

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
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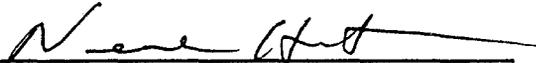
FINAL

FIELD SAMPLING PLAN FOR SITE 4 AND 5
CHLORINATED SOLVENT PLUME DEFINITION
AND SITE 14 SUMP INVESTIGATION
AT ALAMEDA POINT, ALAMEDA, CALIFORNIA

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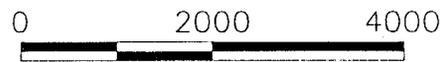
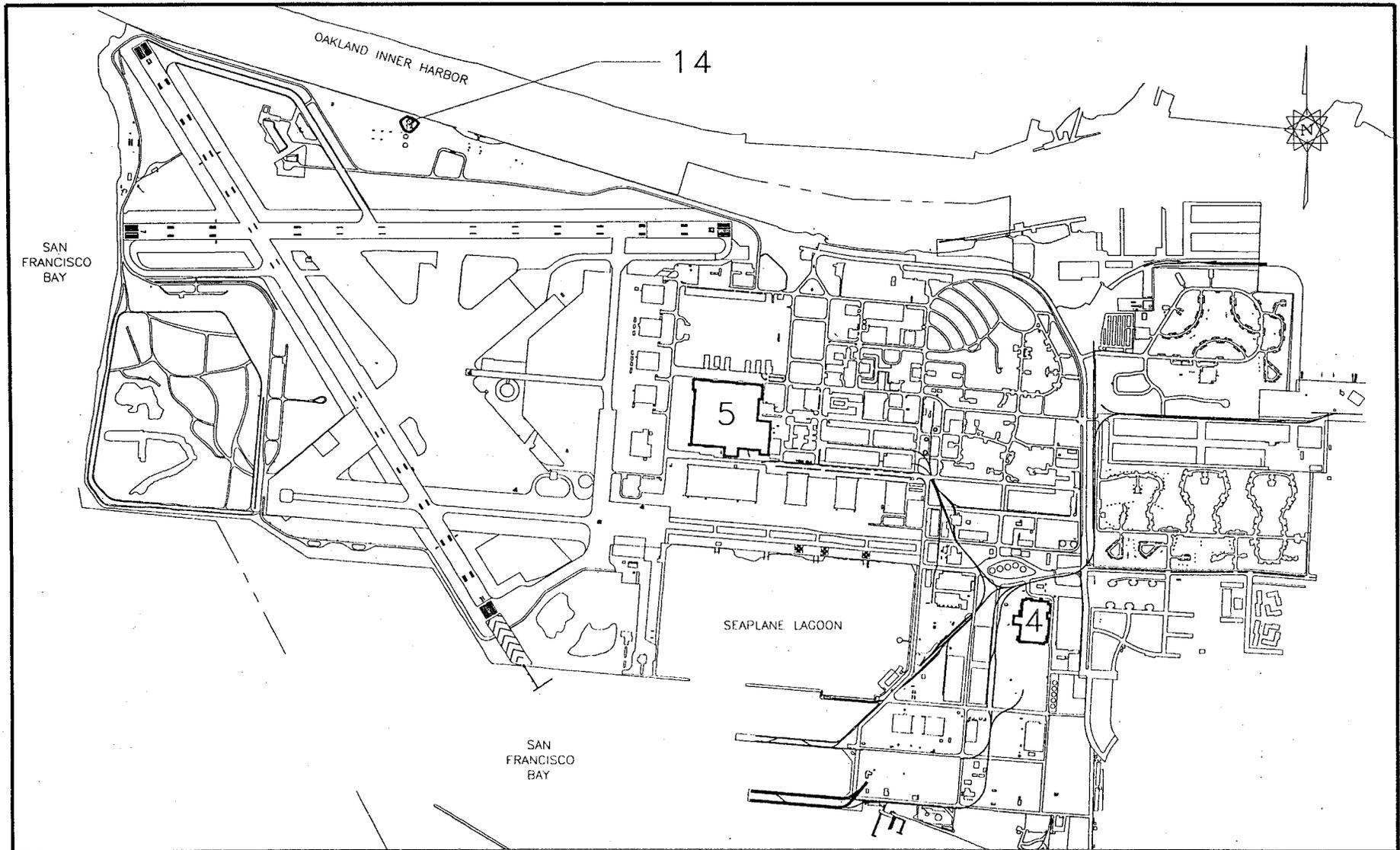
1.0 INTRODUCTION

This field sampling plan (FSP) has been developed for the following investigations at Alameda Point (formerly Naval Air Station, Alameda), in Alameda, California (see Figure 1-1): (1) focused groundwater investigations in the vicinity of Building 360 (Site 4) and Building 5 (Site 5), and (2) a soil and groundwater investigation in the vicinity of the existing sump located at the Fire Training Area (Site 14).

