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March 13, 1995

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

Attn: Ms. Linda G. Saksvig, P.E.
Code 1823

Re: Contract N62470-89-D-4814
Navy CLEAN, District III
CTO-0133, Supplemental Investigations at Site 82, Area B
Operable Unit 2, MCB Camp Lejeune, North Carolina

Dear Ms. Saksvig:

Baker Environmental Inc., (Baker) is pleased to submit this letter report which summarizes results of the Site 82 Supplemental Investigation, Operable Unit No. 2, Marine Corps Base (MCB), Camp Lejeune, North Carolina. The supplemental investigation was performed during the period from December of 1994 through January of 1995 under Contract Task Order (CTO) 133, and included the following field activities:

- Magnetometer survey
- Soil and sediment sampling
- Installation and groundwater sampling of temporary monitoring wells
- Installation and groundwater sampling of deep monitoring wells

The following provides background information, and a summary of the investigations and results.

BACKGROUND

Baker performed a Remedial Investigation (RI) at Site 82 in 1992 through 1993. Results from the RI indicated that soil in the southeastern portion of the site [identified as Area of Concern (AOC) 1] was contaminated with volatile organic compounds (VOCs). During the design phase, the AOC was divided into Areas A and B; Area A is located in the extreme southeastern portion of Site 82 and Area B is located approximately 300 feet north of Area A in the direction of Wallace Creek. It was determined during the remedial design phase that both areas required additional soil characterization.

bcc: APPajak/CF; JWMentz/PROG F; RPWattras/PRJ F; REBonelli(ck);
DPJoiner(ck); MDBartman; Daily File
S.O.#62470-133-0000-02900
Subfile 5
Initials

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OHM Remediation Services Corporation (OHM) collected additional soil samples in July of 1994 in the vicinities of both areas. The samples were collected to further assess the extent of soil contamination to assist in the design of a vapor extraction remediation system. OHM's investigation indicated that soil contamination along the northern and eastern boundaries of Area B is more extensive that originally assessed. Accordingly, additional sampling was recommended to delineate the extent of soil contamination.

During a conference call meeting on September 26, 1994, Baker recommended additional sampling to further evaluate the extent of VOC contamination in groundwater in the vicinity of Area B, and in swamp sediments to the north of Area B. This information is important from a standpoint of determining the feasibility of vapor extraction at Area B, and in the remediation of shallow groundwater. Moreover, a geophysical survey was recommended by OHM to identify potential buried sources of contamination within Area B.

INVESTIGATION ACTIVITIES

Baker initiated the field activities on December 6, 1994. The investigations were completed in two phases. Phase I included a magnetometer survey, soil and sediment sampling, installation and sampling of shallow temporary monitoring wells, and installation of two deep monitoring wells; and Phase II, completed on January 18, 1995, included groundwater sampling of the newly installed deep wells and collecting a round of water level measurements from the deep wells.

Magnetometer Survey

A magnetometer survey was conducted at Area B to confirm the presence or absence of buried metallic objects that could potentially be associated with former VOC disposal operations. The survey was conducted by Geo-Centers, Inc., with oversight from Baker. A 300 by 300 foot grid was established encompassing Area B as shown on Figure 1. The survey was performed by traversing the 9000 squared foot area at 25 foot spacing, north to south and east to west.

Results of the survey did not indicate evidence of buried metallic objects within the areas investigated. Test pits, based on the results of the survey, were to have been excavated within the areas that indicated metallic anomalies. Test pitting was not conducted because no subsurface anomalies were detected.

Soil Samples

Soil samples were collected to further evaluate the extent of contamination at Area B. A sampling grid was established using OHM's grid as a reference. The grid started at approximately 50 feet north and east of OHM's grid as depicted on Figure 2. This grid pattern was selected based on the OHM report which indicated the highest levels of VOC contamination along the northern and eastern boundaries of Area B.

A total of seven borings were advanced. Surface (ground surface to one-foot) and subsurface (below one-foot) samples were collected from each boring. For most of the borings, however, only a surface sample was collected due to high water table conditions. The samples were collected using a stainless-steel spoon or hand auger and under Level B personnel protective equipment (PPE). All sampling activities were conducted in accordance with USEPA Region IV sampling protocols.

