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FINAL PHASE 1 INTERIM INVESTIGATION MEMORANDUM SITE 11 NSB KINGS BAY GA
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PHASE I INTERIM INVESTIGATION MEMORANDUM, SITE 11

NAVAL INSTALLATION RESTORATION PROGRAM
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CTO 041

SEPTEMBER 1992

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
CHARLESTON, SOUTH CAROLINA
29411-0068

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FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act, as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) Program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR Program for all naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR Program was modified and updated to be congruent with CERCLA/SARA and RCRA/HSWA driven DOD IR Program.

The updated nomenclature for the RCRA/SARA process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- Planning and Implementation of Remedial Design

Four sites at Naval Submarine Base (NSB), Kings Bay, Georgia, were identified for investigation under the IR Program. A work plan for conducting a RCRA Facility Investigation/Site Inspection (RFI/SI) at three of four sites has been completed and implemented. No sampling or analyses will be conducted at the fourth site. The Public Works Department at the NSB will gather information for the fourth site to include in the RFI Report.

A Phase I Interim Investigation was conducted at one of the four sites, Site 11, in response to detection of VOC contaminants, primarily vinyl chloride, in a downgradient monitoring well. The investigation included collection and chemical analysis of groundwater samples and collection of stratigraphic information using direct push technology. This report summarizes findings and conclusions resulting from evaluation of data collected during the investigation.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the Navy and Marine Corps IR Program in the southeastern and midwestern United States. Questions regarding this report should be addressed to the SOUTHNAVFACENGCOM Engineer-in-Charge, Mr. Ed Lohr, at (803) 743-0355.

EXECUTIVE SUMMARY

ABB Environmental Services, Inc. (ABB-ES), under contract to Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), conducted site investigation activities at one of four former waste disposal sites at Naval Submarine Base (NSB), Kings Bay, Georgia. This investigation resulted from information obtained from groundwater monitoring activities associated with the RCRA Facility Investigation/Site Inspection that will continue into calendar year 1993. This Phase I Interim Investigation was completed under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (contract number N62467-89-D-0317, Contract Task Order [CTO] number 041) between SOUTHNAVFACENGCOM and ABB-ES.

This memorandum summarizes the scope, findings, and conclusions of the initial phase of an investigation to begin to delineate and characterize groundwater contamination detected downgradient of Site 11. Site 11 is the Old Camden County Landfill, which is on property now owned by the Navy. Vinyl chloride was the primary VOC of concern for this investigation. The investigation included collection of groundwater samples and analysis for target volatile organic compounds (VOCs) in a field laboratory. Two piezocone penetrations were conducted for collection of stratigraphic information. Groundwater sampling was conducted near the western boundary of the landfill, near the NSB property line west of the landfill, and on the western right-of-way to Georgia Spur 40.

Thirty-six groundwater samples, including three duplicate samples, were collected from 25 locations using a hydrocone groundwater sampler and direct push technology. One groundwater sample was collected from an on-site monitoring well, KBA-11-2, using a teflon bailer. Field analyses were performed according to SW-846 Method 8010 modified for field application. Target VOCs for field analyses included chloroethane, vinyl chloride, trans-1,2-dichloroethene, trichloroethene, and tetrachloroethene. Six samples, including a duplicate sample, were submitted for confirmatory analysis at a laboratory approved by the Naval Energy and Environmental Support Activity (NEESA). Confirmatory analyses included halogenated VOCs using SW-846 Method 8010. One of the confirmatory samples was also analyzed for aromatic VOCs using SW-846 Method 8020.

Confirmatory analytical data were compared to the field data for corresponding samples. The field and confirmatory data were in agreement, indicating that the field data was viable for use in site screening.

Stratigraphic information obtained from the piezocone penetrations indicate the subsurface is primarily comprised of interbedded sand and silty sand. No confining layers were identified in the stratigraphic units included in the surficial aquifer. Hydraulic pressures were evaluated at multiple depths during the piezocone penetrations. No downward flow components were identified based on the hydraulic pressures recorded during the piezocone penetrations.

Results of the Phase I Interim Investigation of VOC contamination at Site 11 indicate that two plumes may be present along the western boundary of the landfill and on the western side of Spur 40. Concentrations of vinyl chloride ranging from 2.8 ug/l to 120 ug/l were detected along the right-of-way to Spur

40. Concentrations of vinyl chloride detected near the western boundary of the landfill ranged from 2.2 ug/l to 1400 J ug/l. The two areas of highest concentrations are relatively narrow, however their overall area of influence is approximately 530 feet in the north to south direction. This indicates that the landfill may have two areas where VOCs are being released to groundwater. VOC contaminants were detected at depths ranging from 9 feet below land surface (BLS) to 25 feet BLS.

VOC contaminants detected in the confirmatory samples include halogenated solvents such as vinyl chloride, 1,1-dichloroethane, cis-1,2-dichloroethene, and tetrachloroethene. Fuel related VOCs were also detected, including toluene, benzene, ethylbenzene, and xylenes. Vinyl chloride and cis-1,2-dichloroethene are present in groundwater at concentrations that exceed their respective MCLs of 2 ug/l and 70 ug/l.

Samples collected from the western right-of-way to Spur 40 are located approximately 50 feet east of private property included in Crooked River Plantation subdivision. On September 3, 1992, the residents of Crooked River Plantation were informed of the groundwater contamination and invited to a public meeting held on September 7, 1992.

Navy has made required notifications in accordance with the National Contingency Plan. An interim measures study technical plan has been initiated. The plan will include a schedule for field work to begin in mid-October 1992. Presently, the interim measures study is expected to include, but may not be limited to, the use of direct push technology to further characterize the extent of contamination and stratigraphy. Data will be collected for use in air modeling to support preliminary risk evaluations. Groundwater samples will be collected from existing private irrigation wells potentially influenced by groundwater contaminants. Data collected during the interim measures study will be used to complete a preliminary screening risk evaluation.

The data collected during the interim measures study will be used in development of a RCRA Facility Investigation (RFI) Workplan. The RFI is expected to include installation of confirmatory monitoring wells and collection of data in support of risk assessment and Corrective Measures Study.

ACKNOWLEDGEMENTS

In preparing this report, the personnel at ABB Environmental Services, Inc., commend the support, assistance, and cooperation provided by the personnel at NSB Kings Bay, Georgia, and SOUTHNAVFACENGCOM. In particular, we acknowledge the outstanding effort, dedication, and professionalism provided by the following people in the preparation of this report.

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PHASE I INTERIM INVESTIGATION MEMORANDUM, SITE 11

NAVY INSTALLATION RESTORATION PROGRAM
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

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ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ASTM	American Society for Testing Materials
BLS	below land surface
CERCLA	Comprehensive Environmental Restoration, Compensation and Liability Act
CPT	cone penetrometer testing
ELCD	electrolytic conductivity detector
GA DNR	Georgia Department of Natural Resources
GC	gas chromatograph
MLW	mean low water
NACIP	Naval Assessment and Control of Installation Pollutants
PID	photoionization detector
PSC	potential source of contamination
RCRA	Resource Conservation and Recovery Act
RFI/SI	RCRA Facility Investigation/Site Inspection
SWMU	solid waste management unit
SOUTHNAV-FACENGCOM	Southern Division Facilities Naval Engineering Command
NSB	Naval Submarine Base
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
ug/l	micrograms per liter

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), under contract to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) conducted site screening activities at Site 11, the Old Camden County Landfill, at Naval Submarine Base (NSB), Kings Bay, Georgia. Screening activities were initiated because analytical data from three groundwater sampling events conducted in association with an on-going RCRA Facility Investigation/Site Inspection (RFI/SI) indicated that volatile organic compounds (VOCs) were present in groundwater downgradient of the Old Camden County Landfill. The VOC of primary concern is vinyl chloride. The screening investigation was conducted pursuant to the approved RFI/SI work plan (ABB-ES, 1991) and as detailed in the Preliminary Plan of Action (ABB-ES, 1992).

Screening activities included collection of stratigraphic information and groundwater samples using cone penetrometer testing (CPT), a direct push technology. Groundwater samples were analyzed in the field to facilitate decisions associated with achieving the project objectives. Off-site, confirmatory laboratory analyses were performed on replicate samples. The confirmatory data was used in evaluating the reliability of field analytical data.

Project objectives included: (1) a determination of whether VOC contaminants had migrated off NSB property, (2) generally define the horizontal extent of contamination in the north and south direction near the western boundary of the landfill, (3) generally define the horizontal extent of contamination in the north and south directions on right-of-way property west of Spur 40, if contaminants were present there, or along the NSB property line if contaminants had not migrated to the western side of Spur 40 and (4) investigate the vertical extent of contamination.

Section 2.0 of this document describes the field program for the Phase I Interim Investigation at Site 11. Section 3.0 presents results of the investigation, and Section 4.0 discusses conclusions and follow-on activities. Figures and tables referenced in this report are included in Appendices A and B, respectively.