Between 1988 and 1990, the Navy completed a remedial investigation and feasibility study (RI/FS) work plan for Alameda Point (Canonie 1990). In September 1993, the Navy prepared a work plan addendum that revised the original work plan to include (1) new information gathered during the initial phases of the investigation, (2) updated guidance information, and (3) tasks identified after finalization of the original work plan (PRC and MW 1993a). In March 1997, the Navy prepared an addendum that revised the 1993 RI/FS work plan to include additional field sampling to characterize chlorinated solvent plumes at Sites 4 and 5. This FSP again revises the 1993 RI/FS work plan to further assess the vertical and lateral extents of the chlorinated solvent plumes at Sites 4 and 5. This FSP presents the methodologies for direct push sampling and groundwater analysis in the vicinity of Sites 4 and 5 and for soil and groundwater analysis in the vicinity of the existing sump at Site 14. A separate site-specific Quality Assurance Project Plan (QAPP) is included as Appendix A.

The focused investigations at Sites 4 and 5 are being conducted based on the findings from work completed under Contract Task Order (CTO) 260 (1994-1995) and CTO 107, Mod 21 (1996-1997). The results of the investigations completed under CTO 260 (1994-1995) and CTO 107, Mod. 21 (1996-1997), indicated that data gaps were still present in the chlorinated solvent plumes detected at Sites 4 and 5. This information must be evaluated prior to the completion of the RI/FS for operable unit 2 (OU-2) (draft RI due February 1999). The Navy is conducting these investigations to collect discrete groundwater chemical data to evaluate the nature and extent of chlorinated solvent plumes caused by past releases at Site 4 and Site 5.

The sump investigation at Site 14 is being conducted based on the findings from work completed under CTO 260 (1994-1995) and CTO 121 (1992-1993). The results of the investigations completed under CTO 260 (1994-1995) and CTO 121 (1992-1993) indicated that additional information is needed in the



APPROXIMATE SCALE
 1" = 2000'

FIGURE 1-1

ALAMEDA POINT SITE MAP
 ALAMEDA POINT
 ALAMEDA, CALIFORNIA

vicinity of the sump. This information must be evaluated prior to the completion of the RI/FS for OU-1 (draft RI due February 1998).

The Navy will use the data from these investigations to (1) evaluate the vertical and lateral extent of the chlorinated solvent plume in groundwater at Sites 4 and 5, (2) develop a conceptual model of contaminant distribution, and (3) gather subsurface information to incorporate into the RI/FS process.

2.0 SITE 4 INVESTIGATION

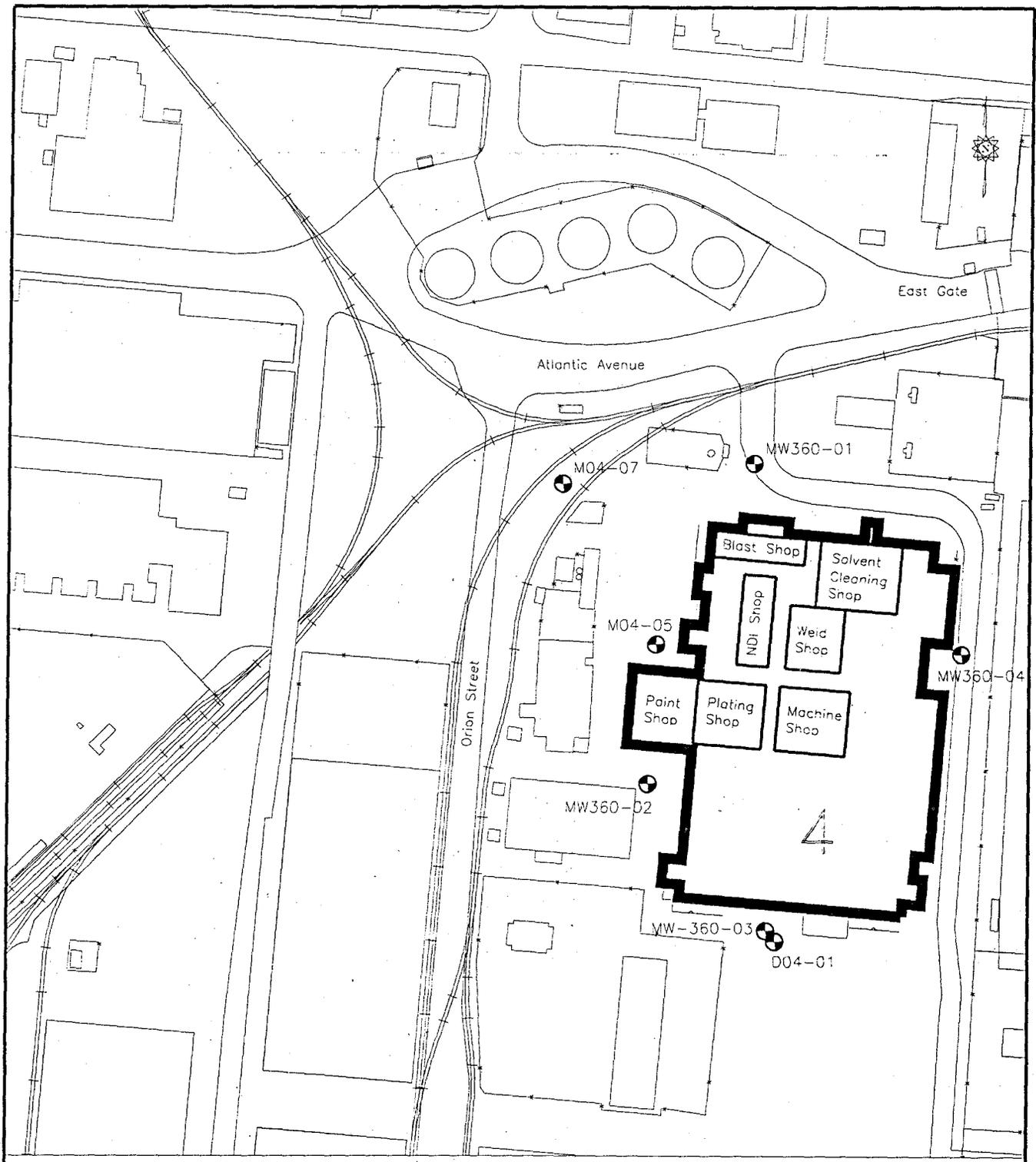
This section describes the events leading up to this investigation and the data quality objectives (DQOs) and field sampling program necessary for the delineation of the chlorinated solvent plume at Site 4. In addition, a discussion on the observed distribution of chemicals in groundwater is presented.

