; regulatory issues; risk formulations and assessments; and preparation of cost estimates for alternatives and conceptual designs. Remedies that were developed and implemented ranged from landfill closure to bioremediation and from groundwater treatment systems to emerging and innovative technologies. Public meetings, advisory board presentations, and client interaction were key responsibilities for many projects in addition to the technical assignments.

Also performed various design and field engineering assignments for projects. Reports and plans such as constructability reviews, operation and maintenance plans, erosion and sedimentation control submittals, quality control plans, and other project documents were prepared. Responsibilities included conceptual design and pre-construction engineering and planning as well as project scope definition and development, technical support for construction projects, client meetings, surveying and drafting oversight and support, data compilation and development, and implementing design changes during site activities. The formulation and development of risk assessment scenarios and the development of sampling and removal strategies were also performed.

Other project responsibilities included the preparation and review of project specifications, preparation of contract and bidding documents, proposal development and support, cost and materials estimating, subcontractor and materials procurement, and preparation of cost evaluations. Technical assignments included civil and environmental engineering calculations, landfill liner and cover system design, storm water routing and design, gas collection and piping design and evaluation, slope stability analysis, geotechnical investigations and evaluations, wetland mitigation design, remedial investigation and feasibility study programs, engineering cost evaluations, regulatory permitting and compliance, and data validation.

Tasks required the use of personal and network computers and programs. Information systems such as internal accounting systems, regulatory compliance software, and databases, as well the corporate intranet and the Internet were essential to many projects. Computer programs including CAD software, spreadsheets, engineering applications, database creation and management, and word processing were used. Various projects required and developed the use of surveying and site planning skills. Additional experience includes quality control (QA/QC) engineering, site management, health and safety officer responsibilities, public meeting presentations, and authoring of final client reports.

Project Manager & Lead Engineer; Joliet Army Ammunition Plant (JOAAP), Illinois. For more than seven years, served in the capacity of Project Manager and Lead Engineer responsible for managing projects involving explosive and contaminants in soil and groundwater at JOAAP with a value of more than $3M. Responsible for managing all phases of the work, including project scheduling, cost estimating, and budgeting. During the course of the work supervised over 20 multi-disciplinary professionals, including field technicians, geologists/hydrogeologists, and engineers. In addition, public meetings, advisory board presentations, and client interaction were key responsibilities for many individual projects at JOAAP.

> Project Manager and Primary Author for the Feasibility Study for the Manufacturing Area of JOAAP. The FS included soil, sediment, surface water, and groundwater contamination of a multitude of constituents, including explosive compounds. The development of remediation goals as associated human health and ecological risk evaluations were primary tasks.

> Provided technical consulting, and managed field coordination and project execution of a pilot-scale bioremediation demonstration with Waste Management. The project involved soil impacted with RDX, HMX, TNT, Tetryl and other explosive compounds from JOAAP site. Bioremediation was a biopile-type of process that was evaluated for possible use at JOAAP and other facilities in the full-scale remediation of explosives-impacted soil.

> Served as a technical consultant during a technology demonstration at JOAAP. The demonstration was performed to evaluate multiple explosives remediation technologies in a controlled “side-by-side” setting for the eventual evaluation and reporting of effective methods for the Army and other DoD agencies to use at future explosives-impacted sites.

> Designed a temporary cover system for the rapid response program for an ash pile at JOAAP. The ten acre site was covered to prevent short-term exposure and leaching from the explosives-impacted ash residue to surface water, surrounding soils, and shallow groundwater.

> Served as Project Manager and Lead Engineer in the Capture Team for the Bioremediation Facility at JOAAP. Developed the site infrastructure for the proposal and developed the overall strategy for the composting of approximately 250,000 cubic yards of explosives-impacted soil at JOAAP. The cost proposal was the lowest cost proposal with other contractual issues the factor in the unsuccessful project.

> Participated in a technology demonstration with Tufts University and Argonne Lab for the use of adaptive sampling strategies for the prediction and determination of environmental sample locations. The demonstration was done in conjunction with additional data collection at JOAAP for the delineation of explosives contamination within two large manufacturing areas and associated facilities. Also led surveying and other tasks associated with the field data collection, including innovative field reporting options and use of field test kits for the collection and processing of more than a thousand of unique soil samples.

- Lead field planning, implementation, and evaluation of development options for a landfill area and ash disposal area at JOAAP for a private developer of the facility. Field activities included test pit excavation and sampling. Recommendations included land use for the proposed inter-modal facility at JOAAP and involved excavation and re-compaction to dynamic compaction and other technical options.

- Project Manager of the Proposed Plan and Record of Decision for JOAAP remedial documents. Participated in partnering team meetings during the complex discussions of remedy selection, RAB presentations, negotiations, and final remedy implementation.

- Managed the development of documents and related mapping necessary for the passage of the Illinois Land Conservation Act of 1995 which was signed into law on February 10, 1996 by President Bill Clinton. This Act established the Midewin National Tallgrass Prairie, two privately owned industrial parks, a county landfill, and the Abraham Lincoln National Veterans Cemetery.

Project Engineer; Concord Resources Group, Inc.; Pittsburgh, Pennsylvania; September 1992 to February 1993.
Projects involved preparing construction documents, design and construction specifications, design calculations, excavation plans, and geotechnical investigations, as well as pipeline design and drawing oversight, land development planning, and preparation of various state and federal permits.