2.0 FIELD PROGRAM

The stratigraphy of the surficial sand aquifer was evaluated and groundwater samples were recovered using direct push methods provided under subcontract by Subsurface Technology, Incorporated of Maitland, Florida. Equipment consisted of a cone penetrometer truck, piezocone, hydrocone groundwater sampler, computer and associated software. One groundwater sample was obtained from existing groundwater monitoring well KBA-11-2 using a teflon bailer.

2.1 DIRECT PUSH TECHNOLOGY

Stratigraphic information was obtained from two piezocone penetrations, PC-1 and PC-2 (Figure 1), completed to refusal at 85 and 97 feet below land surface (BLS), respectively. PC-1 is located on Georgia State Route Spur 40 western right-of-way property, approximately 150 feet west of monitoring well KBA-11-2. The second penetration (PC-2) is located east of Spur 40 on NSB property, approximately 25 feet east of monitoring well KBA-11-2. Due to an error in saving the data for PC-2 on the on-board computer, all data beyond the 17-foot depth were lost.

Piezocone penetrations are made by hydraulically advancing a series of steel rods into the soil at a constant rate. Resistance to penetration at the cone tip and at the outer surface of the sleeve, located near the cone tip, is recorded. Subsurface pore pressure is monitored with a pressure transducer. These measurements are recorded by the on-board computer. Following demobilization, the data are compared to empirically derived measurements or parameters characteristic of different soil types. Thus, the piezocone is able to provide information regarding soil classifications consistent with the Unified Soil Classification System (USCS), relative soil density (split-spoon blow counts), water levels, and effective thickness of confining units, if any.

The hydrocone groundwater sampler provided by Subsurface Technology consists of a telescoping assembly containing a 1-foot length of stainless-steel well screen fitted with a cone tip. This assemblage is hydraulically advanced with a series of rods in the same manner as are the piezocone penetrations. When the screen is exposed by retracting the outer casing of the sample device, natural hydrostatic pressure forces groundwater to flow into the sample collection chamber. The amount of groundwater entering the collection chamber is monitored and controlled by pressuring the collection chamber with argon gas. Argon back pressure prevents volatization of the sample during collection and retrieval. Rate of filling of the chamber is recorded and used to estimate horizontal permeability within the aquifer at the sample interval. The sample is contained in the chamber for retrieval by using argon gas back pressure to impinge a small ball into its check-valve at the bottom of the sample collection chamber. The sample collection chamber and screen assemblage are lifted to the surface to recover the sample. To collect water from multiple intervals, the hole is reentered with a clean sample collection chamber and screen assemblage and the hydrocone is advanced to the desired depth. Cross-contamination is prevented by using O-rings to form a water-tight seal above and below the sample chamber. The pressure transducer and computer allow the sample chamber to be monitored for infiltration of water.

Sample location and depth intervals were chosen based on analytical data provided by an on-site laboratory. Thus, the location and depth interval of successive samples was selected based on analytical information from preceding samples.

Sample locations are shown on Figure 1 in Appendix A. A total of 33 groundwater samples were collected, including duplicate samples, for analysis using the field gas chromatograph (GC). Six replicate groundwater samples, including a duplicate sample, were sent to CH2M HILL Laboratories for confirmatory analysis.

Groundwater sampling began near existing monitoring well KBA-11-2, and continued to the north and south to define the limits of horizontal contamination. Samples were recovered from multiple depths at many of these locations, especially near monitoring well KBA-11-2, because of the need to identify the depth of highest contaminant levels. In some cases, sample depths were restricted by a dense, but permeable, sand lens that could not be penetrated by the hydrocone.

After the horizontal extent of contamination was evaluated near the western landfill boundary, sampling was conducted to the west near the NSB property boundary. One hydrocone penetration, HC-15, was conducted near the property boundary to confirm the general direction that the plume was migrating and to evaluate the vertical extent of contamination. Four groundwater samples were collected at this location from depths ranging from 16 feet BLS to 78 feet BLS, where the hydrocone met refusal. Concentrations of vinyl chloride of 400 J ug/l (estimated) and 11 ug/l were detected at depths of 16 to 17 feet BLS and 24 to 25 feet BLS, respectively, at the location of HC-15. The presence of vinyl chloride near the NSB property line caused sampling to be conducted on right-of-way property west of Spur 40.

2.2 ANALYTICAL PROGRAM

ABB-ES established a mobile laboratory facility at NSB, Kings Bay. A 28-foot field trailer and portable purge and trap GC were mobilized to NSB, Kings Bay. The GC was operated by an ABB-ES chemist. Field analyses included the five target halogenated VOCs listed below. Corresponding detection limits are also listed below.

Compound	Practical Quantitation Limit
Chloroethane	10 ug/l
Vinyl Chloride	2 ug/l
trans-1,2-Dichloroethene	2 ug/l
Trichloroethene	5 ug/l
Tetrachloroethene	2 ug/l

Groundwater samples collected using the hydrocone were decanted into 40-milliliter (ml) vials having Teflon® septa. Hydrochloric acid preservative was added to the vials prior to filling with groundwater. After collection, vials were placed on ice in a cooler, chain-of-custody was completed, and the samples were transported to the field laboratory for analysis.

Samples were analyzed according to SW-846 Method 8010, adapted for field application, for purgeable halocarbons. Quantification of vinyl chloride was done using a photoionization detector (PID). The purge and trap connection to the GC was adapted for use of the PID for measurement of vinyl chloride concentrations. Analysis of performance standards and correlation to off site analytical data confirmed the accuracy of field measurements of low concentrations of vinyl chloride, trans-1,2-dichloroethene, and tetrachloroethene. The practical quantitation limits for chloroethane and

trichloroethene were elevated to 10 ug/l and 5 ug/l, respectively, from 2 ug/l because initial calibration criteria were not met for these compounds.

Groundwater samples HC-1 through HC-5 were collected on Friday, August 7, 1992, in anticipation of the field laboratory overcoming technical problems by noon that day. When noon passed and the field laboratory was still experiencing problems, a decision was made to terminate sampling for a period of two days, the weekend, to either have the field laboratory become functional and fulfill its intended use, or make alternate arrangements. The two day period that sampling was ceased was sufficient for the problems with the field laboratory to be corrected, confirmation of the viability of using the PID for vinyl chloride analysis, and analysis of the five groundwater samples previously collected. The samples were properly preserved with concentrated hydrochloric acid and stored on ice in an ice chest. Analysis of the samples was performed within 3 days of sample collection, which is well within holding time.

2.3 DECONTAMINATION PROCEDURES

All hydrocone sampling equipment in contact with the sample was cleaned as follows:

1) Washed with Alconox® and deionized water.
2) Rinsed with deionized water.
3) Rinsed with pesticide-grade propanol.
4) Rinsed with deionized, carbon-filtered water (ASTM Type II).
5) Air dried.
6) Wrapped in aluminum foil.

Decontamination fluids were collected in the decontamination area, which was lined with black plastic. The thin layer of decontamination water collected on the plastic was allowed to evaporate, during which time volatization of VOCs would also occur. At the end of the field effort the remaining decontamination water and unused portions of groundwater samples were returned to the site and disposed within the area of contamination in accordance with the U.S. Environmental Protection Agency (USEPA) guidance for management of investigation-derived waste (USEPA, 1991).

2.4 LOCATION SURVEY

Piezocone and hydrocone sampling locations were surveyed by a Georgia licensed surveyor provided under subcontract by Privett and Associates Land Planners and Surveyors, of St. Mary's, Georgia. A closed loop horizontal and vertical location survey was done to determine each piezocone and hydrocone location with 0.1 feet of horizontal and 0.01 feet of vertical accuracy. Horizontal locations were tied to existing control points on the base and meet the requirements of a third order Class III Survey. Horizontal measurements are precise to 1 foot in 10,000 feet. Vertical elevations are relative to mean low water (MLW), consistent with other NSB, Kings Bay, survey data.

3.0 RESULTS

The following subsections discuss analytical results, evaluations, and interpretations for the Phase I Interim Investigation, Site 11, conducted August 4 through 13, 1992.

3.1 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATION RESULTS

Geologic and hydrogeologic information was obtained from two piezocone penetrations conducted during the investigation. Estimates of hydraulic conductivity (K) were also obtained from information recorded during sampling using the hydrocone.

Figure 2 is a geologic cross-section (A - A') developed from stratigraphic information obtained from the piezocone penetrations. Sample locations and the location of the cross-section are shown in Figure 1. The stratigraphy of the site is primarily comprised of interbedded layers of sand and silty sand. Thin layers of clayey sand or clay are present over the interval penetrated. Data for piezocone penetration PC-1 beyond the 17-foot depth were lost due to operator error.

Table 1 summarizes K data obtained during collection of samples using the hydrocone. Estimated K values range from 2.6×10^{-5} feet per minute (ft/min) to 9.3×10^{-3} ft/min. The arithmetic mean and geometric mean were calculated to be 2.0×10^{-3} ft/min and 1.0×10^{-3} ft/min, respectively. Seepage velocities calculated from the K estimates range from 2.6×10^{-7} ft/min to 9.3×10^{-5} ft/min. Calculations of seepage velocities assumed Darcian flow, 30 percent effective porosity, and an average horizontal hydraulic gradient of 0.003 ft/ft. The hydraulic gradient was determined from potentiometric surface maps developed from water levels measured in February, May, July, and August 1992. Figure 3 in Appendix A is a potentiometric map developed from groundwater levels measured on August 7, 1992. Groundwater flow directions shown in Figure 3 are consistent with previous data collected during the RFI/SI.