Because of high water table conditions at most of the sampling locations, only one to two samples per boring were collected for laboratory analysis with the exception of soil boring SB-07. At this location, which is located approximately 75 feet southeast of Area, lower water table conditions permitted the collection of soil samples to a depth of 15 feet bgs. The sampling intervals are as follows:

- SB01 - 0 to 1.0 foot
- SB02 - 0 to 1.0 foot
- SB03 - 0 to 1.0 foot
- SB04 - 0 to 1.0 foot
- SB05 - 0 to 1.0 foot
  1.0 to 3.0 feet
- SB06 - 0 to 1.0 foot
  3.0 to 5.0 feet
- SB07 - 0 to 1.0 foot
  3.0 to 5.0 feet
  13.0 to 15.0 feet

All samples were submitted for Target Compound List (TCL) volatile analysis.

Analytical results indicated detection of volatiles in all 11 samples. As shown on Figure 2, the highest concentrations were detected in surface samples from borings SB02, SB03, and SB04. Trichloroethene (340 ug/Kg to 24,000 ug/Kg), tetrachloroethene (1,800 to 24,000 ug/Kg), and 1,1,2,2-tetrachloroethene (3 J to 160,000 ug/Kg) were the most prevalent volatiles detected. Samples obtained from soil borings SB-06 and SB-07 exhibited very little contamination. The data confirms OHM's results which indicated significant VOC levels in soil along the northern and eastern boundaries of Area B.

Sediment Samples

A total of 11 sediment samples were collected from the swamp located between Area B and Wallace Creek. The swamp area was investigated to determine if volatile contamination from Site 82 has migrated downgradient from Area B. The samples were collected using a stainless steel spoon in accordance with USEPA Region IV sampling protocols. A single sample, collected from the ground surface to six-inches, was obtained at each station and submitted for TCL volatile analysis. The location of the sediment samples are depicted on Figure 3.

Volatiles were detected in five of the 11 sediment samples (see Figure 3). The highest concentrations were detected in sample SD03 (trichloroethene - 2,700 ug/Kg, 1,2-dichloroethene - 3,400 J ug/Kg, 1,1,2,2-tetrachloroethene - 7700 ug/Kg) located approximately 125 feet north of Area B. The data supports the occurrence and position of the volatile plume migrating north to northeast of Area B. Note that volatiles (excluding methylene chloride and acetone) were not detected north of SD03, suggesting that the contaminated sediments are limited to the area between Area B and just north of station SD03.

Groundwater Samples from the Temporary Wells

A total of nine shallow temporary monitoring wells were installed to collect groundwater samples from the upper four feet of the surficial aquifer in order to further define the extent of shallow groundwater contamination at Area B and towards Wallace Creek. As shown on Figure 4, three wells were installed in the immediate vicinity of Area B and six wells were installed at various locations in the swamp. Note that several of the temporary wells are located at sediment sample stations.

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Installation of the temporary wells was performed in two steps. The boring was initially advanced with a hand auger to just below the water table. The final depth was reached by pushing a 2-inch PVC well screen to approximately four feet into the saturated zone. A filter sock was placed over the well screen prior installation to prevent fine-grained materials from entering the well.

Each well was purged of five volumes to remove stagnate water and to establish hydraulic connection with the aquifer. After purging was completed, a groundwater sample was collected and submitted for TCL volatile analysis.

Volatiles were detected in eight of the nine wells. As shown on Figure 4, the highest concentrations were detected in wells TGW03, TGW04, and TGW05, which are located within Area B or just north of Area B. Trichloroethene (54 J to 1,300 J ug/L), 1,1,2,2-tetrachlorocthane (180 J to 2,000 ug/L), 1,2-dichloroethene (1 J to 1,500 ug/L) and vinyl chloride (3 to 23 ug/L) were the most prevalent volatiles detected. The distribution of the groundwater volatile plume correlates with the soil and sediment data, suggesting that the plume is migrating northward away from Area B. The extent of the VOC contamination within the swamp, however, appears to be concentrated only in the southern portion just north of Area B.