Project Engineer; Paul C. Rizzo Associates, Inc.; Monroeville, Pennsylvania; July 1991 to September 1992.
Worked on a variety of projects, including a groundwater, waste, and soil sampling program at a site in Puerto Rico. Designed landfill cells and storm water controls, wrote specifications, authored reports, completed site assessments and feasibility studies, and performed data validation and cost estimating.

Staff Engineer - Manager in Training; Professional Service Industries; Ohio Region; April 1990 to July 1991.
Position involved marketing, bidding, and supervising geotechnical and environmental projects; scheduling drilling rigs and crews; laboratory testing and classification of soils; and writing of final geotechnical reports. Also included field construction testing and inspection services, project engineering, and consultant work. Performed office functions such as report reviews, payroll, billing, technician scheduling, business projections, and employee interviewing.

Student Manager of Technical Services; University of Pittsburgh; Pittsburgh, Pennsylvania; April 1986 to April 1990.
Hired, trained, and managed technical staff. Scheduled and arranged audio, video, and lighting for various university events. Made equipment purchasing decisions and designed sound reinforcement systems. Wrote technical manual to be used for training and reference.

Engineering and Scientific Technical Intern; Pennsylvania Department of Transportation, District 11; Pittsburgh, Pennsylvania; May 1988 to August 1988 and May 1989 to August 1989.
Inspected roadway and bridge construction. Kept project records, diaries, and estimate books. Field assignments included paving, subbase preparation, drainage, reinforced concrete work, signalization, excavation, and stream control.

PROFESSIONAL AFFILIATIONS:

Society of American Military Engineers (non-member volunteer)

PUBLICATIONS/RECOGNITIONS:

Technical Achievement Award; Technical Innovation – Technical Group; Pittsburgh Innovative Strategies Team – TetraTech (corporate) FY2005

Abstract for Platform Presentation; Battelle Conference; 2006; Web-Based Land Use Control Management Tools
Abstract for Poster Presentation; Battelle Conference; 2006; Electronic Data Collection

NAVFAC Fact Sheet; Land Use Control Sign Inspection; Naval Air Station Key West; February 2006

TtNUS eData Software Manual and Procedure Development, January 2007 (ongoing)
TtNUS Internal eData Training Program, December 2006 (ongoing sessions)
TtNUS Internal GPS Training Program, July 2005 (ongoing sessions)
TtNUS Brown Bag University, eData, February 12, 2007
TtNUS Brown Bag University, Geothermal Technology, February 2, 2004
TtNUS Brown Bag University, Surveying 201 - GPS Basics, June 30, 2003
TtNUS Brown Bag University, Surveying 101, July 8, 2002

ENCLOSURE 9

RESPONSES TO RIDEM FOLLOW-UP COMMENTS ON NAVY RESPONSES TO COMMENTS ORIGINALLY RECEIVED ON NOVEMBER 28, 2006

RIDEM FOLLOW-UP COMMENTS WERE RECEIVED VIA ELECTRONIC MAIL ON MARCH 5, 2007
RIDEM CORRESPONDENCE WAS DATED FEBRUARY 19, 2007

ENCLOSURE NO. 9
RESPONSES TO RIDEM FOLLOW-UP COMMENT ON NAVY RESPONSES TO COMMENTS ORIGINALLY RECEIVED FROM RIDEM ON NOVEMBER 28, 2006 (RIDEM FOLLOW-UP COMMENTS RECEIVED VIA E-MAIL ON MARCH 5, 2007) DRAFT PHASE III REMEDIAL INVESTIGATION QAPP FOR IR SITE 16 FORMER NCBC DAVISVILLE

State of Rhode Island Follow-up Comment No. 3:

RIDEM disagrees with the Navy on this issue and considers the Marina as a recreational area. The Marina portion of Site 16 must meet residential direct exposure criteria under Rule 3.58 of the Site Remediation Regulations which includes recreational use.

Navy Response to State of Rhode Island Follow-up Comment No. 3:

The regulation cited in the comment, Rule 3.58, which defines "residential activity", applies to residential areas and "unrestricted outdoor recreational areas". Please note that the current lease issued by the Navy restricts the property from residential use. As noted in the Navy's original response to RIDEM No. 3**,** the Comprehensive Base Reuse Plan identifies the area around E-107 as ***waterfront commercial.*** The FOSL found this area suitable for lease "in accordance with the Comprehensive Reuse Plan approved by the Town of North Kingstown and RIEDC in February 1994 and the National Environmental Policy Act (NEPA), Record of Decision (ROD), signed in July 1997". While the current tenants may occasionally contact surface soils, surface waters, and sediments in the general vicinity of the docking area while maintaining/utilizing their boats, exposure is likely to be limited and reflective of industrial/commercial/ restricted recreational types of exposures. In a similar instance at Naval Station Newport, RI, where recreational standards were at issue on a site being investigated by the Navy, Navy correspondence dated November 6, 2006 and State of Rhode Island correspondence dated January 19, 2007 resulted in the acknowledgement by RIDEM that "activities related to outdoor recreational sites with limits in place to limit exposure" fall under the definition of Industrial Commercial Activity. In summary, the Navy believes that RIDEM commercial/industrial direct contact exposure criteria or site-specific criteria derived based on the potential for exposure and risk are more appropriate than RIDEM residential criteria for this particular area.