The landfill opened 18 years ago and closed 11 years ago. Over a period of 18 years, the estimated distance of contaminant migration, based on the maximum seepage velocity stated in the above paragraph, is 880 feet. Over a period of 11 years, the estimated maximum distance of contaminant migration is 540 feet. Estimates of contaminant migration based on the arithmetic mean, geometric mean, and lowest seepage velocity range from 2.5 feet to 189 feet over an 18 year period. Data associated with this investigation indicate that contaminants have migrated at least 200 feet.

Vertical flow gradients were evaluated by pore pressures measured at four depths during penetration PC-1. Hydraulic pressures increased with depth, being 10.4 pounds per square inch (psi) at 31 feet BLS and 34.23 psi at 84 feet BLS. These data do not suggest downward groundwater flow components.

3.2 ON SITE GROUNDWATER CONTAMINATION

The initial objective of hydrocone sampling was to verify the viability of the technique by obtaining groundwater samples from an interval equivalent to the middle of the screened interval of monitoring well KBA-11-2, which is 8 feet BLS at the well location. A depth of 10 feet BLS was targeted based on differences in elevation at the well location and at the area where hydrocone penetrations

would be placed. The first attempt to collect a groundwater sample from 10 feet BLS was unsuccessful because the hydraulic head at 10 feet BLS was insufficient to provide adequate sample volumes.

Twenty-three groundwater samples, including two duplicate samples, were collected from 15 locations on NSB property using the hydrocone groundwater sampler (Figure 1 in Appendix A). Field analytical data are presented in Table 2 in Appendix B. Figure 4 in Appendix A is a cross-section (B - B') showing field GC data for samples collected near the western boundary of the landfill. This cross-section shows the relationship between sample depths and vinyl chloride concentrations in groundwater.

One groundwater sample was collected from monitoring well KBA-11-2 using a decontaminated teflon bailer. Five well volumes were purged prior to sample collection. During field analysis vinyl chloride was detected at a concentration of 93 ug/l in a groundwater sample from the monitoring well. Concentrations of vinyl chloride detected in five groundwater samples collected from monitoring well KBA-11-2 during three monitoring events in February, May, and July 1992 ranged from 18 ug/l to 150 ug/l.

Groundwater sample HC-1 was collected from a location approximately 25 feet upgradient (east) of monitoring well KBA-11-2. Field analysis of this sample indicated 4.2 ug/l of vinyl chloride, well below the 93 ug/l of vinyl chloride detected in a sample from the monitoring well. Samples HC-2 through HC-5 were collected from locations 75 feet and 150 feet to the north and to the south of monitoring well KBA-11-2. Field analytical data for groundwater samples HC-2 through HC-5 indicated that sample HC-2 contained 2.2 ug/l vinyl chloride and that the other three samples did not contain detectable levels of vinyl chloride.

Sample location HC-6 was placed directly beside the monitoring well. Four groundwater samples were collected from four depths at this location. Sample HC-6A was collected from 7 to 8 feet BLS, approximately 2 feet below the water table. No target VOCs were detected during field analysis of this sample. The second sample, HC-6B, was collected from 9.5 to 10.5 feet BLS and contained 40 ug/l of vinyl chloride. The third sample, HC-6C, was collected from 12.5 to 13.5 feet BLS and contained an estimated concentration of vinyl chloride of 700 J ug/l. The fourth sample, HC-6D, was collected from 15.5 to 16.5 feet BLS and contained an estimated concentration of vinyl chloride of 1400 J ug/l. The linear range of the GC was calculated to be 40 ug/l for vinyl chloride. All concentrations of vinyl chloride in excess of 40 ug/l are considered estimated, but are also considered to be valid for the intended use of the data (site screening). The data from the four groundwater samples collected from sample location HC-6 indicated that VOC contaminants are not present in the upper 2 feet of the water table, and that concentrations of vinyl chloride an order of magnitude greater than that detected in samples from monitoring well KBA-11-2 are present in groundwater 3.5 feet below the screened interval of KBA-11-2.

Based on field GC data for the groundwater samples from HC-6, it became clear that the sample depths for locations HC-1 through HC-5 were too shallow. Samples collected from depths corresponding to the middle of the screened interval of monitoring well KBA-11-2 would not result in concentrations of vinyl chloride similar to that detected in a sample from the monitoring well. A decision was made to sample at greater depths.

Groundwater samples HC-7 through HC-13 were collected from locations to the north and south of monitoring well KBA-11-2 to evaluate the horizontal extent of contamination near the western boundary of the landfill. The target sample depth for these samples was 16 to 17 feet BLS. A dense fine sand layer located approximately 14 feet BLS occasionally prevented penetrations from reaching the target depth. Sample depths were either 14 to 15 feet BLS or 16 to 17 feet BLS, as indicated on Table 2.

Sample locations HC-7, HC-9, and HC-11 are located 300 feet, 150 feet and 50 south of monitoring well KBA-11-2, respectively. No target VOCs were detected in groundwater sample HC-7. Groundwater samples HC-9 and HC-11 contained 2.5 ug/l and 9.0 ug/l of vinyl chloride, respectively.

Sample locations HC-10, HC-8, HC-13, and HC-12 are 380 feet, 300 feet, 135 feet, and 40 feet north of monitoring well KBA-11-2, respectively. Vinyl chloride was the only target VOC detected and was found in all four of these samples. The concentration of vinyl chloride in groundwater sample HC-8 was 40 ug/l. Concentrations of vinyl chloride in HC-12 and HC-13, to the south of sample location HC-8, were 3.2 ug/l and 5.7 ug/l, respectively. Groundwater sample HC-10, collected from a location to the north of sample location HC-8, contained 4.3 ug/l of vinyl chloride. These data suggest that releases may have occurred from two disposal trenches in the landfill, which would result in two slugs of contamination. These two slugs of contamination are referred to as two plumes, plume A and plume B, in Figure 4. Additional data are needed to verify that two plumes are present.

Sample location HC-14 is adjacent to monitoring well KBA-11-2 on the downgradient side of the well. This location was targeted for groundwater sampling at multiple depths, and was anticipated to provide information regarding the vertical extent of contamination. A dense fine sand layer caused refusal, so a sample was collected from 19 to 20 feet BLS, the depth of refusal. This sample, HC-14, contained an estimated concentration of 60 J ug/l of vinyl chloride. This may indicate that the highest concentrations of vinyl chloride in the VOC contaminant plume are approximately 16 feet BLS in the vicinity of monitoring well KBA-11-2. This is based on the estimated concentration of 1400 J ug/l of vinyl chloride detected in groundwater sample HC-6D.

Sampling activities moved to the west near the NSB property line and outside the perimeter fence. Sample location HC-15 is west-northwest of monitoring well KBA-11-2. The objective of sampling near the property line was to determine whether site-related VOCs were present in groundwater, which would provide an indication that contamination had moved off NSB property and indicate the general direction of contaminant migration. Sample HC-15A was collected from a depth of 16 to 17 feet BLS and contained an estimated concentration of vinyl chloride of 400 J ug/l. Three other intervals were sampled at this location. Sample HC-15B was collected from 24 to 25 feet BLS, HC-15C from 49 to 50 feet, and HC-15D from 77 to 78 feet BLS (at refusal). The only target VOC detected in these three samples was in sample HC-15B (24 to 25 feet BLS), which contained 11 ug/l of vinyl chloride.

In summary, field GC data for groundwater samples collected from locations along the western landfill boundary indicate that VOC contamination may be comprised of two plumes, as shown in Figure 4. The location of cross-section B - B' is shown in Figure 1. In the area of monitoring well KBA-11-2 vinyl chloride was detected at a concentration of 1400 ug/l. Approximately 300 feet north of

monitoring well KBA-11-2 at sample location HC-8 40 ug/l of vinyl chloride was detected. The concentrations of vinyl chloride between the two potential plumes range from 3.2 ug/l to 5.7 ug/l, based on concentrations detected in samples HC-12 and HC-13. Contamination is present near the NSB property line, where concentrations of vinyl chloride of 400 J ug/l and 11 ug/l were detected at 16 to 17 feet BLS and 24 to 25 feet BLS, respectively.

3.3 OFF SITE GROUNDWATER CONTAMINATION

Ten groundwater samples were collected from locations on the western right-of-way of Spur 40 on property owned by the Georgia Department of Transportation (GA DOT). These locations are hydraulically downgradient of the landfill. Results of field analyses indicate a similar scenario regarding distribution of groundwater contaminants as was found near the landfill boundary. Figure 5, cross-section C - C', shows the general location of what may be two plumes (A and B) based on field GC data for samples collected from the right-of-way property. Figure 6, cross-section D - D', shows field GC data for the VOC contamination detected at the location of monitoring well KBA-11-2 (designated as plume A). Cross-section D - D' extends from the landfill to the western right-of-way of Spur 40. Sample locations and the location of the cross-sections are shown in Figure 1.