2.1 DESCRIPTION AND HISTORY

Site 4 consists of Building 360, which is located near the eastern perimeter of the base. Building 360 has been used as an aircraft engine repair and testing facility, and consisted of former machine shops, cleaning and plating shops and parts assembly areas (Figure 2-1). Processes in the former plating shop included paint stripping by blasting, metal stripping, and etching and metal plating. Chemicals used in the cleaning shop historically included a mixture containing 55 percent tetrachloroethene (PCE) and other components; several other mixtures have been used that contained dichlorobenzene, methylene chloride, toluene; and 30 to 70 percent solutions of sodium hydroxide.

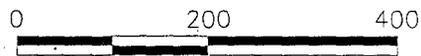
The following environmental studies have been conducted at Site 4:

- In 1981 and 1982, the Navy collected surface soil samples beneath the plating shop (Figure 2-1) for analytical testing (ERG 1982). The results of the Navy's study are summarized in the Data Summary Report (DSR) Phases 2B and 3 (PRC and JMM 1992). The exact sampling locations are not known but, based on sketch maps, the samples appear to have been collected from near the waste lines in the southwestern corner of the shop. The samples were analyzed for pH, cyanide, anions, organic compounds, and various elements. The analytical results indicated the pH of the soil samples ranged from 6.3 to 9.8 and that cyanide, lead, nickel and chromium were detected.
- In 1989, the Navy installed four monitoring wells around the perimeter of Building 360 and collected soil and groundwater samples in order to evaluate if surface spills or subsurface sewer leaks in areas (other than the plating shop) have contaminated the site. The results of this investigation are presented in the DSR Phases 1 and 2A (PRC and MW 1993b). Low concentrations of semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), and metals were detected in soil samples. Elevated levels of VOCs (up to 4,900 micrograms per liter [$\mu\text{g/L}$] of trichloroethene [TCE]) were detected from the wells located on the eastern (MW360-04), northern (MW360-01), and western (MW360-02) sides of Building 360; SVOCs (120 $\mu\text{g/L}$ of 1,2-dichlorobenzene) and metals were detected in the groundwater samples collected from the four monitoring wells.
- In 1991 and 1992, the Navy collected 20 surface soil samples, 9 grab groundwater samples, and a total of 14 wipe and scrape samples from the plating shop. The results of the 1991 and



LEGEND

⊕ Groundwater Monitoring Well



APPROXIMATE SCALE
1" = 200'