Data from the December 1994 sampling event was utilized to further evaluate the extent of shallow groundwater contamination at Site 82. Figure 5 depicts the estimated extent of shallow groundwater contamination utilizing existing (1992 and 1993) and newly acquired (December 1994) data. Groundwater data from temporary wells installed in the swamp confirms previous speculation that contamination has migrated to the swamp. Based on the new data, however, it appears that the swamp may be serving as a natural barrier which impedes the migration of VOCs in the shallow groundwater.

Deep Well Installation and Groundwater Sampling

Two deep Type III monitoring wells were installed by Baker to further evaluate groundwater quality from the Castle Hayne aquifer. One well (6-GW40DWA) was installed at 120 feet below ground surface (bgs) to monitor the upper portion of the aquifer. Previous investigations have referred to this zone as the intermediate zone of the Castle Hayne. Well 6-GW40DW was installed at 250 feet bgs to monitor the deeper portion of the Castle Hayne. These depths were selected based on the results of Baker's 1992 through 1993 investigations. Note that well 6-GW40DW was installed approximately one-foot into a silty-clay material, which is believed to be the upper portion of a retarding layer. Based on other test borings advanced in the area by Baker, the thickness of this layer varies from approximately five to eight feet. Test boring and well construction records for the two deep wells, along with the well development records, are provided in Attachment A. Following well development, each well was sampled for analysis of TCL volatiles.

Volatiles were detected in both of the newly-installed deep wells. Groundwater from well 6-GW40DWA indicated concentrations of 1,2-dichloroethene (2,100 ug/L), trichloroethene (3,600 ug/L), and vinyl chloride (110 ug/L). These levels are similar to VOC levels detected previously in well 6-GW28D, which is screened in the approximate same zone and is located due west of this well. Groundwater from well 6-GW40DW indicated 1,2-dichloroethene (29 ug/L), trichloroethene (23 ug/L), benzene (3 J ug/L), toluene (2 J ug/L), and xylenes (2 J ug/L). The significant decrease in concentrations observed in the deeper portion of the Castle Hayne (as compared to the intermediate zone at approximately 110 to 120 feet bgs) is consistent with what was observed in other well clusters during the RI (e.g., 6-GW1 and 6-GW27). The data indicates that the concentrations are decreasing with depth and that the contaminants are primarily concentrated in the intermediate zone. VOCs have migrated to the top of the retarding layer in the Castle Hayne, but at relatively low levels.

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Conclusions

Based on the results of the 1993 RI, and the Supplemental Investigation, the following conclusions were developed.

- Results generated by the magnetometer survey did not indicate any evidence of buried metallic objects in the vicinity of Area B. There does not appear to be a VOC source in this area due to buried wastes.

- Significant VOC soil contamination (greater than 100 ppm total VOCs) is present along the northern and eastern portions of Area B. The contamination extends northward toward the swamp and likely extends to Piney Green Road to the east.

- The vadose zone in the area of VOC soil contamination at Area B (and to the north and east of Area B) ranges from a few feet to less than one foot. Because of this shallow zone, it is likely that the soil is contaminated due to vaporization of VOCs in groundwater. Another possibility is that the shallow groundwater periodically comes into contact with the soil due to water table fluctuations.

- Deep groundwater just south of Area B exhibited significant VOC levels at a depth of 120 feet bgs, but much lower concentrations at a depth of 220 feet bgs. This decrease is consistent to what was observed at other well clusters representing similar monitoring zones. (e.g., 6GW1D and 6GW27D).

- The extent of VOC contamination in the intermediate zone (i.e., approximately 110 to 120 feet bgs) has been found to extend just beyond Wallace Creek (intermediate zone monitoring well 6GW36D exhibited low levels of VOCs);

- The highest levels of VOCs in the intermediate zone were observed in wells 6GW1D, 6GW27D, 6GW28D, and 6GW40DWA, which are located south of the swamp.

- The levels of VOCs in the intermediate zone under the swamp are unknown since deep monitoring wells could not be constructed in this area; however, low levels of VOCs have been detected in well 6-GW36D, which is located across Wallace Creek. Therefore, it can be concluded that VOCs are likely present under the swamp and have migrated under Wallace Creek. It is also possible that these VOCs are discharging into Wallace Creek.