Groundwater sample HC-16 was collected from 12 to 13 feet BLS, at refusal on a dense fine sand layer, and found to contain an estimated concentration of vinyl chloride of 120 J ug/l and 6.2 ug/l of tetrachloroethene. Tetrachloroethene was not detected in samples collected near the source of contamination on NSB property, but is a potential parent compound of vinyl chloride. Typically, parent compounds such as tetrachloroethene would not be expected near the leading edge of the plume if they were not detected near the source area.

Groundwater sample HC-25 was collected from a depth of 13 to 14 feet BLS and contained and estimated 54 J ug/l of vinyl chloride and 6.4 ug/l of tetrachloroethene. Sample location HC-25 is approximately 350 feet north of sample location HC-16.

Sample locations HC-17, HC-19, HC-21, HC-22, and HC-23 are located between locations HC-16 and HC-25. These samples were collected from depths ranging from 16 to 20 feet BLS. Sample depth intervals for the samples ranged from 12.5 to 13.5 feet BLS to 19 to 20 feet BLS (Table 2). Concentrations of vinyl chloride in these samples range from an estimated 45 J ug/l, near location HC-16, to 2.8 ug/l at sample location HC-22. Two of these samples, HC-17 and HC-19, contained detectable concentrations of tetrachloroethene of 4.6 ug/l and 3.2 ug/l, respectively.

Groundwater sample HC-20 was collected from a location approximately 250 feet to the north of sample location HC-25 to evaluate for contaminant migration to a pond located northwest of the sample point. Sample HC-20 was collected from a depth of 15 to 16 feet BLS and did not contain detectable concentrations of target VOCs.

Sample locations HC-18 and HC-24 are located south of sample location HC-16, where 120 J ug/l of vinyl chloride was detected. These samples contained 6.2 ug/l and 3.2 ug/l of vinyl chloride, respectively.

3.4 CONFIRMATION LABORATORY ANALYTICAL RESULTS

Six groundwater samples, including one duplicate sample, were sent to CH2M HILL Laboratories for analysis of halogenated VOCs according to SW-846 Method 8010 (USEPA, 1986). One of the six was also analyzed for aromatic VOCs according to SW-846 Method 8020. Table 3 summarizes analytical results for VOCs included in the field analyses and other VOCs detected in the six groundwater samples.

3.3.1 Correlation of Confirmatory and Field Analytical Data Groundwater samples HC-2, HC-3, HC-10, HC-15B, and HC-23 were replicated for analysis at CH2M HILL Laboratories. The field analytical data and corresponding confirmatory analytical data, in units of ug/l, are as follows:

Sample	Compound	Field	Confirmatory
HC-2	vinyl chloride	2.2	2.0
HC-3	(no target VOCs detected by either analysis)		
HC-10	vinyl chloride	4.3	1.4
HC-15B	vinyl chloride	11	11
HC-23	trichloroethene	5 U	4.9/4.7
	vinyl chloride	45 J	32 J/35 J

The field data and confirmatory data for vinyl chloride are generally in agreement, indicating the field GC data for the 33 groundwater samples is adequate for the intended use. The field laboratory experienced difficulty in quantification of trichloroethene due to poor integration for this compound. The detection limit for trichloroethene was elevated to 5 ug/l for the field analyses. The concentrations of 4.9 ug/l and 4.7 ug/l of trichloroethene reported for the confirmatory analyses are below the practical quantitation limit of the field GC.

3.3.2 Other VOCs Detected in Groundwater by Confirmatory Analysis Confirmatory analytical data for groundwater sample HC-15B (Table 3 in Appendix B) provide an initial characterization of the nature of the contaminant plume. Twelve VOCs, including vinyl chloride, were detected in groundwater sample HC-15B (24 to 25 feet BLS) as shown in Table 3. Three compounds, 1,1-dichloroethane, cis-1,2-dichloroethene, and toluene were detected at concentrations ranging from 100 ug/l to 230 ug/l. Cis-1,2-dichloroethene in this sample exceeds its Federal Primary Drinking Water Standard MCL of 70 ug/l. Federal Primary Drinking Water Standard MCLs are shown in Table 3 for those VOCs that are regulated under the Safe Drinking Water Act.

Chlorobenzene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene were detected at concentrations ranging from 2.3 ug/l to 4.6 ug/l in groundwater sample HC-10. These compounds have been detected in groundwater samples from monitoring well KBA-11-3 during previous sampling events associated with the RFI/SI. Concentrations detected in groundwater samples collected from the monitoring well and using the hydrocone are below corresponding Federal Primary Drinking Water Standard MCLs.

Three VOCs were detected in confirmatory groundwater samples at concentrations near their corresponding MCLs. Tetrachloroethene was detected in replicate groundwater samples from sampling location HC-23 at concentrations of 4.9 ug/l and 4.7 ug/l, which approximates the MCL for tetrachloroethene of 5 ug/l. Benzene and 1,1-dichloroethane were detected in sample HC-15B at concentrations

of 1.7 ug/l and 3.9 ug/l, respectively. The MCL for benzene is 5 ug/l and the MCL for 1,1-dichloroethane is 7 ug/l.

Confirmatory laboratory analysis of groundwater samples collected during the Phase I Interim Investigation at Site 11 indicate the nature of VOC contaminants in the plume. VOC contaminants include halogenated solvents such as vinyl chloride, 1,1-dichloroethane, cis-1,2-dichloroethene, and tetrachloroethene. Fuel related VOCs were also detected, including toluene, benzene, ethylbenzene, and xylenes.

4.0 CONCLUSIONS AND FOLLOW-ON ACTIVITIES

4.1 CONCLUSIONS

Results of the Phase I Interim Investigation of VOC contamination at Site 11 indicate that two plumes may be present along the western boundary of the landfill and on the western side of Spur 40. The two areas of highest concentrations are relatively narrow, however their overall area of influence is approximately 530 feet in the north to south direction. This indicates that the landfill may have two areas where VOCs are being released to groundwater. VOC contaminants were detected at depths ranging from 9 feet BLS to 25 feet BLS.

VOC contaminants include halogenated solvents such as vinyl chloride, 1,1-dichloroethane, cis-1,2-dichloroethene, and tetrachloroethene. Fuel related VOCs were also detected, including toluene, benzene, ethylbenzene, and xylenes. Vinyl chloride and cis-1,2-dichloroethene are present in groundwater at concentrations that exceed their respective MCLs of 2 ug/l and 70 ug/l.

Samples collected from the western right-of-way to Spur 40 are located approximately 50 feet east of private property included in Crooked River Plantation subdivision. Concentrations of vinyl chloride ranging from 2.8 ug/l to 120 ug/l were detected along the right-of-way.

4.2 FOLLOW-ON ACTIVITIES

Prior to and during completion of this report the Navy has notified the National Response Center, USEPA Region IV, and the Georgia Department of Natural Resources (GA DNR) regarding the release of hazardous substances from the site. On September 3, 1992, a public meeting was held for the purpose of informing residents of Crooked River Plantation subdivision of the results of this investigation, and plans to further investigate the problem and initiate remedial measures. On September 9, 1992, SOUTHNAVFACENGCOM, NSB, and ABB-ES representatives met with representatives from GA DNR to discuss regulatory matters associated with continuing the investigation and planning of corrective measures.

Recommendations for follow-on work include development and implementation of interim measures. An interim measures study technical plan has been initiated. A draft technical plan for interim measures will be submitted to GA DNR in early October 1992. The plan will include a schedule for field work to begin in mid-October 1992. Presently, the interim measures study is expected to include, but may not be limited to; the use of direct push technology to further characterize the extent of contamination and stratigraphy; collection of data for use in air modeling to support preliminary risk evaluations; and collection and analysis of groundwater samples from existing private irrigation wells potentially influenced by groundwater contaminants. Completion of a preliminary screening risk evaluation based on data collected during the interim measures study.

The data collected during the interim measures study will be used in development of an RFI Workplan. The RFI is expected to include installation of confirmatory monitoring wells and collection of data in support of risk assessment and Corrective Measures Study.