FIGURE 2-1

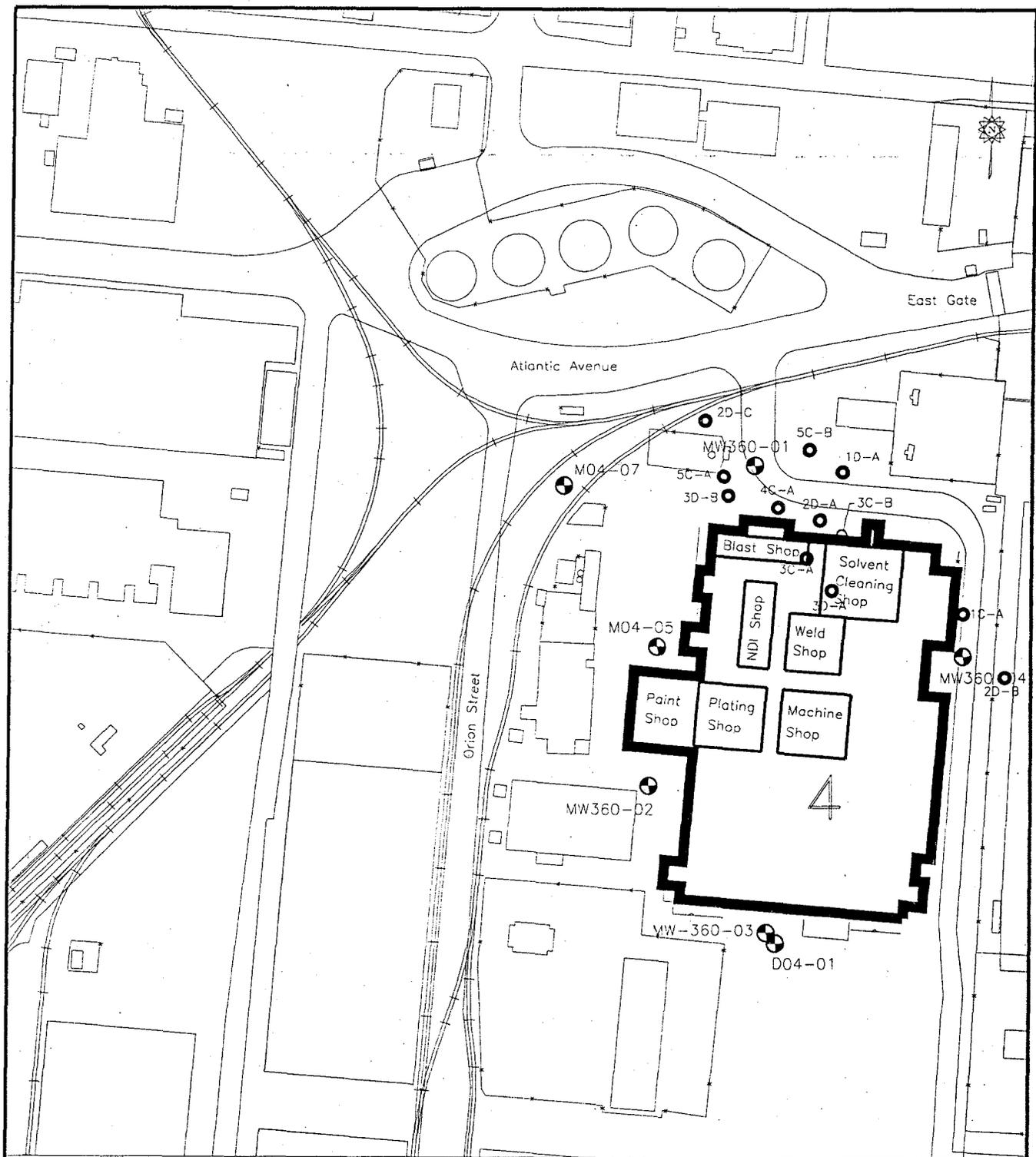
SITE 4 - SITE MAP
ALAMEDA POINT
ALAMEDA, CALIFORNIA

1992 investigations are presented in the DSR Phases 2B and 3 (PRC and JMM 1992) and the DSR Background and Tidal Influence Studies and Additional Work at Sites 4 and 5 (PRC and MW 1995). Metals (chromium - 1,060 milligrams per kilogram [mg/Kg], copper - 99.6 mg/Kg, lead - 68.5 mg/Kg, and nickel - 692 mg/Kg), SVOCs (fluoranthene - 1,900 µg/Kg), and cyanide (19 mg/Kg) were detected in soil samples. VOCs (1,1-dichloroethene [1,1-DCE] 180 µg/L) and metals were detected in the grab groundwater samples. This investigation indicated that the extent of VOCs and metals in groundwater have not been defined.