- Sediment results indicate that VOCs (trichloroethene - 2,700 ug/Kg, 1,2-dichloroethene - 3,400 J ug/Kg, 1,1,2,2-tetrachloroethene - 7700 ug/Kg) have migrated into the southern portion of the swamp. The extent of the impacted sediments is limited to just north of Area B. Sediments near Wallace Creek exhibited no contamination.

- Shallow groundwater contamination has also migrated north of Area B, however, the most concentrated area appears to be limited to the southern portion of the swamp. The highest concentrations (trichloroethene [1,300 J ug/L], 1,1,2,2-tetrachloroethane [2,000 ug/L], 1,2-dichloroethene [1,500 ug/L] and vinyl chloride [23 ug/L] were detected in temporary wells located immediately north of Area B with the concentrations decreasing to non-detectable levels in wells located further north (in the direction of Wallace Creek). Based on the results, the swamp appears to be serving as a natural barrier to contaminant movement.

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- Based on the results from all of the media sampled, it appears that VOC contamination is migrating from Area B to the swamp (or downgradient). The origin of the VOCs, however, may not be from or near Area B based on the magnetometer survey which did not indicate any evidence of buried metallic objects in the area. Moreover, it is unlikely that a source (i.e., drums) would be buried in the vicinity of Area B due to the high water table.

- The origin of the volatiles in shallow and deep groundwater appears to be from the southeastern portion of Site 82 in the vicinity of Area A. The data suggests that contaminated shallow groundwater is contributing to the impacted soil and sediment within Area B and the swamp.

Recommendations

- Soil vapor extraction (SVE) at Area B may not be feasible due to two factors: (1) the high water table (one to three feet bgs) will impact the implementability and effectiveness of SVE; and (2) soil contamination is likely a result of vaporization of volatiles in shallow groundwater and not from previous disposal operations.

- Additional shallow extraction wells should be considered at Area B since elevated levels of VOCs are present in groundwater. Remediation of shallow groundwater in this area would help to mitigate further migration of VOCs to the swamp and perhaps Wallace Creek.

- Additional intermediate zone extraction wells (approximately 110 to 120 feet bgs) should be considered at Area B since elevated levels of VOCs are present in this area. Remediation of intermediate zone groundwater would help mitigate further migration towards Wallace Creek.

- Remediation of deeper groundwater (i.e., at depths of 220 feet or greater) is not recommended since this zone is not significantly contaminated. Contamination in this zone is due to vertical migration of VOCs from the intermediate zone of the Castle Hayne. The intermediate zone will be remediated under the current design of the remedial alternative.

- Remediation of swamp sediment or groundwater under the swamp is not recommended for several reasons. First, the contamination of the sediment appears to be limited to the southern portion of the swamp (i.e., near Area B). Remediation of shallow and intermediate zone groundwater near Area B will reduce VOC levels in swamp sediments and groundwater under the swamp over time. Second, remediation of swamp sediment and groundwater in this area will be costly due to site conditions. Third, disturbance of the sediments may create a worse situation from an environmental standpoint.

- Increasing the capacity of the Site 82 treatment plant may not be necessary. Baker favors pumping the extraction wells in phases. For example, certain extraction wells can be operated for a designated period (e.g., 12 months) while other extraction wells are shut down. When VOC levels begin to reach asymptotic levels in certain wells (this would be determined through long-term monitoring), these wells would be shut down for a designated period (e.g., 12 months). The reduction in influent capacity would be offset by operating other wells which were not previously in operation. The sequence and determination of operating wells would be determined through the long-term monitoring program which will be in place as part of the alternative. This option is favorable since no additional capital costs need to be incurred for upgrading the treatment plant, and because "phased" remediation is an effective way to extract VOCs from groundwater.

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Ms. Linda Saksvig
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Baker recommends that we discuss the results and conclusions as soon as possible since construction activities are ongoing at Site 82. If you have any questions, please do not hesitate to contact me at (412) 269-2016.

Sincerely,

BAKER ENVIRONMENTAL, INC.

Raymond P. Wattras
Deputy Program Manager

Attachments

RPW/lq

cc: Ms. Lee Anne Rapp, Code 183 (w/o attachments)
Ms. Beth Collier, Code 02115 (w/o attachments)
Mr. Neal Paul, MCB CLEJ
Mr. James Dunn, OHM