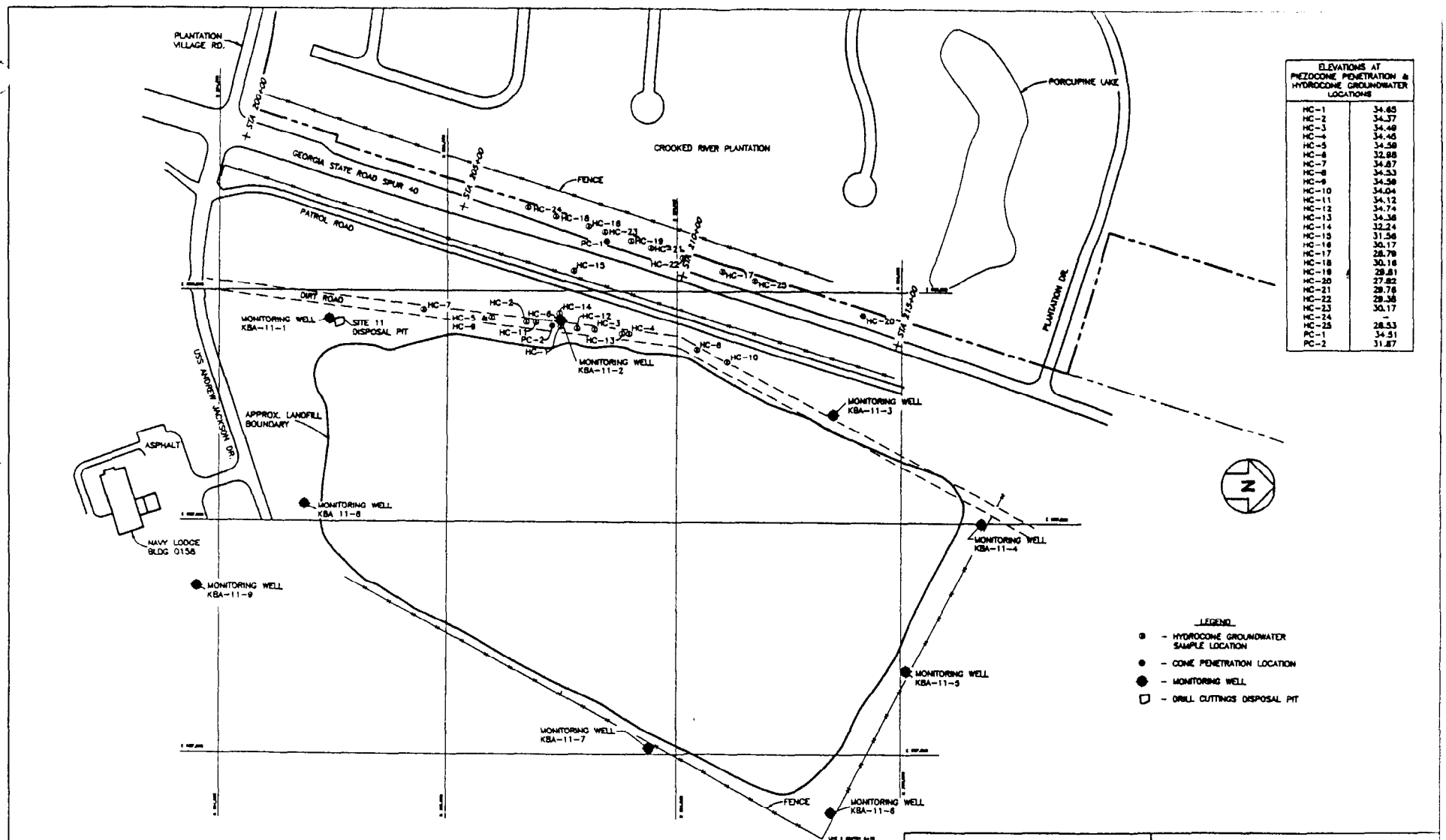
REFERENCES

ABB Environmental Services, Inc. (ABB-ES), 1991. Naval Submarine Base, Kings Bay, Georgia, Potential Source of Contamination (PSC) Site Investigation/Solid Waste Management Unit (SI/SWMU), RCRA Facility Investigation (RFI) Work Plan; Prepared for Southern Division Naval Facilities Engineering Command; October 1991.

U.S. Environmental Protection Agency (USEPA), 1991. Management of Investigation-Derived Waste During Site Inspections; Office of Research and Development; May 1991.

APPENDIX A

FIGURES



ELEVATIONS AT PIEZOCONE PENETRATION & HYDROCONE GROUNDWATER LOCATIONS	
HC-1	34.65
HC-2	34.37
HC-3	34.49
HC-4	34.45
HC-5	34.58
HC-6	32.88
HC-7	34.87
HC-8	34.53
HC-9	34.58
HC-10	34.04
HC-11	34.12
HC-12	34.74
HC-13	34.36
HC-14	32.24
HC-15	31.56
HC-16	30.17
HC-17	28.79
HC-18	30.16
HC-19	29.81
HC-20	27.82
HC-21	29.76
HC-22	29.36
HC-23	30.17
HC-24	-
HC-25	28.53
PC-1	34.51
PC-2	31.87

FIGURE 1

SITE 11
CONE PENETROMETER LOCATIONS

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

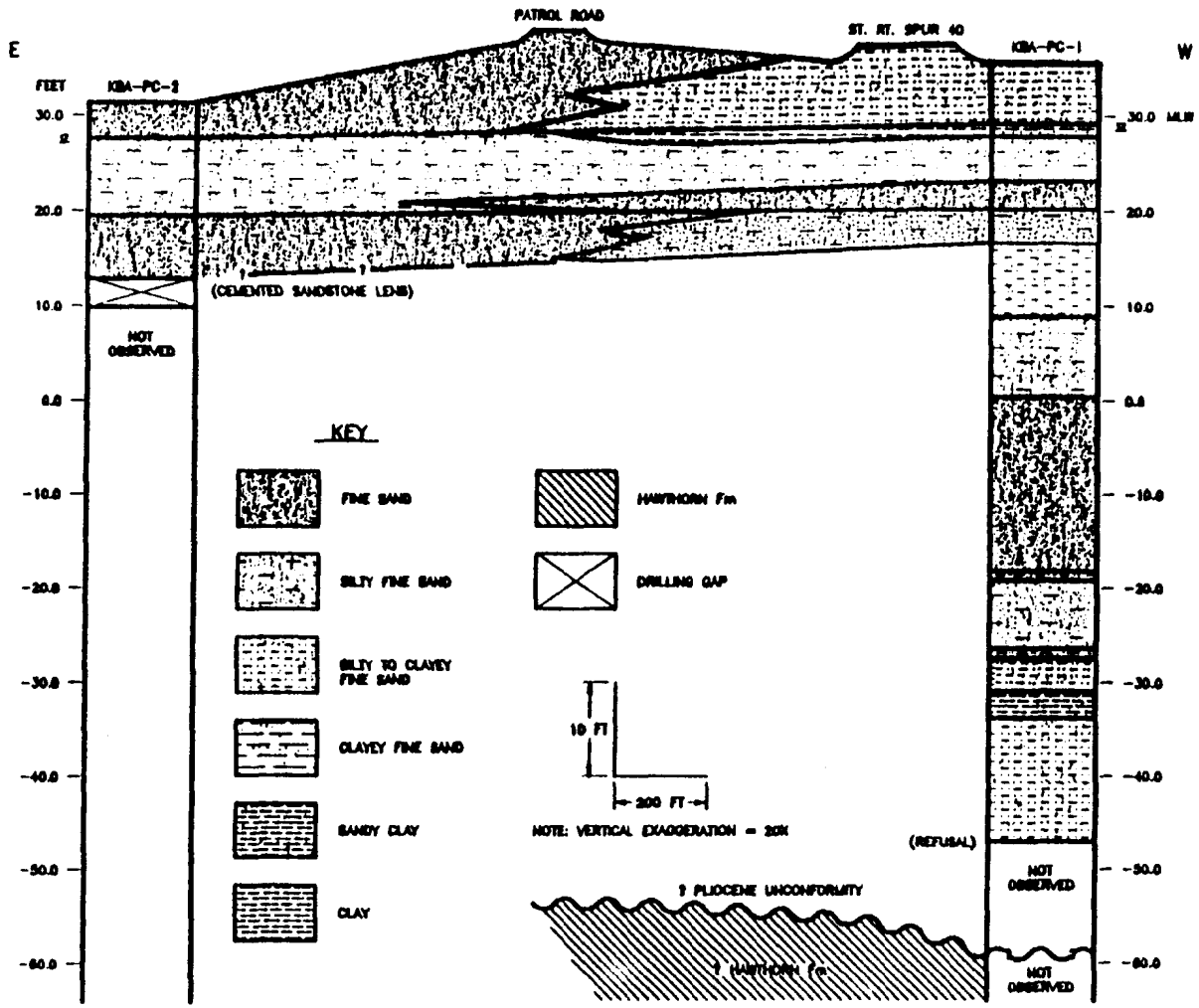


FIGURE 2
CROSS-SECTION A - A'