- In 1994, the Navy collected 27 surface soil samples, 71 subsurface soil samples, installed 6 groundwater monitoring wells, collected groundwater samples from 10 wells and 19 HydroPunch locations, and conducted 9 cone penetrometer tests (CPT). The results of the 1994 investigations were presented in the CTO 260 RI/FS Data Transmittal Memorandum (PRC and MW 1995b) and the CTO 280 RI/FS Data Transmittal Memorandum (PRC and MW 1995c). VOCs, SVOCs, and metals were detected in the surface and subsurface soil samples. Low levels of SVOCs were detected in groundwater samples collected from shallow monitoring wells at Site 4. Elevated levels of VOCs were detected in groundwater samples collected from shallow monitoring wells (MW360-01, MW360-02, and MW360-04) and intermediate depth HydroPunch locations north (CPT-S04-01) and east (CPT-S04-02) of Building 360. Metals were detected in the groundwater samples collected from all depths (10 feet to 40 feet below ground surface [bgs]) within the first water bearing zone. Beneficial uses of groundwater in the vicinity of Site 4 have not been determined, however, due to the high total dissolved solids (TDS) concentrations detected in groundwater samples collected from Site 4, metals are assumed to be a non-issue but will be further evaluated in the RI report. The significance of the presence of metals above background levels will also be further evaluated during the risk assessment.
- In March 1997, the Navy collected 20 grab groundwater samples (see Figure 2-2 for boring locations) in order to further evaluate the extent of chlorinated solvents in groundwater. Elevated levels of chlorinated solvents (24,000 µg/L of TCE, 2,200 µg/L of vinyl chloride and 8,600 µg/L of cis-1,2-dichloroethene [cis-1,2-DCE]) were detected between 5.5 feet and 15.5 feet bgs. The results of the 1997 investigation were presented in the Geochemical Profiling for Definition of Chlorinated Solvent Plumes, Sites 4 and 5 report dated May 27, 1997 (OGISO 1997), are further discussed in Section 2.3 of this work plan, and will be presented in-depth in the OU-2 RI report.

2.2 GEOLOGY AND HYDROGEOLOGY

Site 4 is underlain by a fine-grained fill material (sand/silty sand) unit to a depth of approximately 11.5 feet bgs. This permeable unit is underlain by a relatively impermeable Merritt Sand layer to the total depth explored. A definable Halocene Bay Mud unit has not been encountered in the southeastern portion of Alameda Point. Figure 2-3 shows a geologic cross section of Site 4.



LEGEND

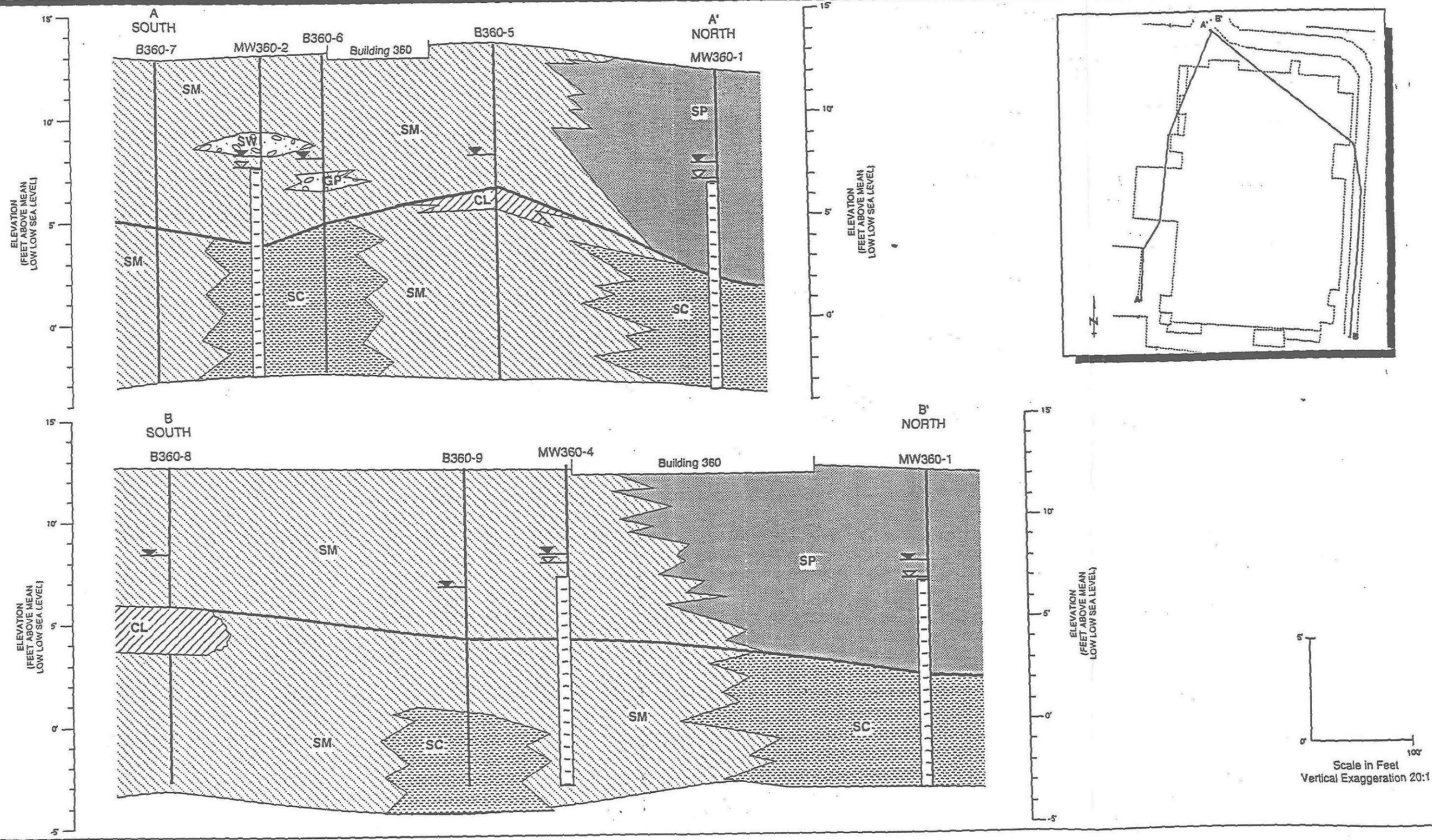
- March 1997 Groundwater Sampling Location
(Approximate locations, based on OGISO Figure 3c, March 1997)
- ⊕ Groundwater Monitoring Well



APPROXIMATE SCALE
1" = 200'

FIGURE 2-2

SITE 4
MARCH 1997 GROUNDWATER SAMPLING LOCATIONS
ALAMEDA POINT
ALAMEDA, CALIFORNIA



- LEGEND:**
- GP Gravelly Sand
 - SC Clayey Sand
 - CL Clay
 - AS Asphalt
 - SM Silty Sand
 - Approximate Fill/Native Sediment Interface
 - Water Level During Water Sampling
 - First Water During Drilling
 - Monitoring Well
 - Screened Interval

This cross section is based on logs of wells and borings drilled and logged by Canotie Environmental, Inc. All water levels were measured by Canotie Environmental, Inc.

FIGURE 2-3
SITE 4 - GEOLOGIC CROSS SECTION A-A', B-B'
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 3c, May 1997.

The first water bearing zone has been encountered at a depth of approximately 5 feet bgs and appears to be located within the Merritt Sand layer. During the Navy's 1997 investigation, groundwater samples were collected from within the Merritt Sand layer. However, due to apparent low permeability of some strata in this layer, the sampling device did not collect any groundwater. Temporary wells were installed and left in the ground overnight to obtain enough groundwater for a sample.

Based on the June 1994 groundwater monitoring event, the depth to groundwater in the Site 4 monitoring wells ranged between 4.4 feet and 5.6 feet bgs with groundwater flow direction toward the northwest. Due to the heavy irrigation occurring at Site 3, located north of Site 4, groundwater flow direction north of site 4 appears to be southerly, impeding the natural flow of groundwater. This impedance appears to have forced the groundwater flow more toward the west. The vertical gradient is downward based on the hydraulic heads in shallow monitoring well MW360-3 and deep monitoring well D04-01. The location of these two wells are shown on Figure 2-1.

2.3 OBSERVED DISTRIBUTION OF CONTAMINATION

The upper 35 feet of vadose zone and saturated zone at Site 4 will be investigated during this field effort. Investigations conducted prior to 1997 detected a chlorinated solvent plume at the northeastern side of Building 360. Chlorinated solvents also appear in groundwater at the northwestern corner of the building. The quarterly monitoring results from the well on the northeastern side of Building 360 show elevated levels of several solvents, with the highest concentration being 4,100 µg/L of TCE. The well is screened at approximately 10 to 15 feet bgs.

In March 1997, the chlorinated solvent plume was further analyzed at Site 4 during the Navy's groundwater investigation. All of the samples collected during the 1997 investigation were analyzed for chlorinated solvents. Three analytes (TCE, cis-1,2-DCE, and vinyl chloride) were chosen to represent the chlorinated solvent plume.

TCE. Figure 2-4 shows the estimated TCE plume for each depth interval at Site 4 based solely on the 1997 groundwater investigation (OGISO 1997). The concentration of TCE generally increases to a maximum concentration at the depth interval of 13.5 to 15.5 feet bgs. The maximum concentration of TCE (24,000 µg/L) was detected in the 13.5 to 15.5 feet bgs groundwater sample collected from boring 2D-C. Additional information collected from depths greater than 15.5 feet bgs is necessary to adequately