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

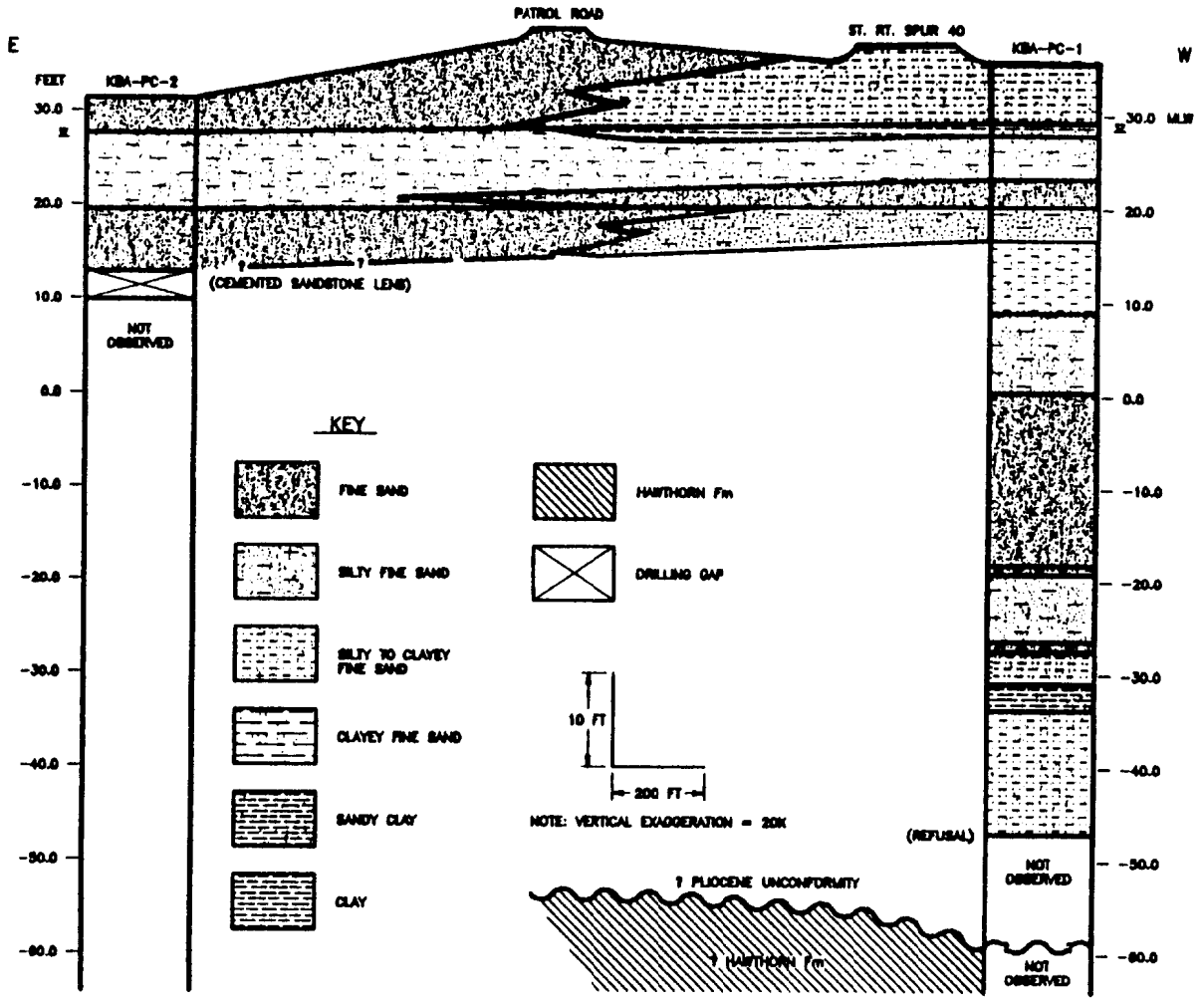


FIGURE 2
CROSS-SECTION A - A'