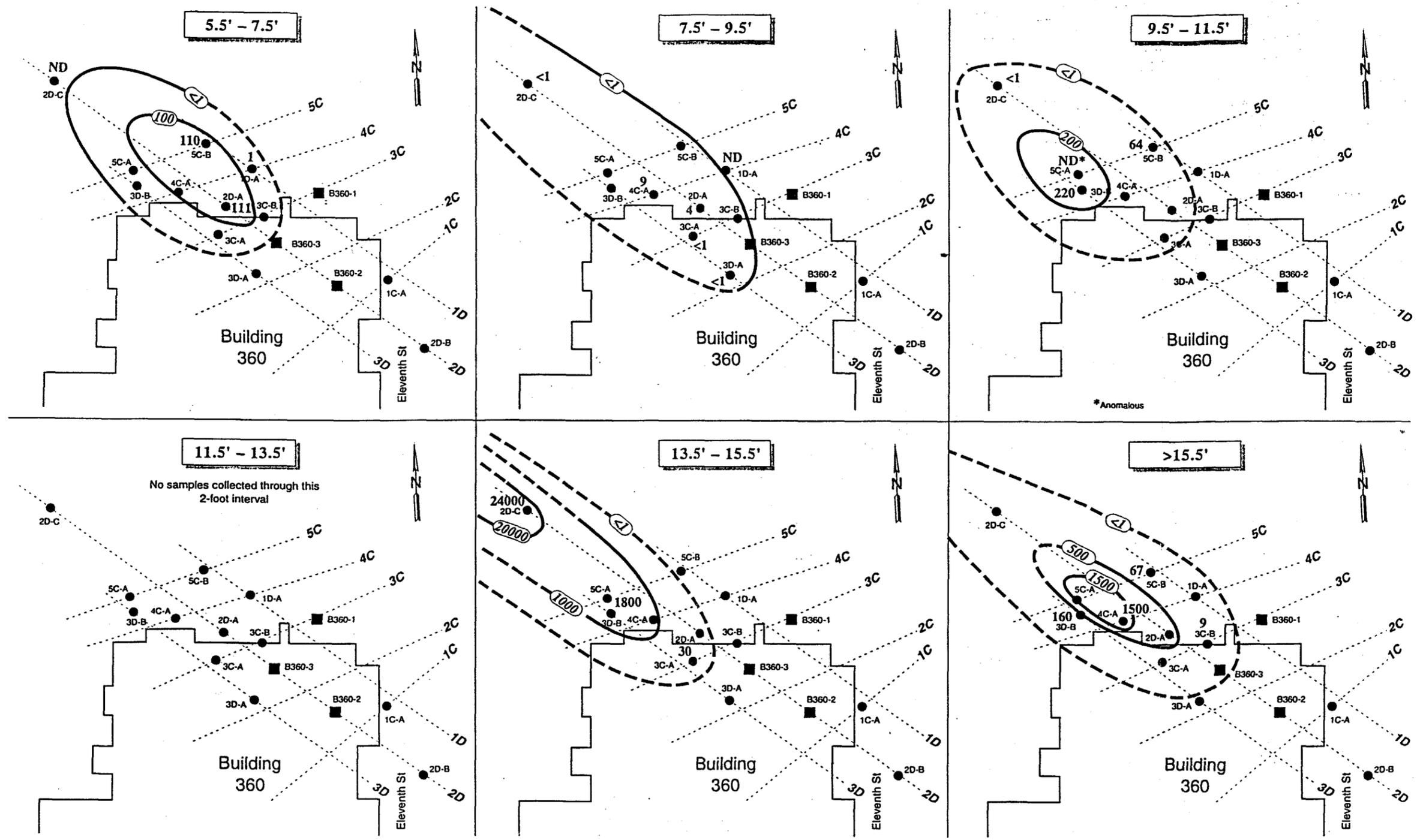


FIGURE 2-4
 SITE 4 - TCE CONCENTRATIONS IN GROUNDWATER
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 3c, May 1997.

assess the vertical extent of TCE. Boring 2D-C was the farthest northwest boring advanced during the March 1997 investigation, therefore, additional information is also needed northwest of Site 4 to adequately assess the lateral extent of the TCE plume.

1,2-DCE. Figure 2-5 shows the estimated 1,2-DCE plume for each depth interval at Site 4 based solely on the 1997 groundwater investigation (OGISO 1997). The concentration of 1,2-DCE generally increases to a maximum concentration at the depth interval of 13.5 to 15.5 feet bgs. The maximum concentration of 1,2-DCE (8,600 µg/L) was detected in the 13.5 to 15.5 feet bgs groundwater sample collected from boring 2D-C. Additional information collected from depths greater than 15.5 feet bgs is necessary to adequately assess the vertical extent of 1,2-DCE. Boring 2D-C was the farthest northwest boring advanced during the March 1997 investigation, therefore, additional information is also needed northwest of Site 4 to adequately assess the lateral extent of the 1,2-DCE plume.

Vinyl Chloride. Figure 2-6 shows the estimated vinyl chloride plume for each depth interval at Site 4 based solely on the 1997 groundwater investigation (OGISO 1997). The concentration of vinyl chloride generally increases to a maximum concentration at the depth interval of 13.5 to 15.5 feet bgs. The maximum concentration of vinyl chloride (2,200 µg/L) was detected in the 13.5 to 15.5 feet bgs groundwater sample collected from boring 2D-C. The concentrations of vinyl chloride generally decreased at depths greater than 15.5 feet bgs. Boring 2D-C was the farthest northwest boring advanced during the March 1997 investigation, therefore, additional information is also needed northwest of Site 4 to adequately assess the lateral extent of the vinyl chloride plume.