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

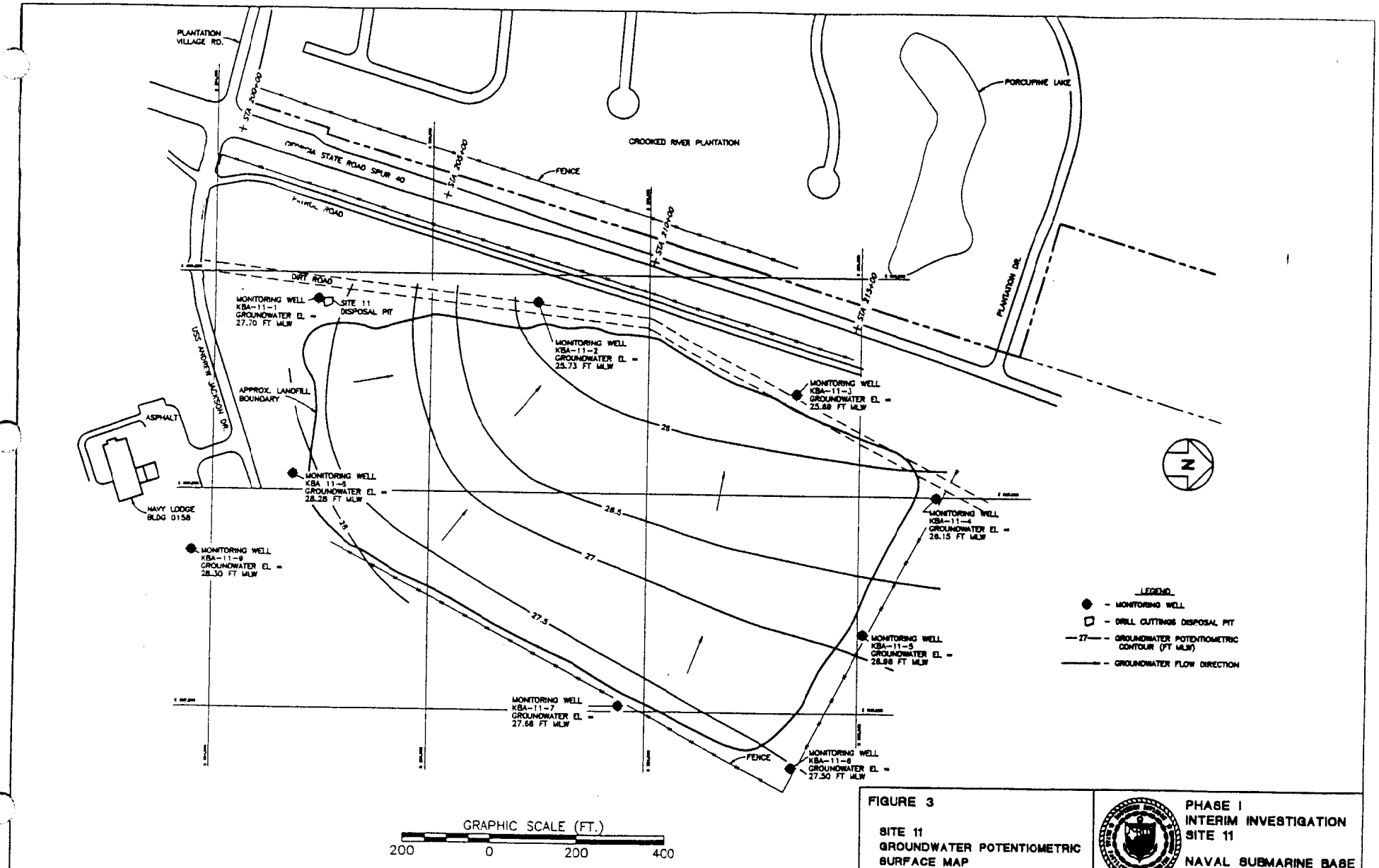


FIGURE 3

SITE 11
GROUNDWATER POTENTIOMETRIC SURFACE MAP

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

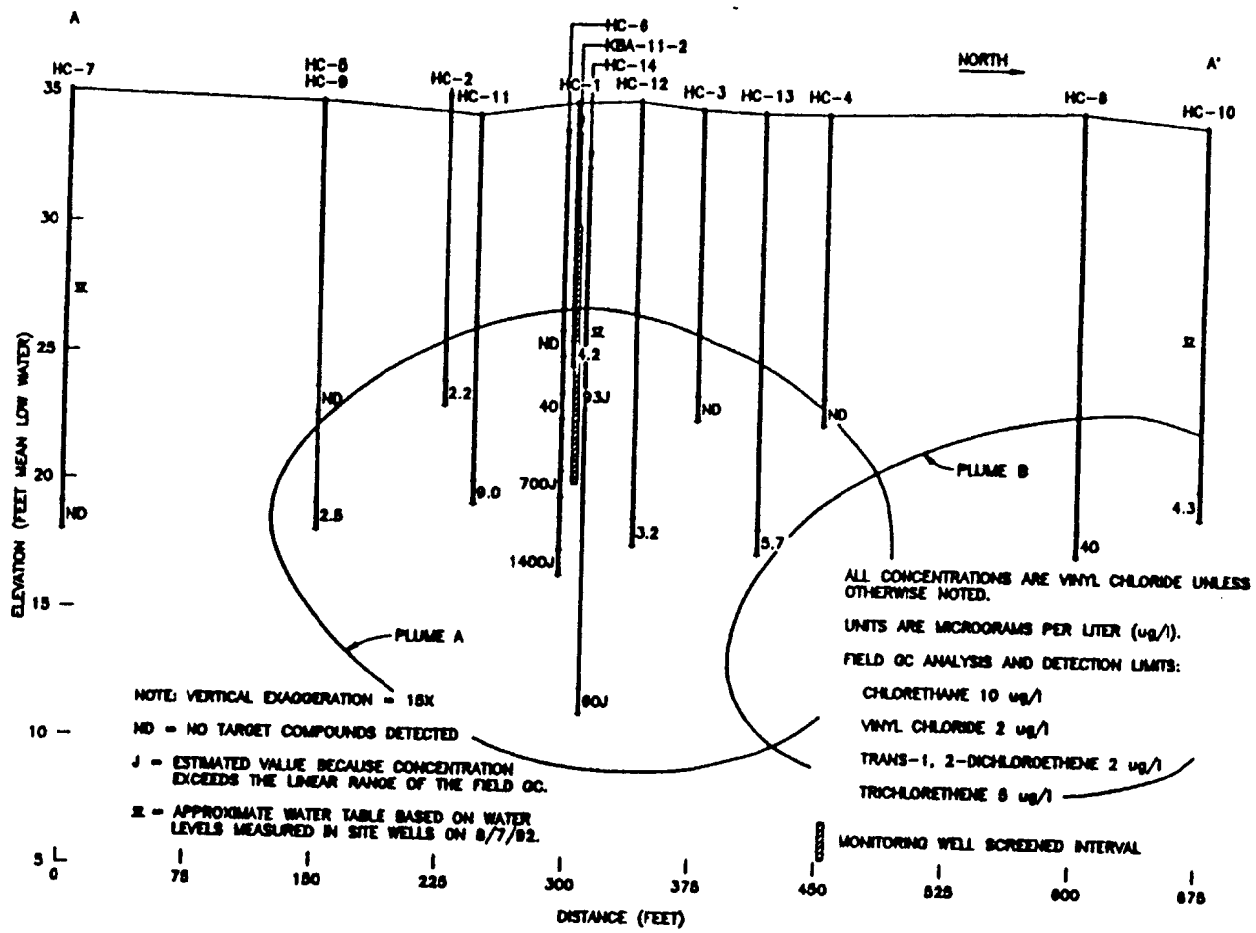


FIGURE 4
CROSS-SECTION B - B'
(HC-7 TO HC-10)
FIELD GC DATA

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

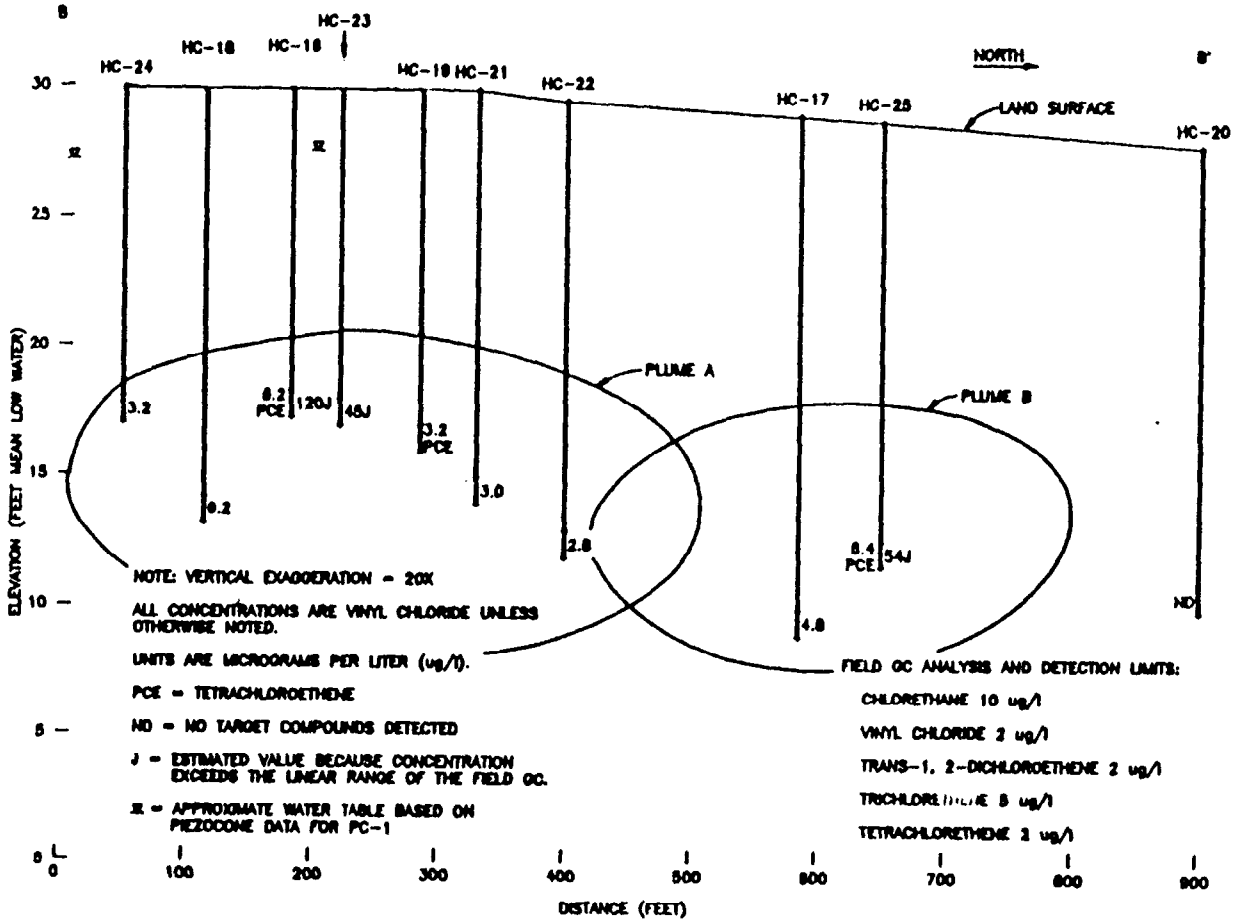


FIGURE 5
CROSS-SECTION C - C'
(HC-24 TO HC-20)
FIELD GC DATA

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

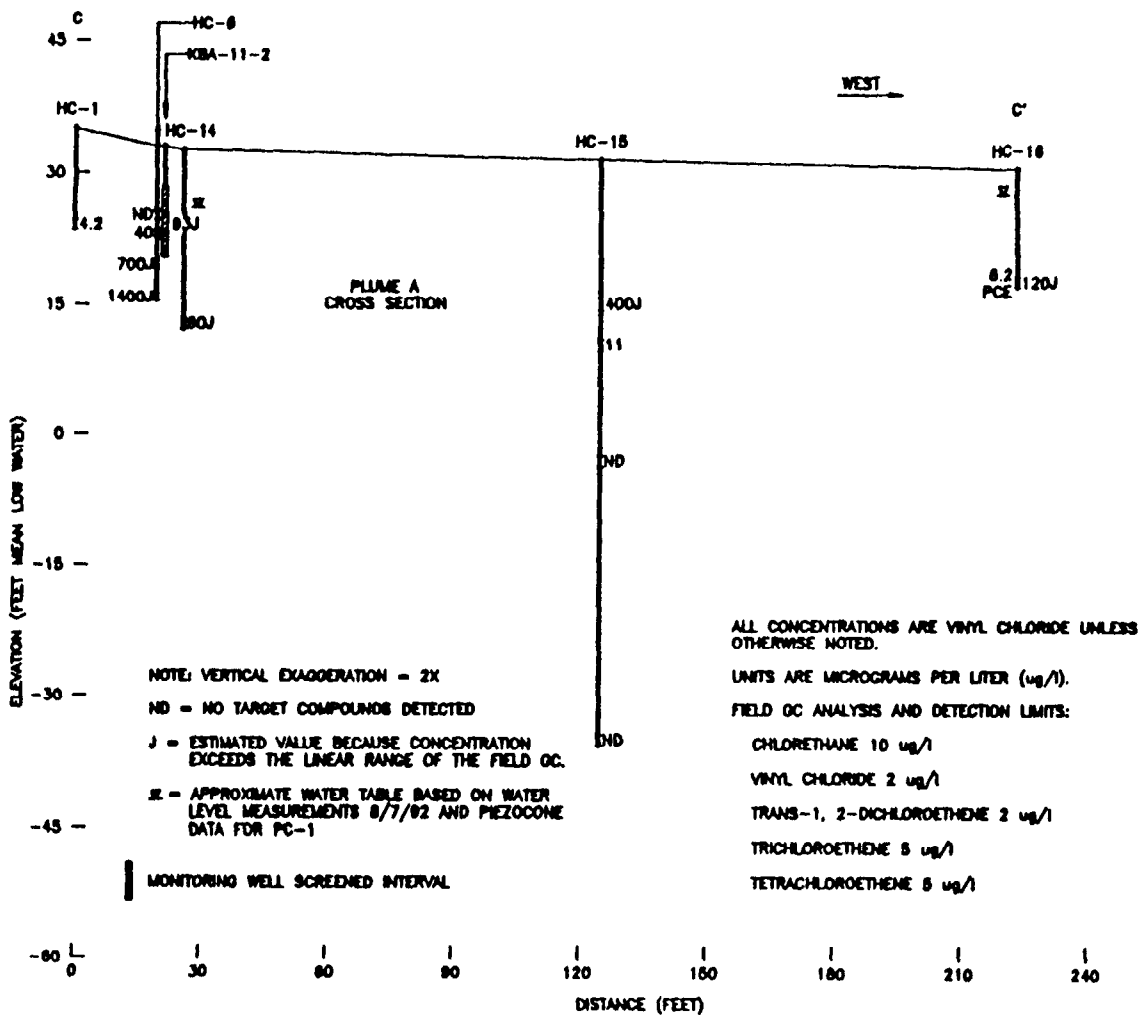


FIGURE 6
CROSS-SECTION D - D'
(HC-1 TO HC-16)
FIELD GC DATA

PHASE I
INTERIM INVESTIGATION
SITE 11

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

APPENDIX B

TABLES

Table 1 - Hydraulic Conductivity Estimates Based on Hydrocone Data

Sample ID	Depth		Estimated Hydraulic Conductivity		
	ft BLS	ft MLW	ft/min	ft/yr	gal/day/ft^2
HC-1	11 - 12	25.65 - 24.65	3.9E-03	2.0E+03	37
HC-2	10.5 - 11.5	23.87 - 22.87	2.2E-03	1.2E+03	21
HC-3	11 - 12	23.49 - 22.49	2.5E-03	1.3E+03	24
HC-4	11 - 12	23.45 - 22.45	3.5E-03	1.8E+03	34
HC-5	11 - 12	23.59 - 22.59	6.6E-03	3.5E+03	63
HC-6A	7 - 8	25.98 - 24.98	NR	NR	NR
HC-6B	9.5 - 10.5	23.48 - 22.48	9.3E-03	4.9E+03	89
HC-6C	12.5 - 13.5	20.48 - 19.48	3.1E-03	1.6E+03	30
HC-6D	15.5 - 16.5	17.48 - 16.48	1.4E-03	7.4E+02	13
HC-7	16 - 17	18.87 -17.87	6.3E-04	3.3E+02	6.0
HC-8	16 - 17	18.53 - 17.53	6.3E-04	3.3E+02	6.0
HC-9	15.5 - 16.5	19.09 - 18.09	4.8E-05	2.5E+01	0.46
HC-10	14 - 15	20.04 - 19.04	3.9E-04	2.0E+02	3.7
HC-11	14 - 15	20.12 - 19.12	4.0E-04	2.1E+02	3.8
HC-12	16 - 17	18.74 - 17.74	3.7E-04	1.9E+02	3.5
HC-13	16 - 17	18.36 - 17.36	6.4E-04	3.4E+02	6.1
HC-14	19 - 20	13.24 - 12.24	8.0E-04	4.2E+02	7.7
HC-15A	16 - 17	15.56 - 14.56	NR	NR	NR
HC-15B	24 - 25	7.56 - 6.56	4.3E-04	2.3E+02	4.1
HC-15C	49 - 50	<17.44 - 16.44>	NR	NR	NR
HC-15D	77 - 78	<45.44 - 44.44>	2.6E-05	1.4E+01	0.25
HC-16	12 - 13	18.17 - 17.17	5.4E-04	2.8E+02	5.2
HC-17	19 - 20	9.79 - 8.79	NR	NR	NR
HC-18	16 - 17	14.16 - 13.16	2.5E-03	1.3E+03	24
HC-19	13 - 14	16.81 - 15.81	NR	NR	NR
HC-20	17 - 18	10.82 - 9.82	7.2E-04	3.8E+02	6.9
HC-21	15 - 16	14.76 - 13.76	NR	NR	NR
HC-22	16 - 17	13.38 - 12.38	3.2E-03	1.7E+03	31
HC-23	12.5 - 13.5	17.67 - 16.67	8.5E-04	4.5E+02	8.2
HC-24	13 - 14	17.00 - 16.00*	3.8E-03	2.0E+03	36
HC-25	13 - 14	15.53 - 14.53	5.6E-03	2.9E+03	54

Notes:
ft = feet
BLS = below land surface
MLW = mean low water
ft/min = feet per minute
ft/yr = feet per year
gal/day/ft^2 = gallons per day per square foot
NR = not reported because silt interfered with data collection
* elevation estimated based on topographic gradient because elevation was not reported with survey.

Table 2
Phase I Interim Investigation Site 11
Field Laboratory Results for Groundwater Samples (μg/ℓ)

Parameter	Sample I.D. and Depth (ft BLS)						
	KBA-11-2[1] 3-13	HC-1 11-12	HC-2 10.5-11.5	HC-3 11-12	HC-3[Dup] 11-12	HC-4 11-12	HC-5 11-12
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Vinyl Chloride[2]	93 J	4.2	2.2	2 U	2 U	2 U	2 U

Parameter	Sample I.D. and Depth (ft BLS)								
	HC-6A 7-8	HC-6B 9.5-10.5	HC-6C 12.5-13.5	HC-6D 15.5-16.5	HC-7 16-17	HC-8 16-17	HC-9 15.5-16.5	HC-10 14-15	HC-11 14-15
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Vinyl Chloride	2 U	40	700 J	1400 J	2 U	40	2.5	4.3	9.0

Explanation

1 Monitoring Well
2 Values flagged J as estimated because concentrations exceeded the linear range of the GC
Dup Duplicate
U Compound analyzed but not detected above or below the indicated practical quantitation limit.

Table 2 (Continued)
Phase I Interim Investigation Site 11
Field Laboratory Results for Groundwater Samples (μg/ℓ)

Parameter	Sample I.D. and Depth (ft BLS)								
	HC-12 16-17	HC-12[Dup] 16-17	HC-13 16-17	HC-14 19-20	HC-15A 16-17	HC-15B 24-25	HC-15C 49-50	HC-15D 77-78	HC-16 12-13
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	6.2
Vinyl Chloride[2]	3.2	2.7	5.7	60 J	400 J	11	2 U	2 U	120 J

Parameter	Sample I.D. and Depth (ft BLS)								
	HC-17 19-20	HC-18 16-17	HC-19 13-14	HC-20 15-16	HC-21 15-16	HC-22 16-17	HC-23 12.5-13.5	HC-24 13-14	HC-25 13-14
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Tetrachloroethene	4.6	2 U	3.2	2 U	2 U	2 U	2 U	2 U	6.4
Vinyl Chloride[2]	4.8	6.2	2 U	2 U	3.0	2.8	45 J	3.2	54 J

Explanation

1 Monitoring Well
2 Values flagged J as estimated because concentrations exceeded the linear range of the GC
Dup Duplicate
U Compound analyzed but not detected above or below the indicated practical quantitation limit.

Table 3
Phase I Interim Investigation Site 11
Confirmatory Laboratory Results for Groundwater Samples (ug/l)

Parameter	MCL	Sample I.D. and Depth (ft BLS)					
		HC-2[Lab] 10.5-11.5	HC-3[Lab] 11-12	HC-10[Lab] 14-15	HC-15B[Lab] 24-25	HC-23[Lab] 12.5-13.5	HC-23[Dup] 12.5-13.5
Chloroethane		1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
trans-1,2-Dichloroethene	100	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Trichloroethene	5	1.0 U	1.0 U	1.0 U	1.0 U	4.9	4.7
Tetrachloroethene	5	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Vinyl Chloride[1]	2	2.0	1.0 U	1.4	11 J	32 J	35 J
Benzene	5	1.0 U	1.0 U	1.0 U	1.7	1.0 U	1.0 U
Bromomethane		1.0 U	1.0 U	1.0 U	1.0 U	1.5	1.1
Chlorobenzene		1.0 U	1.0 U	2.3	1.0 U	1.0 U	1.0 U
1,2-Dichlorobenzene	60	1.0 U	1.0 U	6.4	1.0 U	1.0 U	1.0 U
1,4-Dichlorobenzene	75	1.0 U	1.8	4.6	1.0 U	1.0 U	1.0 U
Dichlorodifluoromethane		1.0 U	1.0 U	1.0 U	5.3	1.0 U	1.0 U
1,1-Dichloroethane		1.0 U	1.0 U	1.0 U	100	1.0 U	1.0 U
1,1-Dichloroethene	7	1.0 U	1.0 U	1.0 U	3.9	1.0 U	1.0 U
Cis-1,2-Dichloroethene	70	1.0 U	1.0 U	1.0 U	200	29	28
Ethyl Benzene	700	1.0 U	1.0 U	1.0 U	10	1.0 U	1.0 U
Methylene Chloride	5	1.0 U	1.0 U	1.0 U	15	1.0 U	1.0 U
Toluene	1000	1.0 U	1.0 U	1.0 U	230	1.0 U	1.0 U
m- and p-Xylene	10,000	2.0 U	2.0 U	2.0 U	17	2.0 U	2.0 U
o-Xylene	10,000	1.0 U	1.0 U	1.0 U	15	1.0 U	1.0 U
Total Xylenes	10,000	1.0 U	1.0 U	1.0 U	31	1.0 U	1.0 U

Explanation

1 Values flagged J as estimated because the continuing calibration standard exceeded QC limits.
Dup Duplicate
Lab Off-site Laboratory Analysis
U Compound analyzed but not detected