During the past year, the Navy has completed an environmental baseline study (EBS) on parcels not currently included in the Installation Restoration (IR) program. This investigation included the collection of several groundwater samples in the vicinity of Site 4. These samples were analyzed for many different chemicals to determine if any of the parcels pose a risk to human health or the environment.

Groundwater samples were collected from parcel 134, west of Site 4. For consistency, the analytical results of chemicals TCE, 1,2-DCE and vinyl chloride in the groundwater samples were used to represent the chlorinated solvent distribution in groundwater. The results of the groundwater samples collected during the EBS investigation at parcel 134 indicated that 1,2-DCE and TCE were detected in the 9 feet to 10 feet bgs range. The maximum concentrations of 1,2-DCE and TCE detected in these samples were

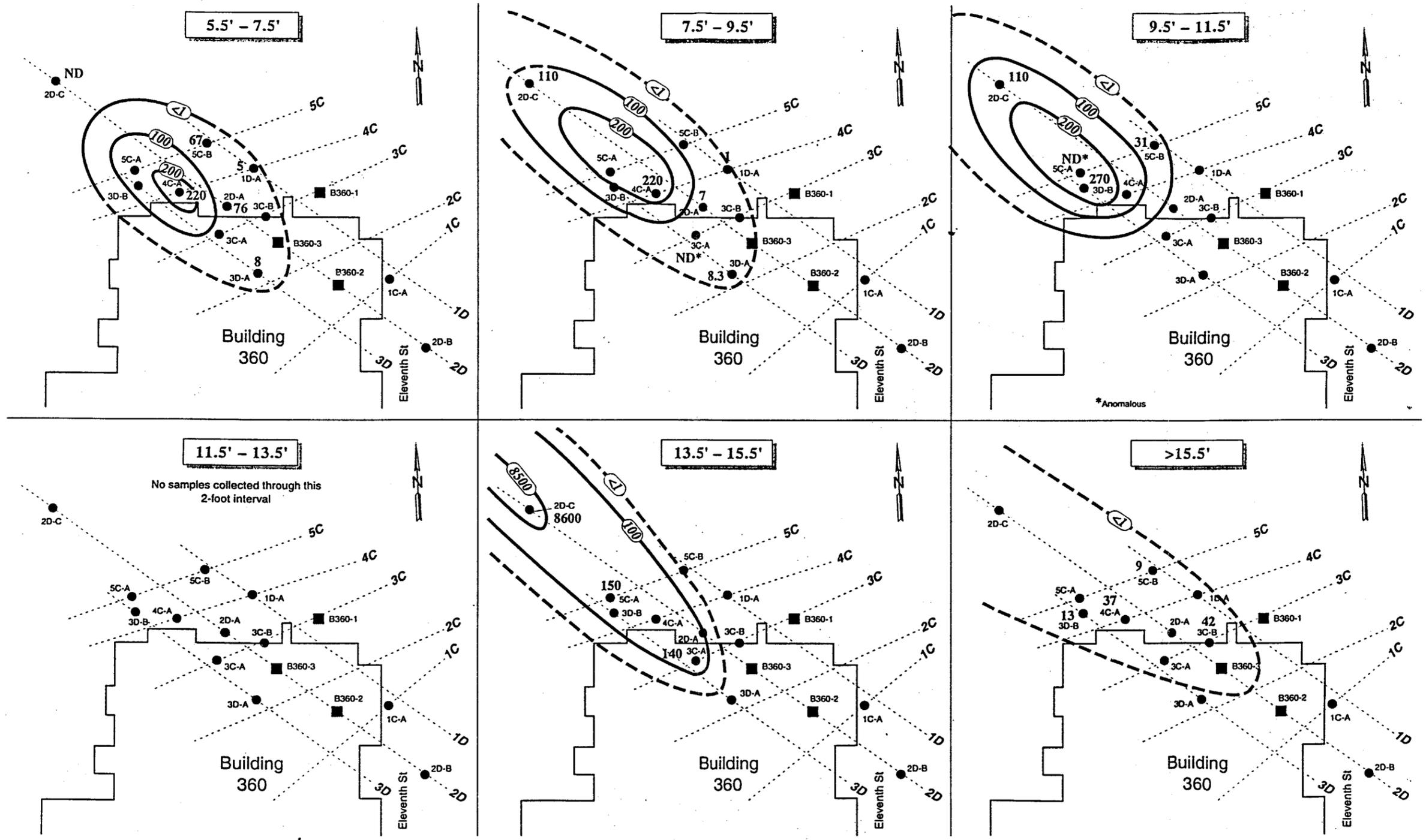
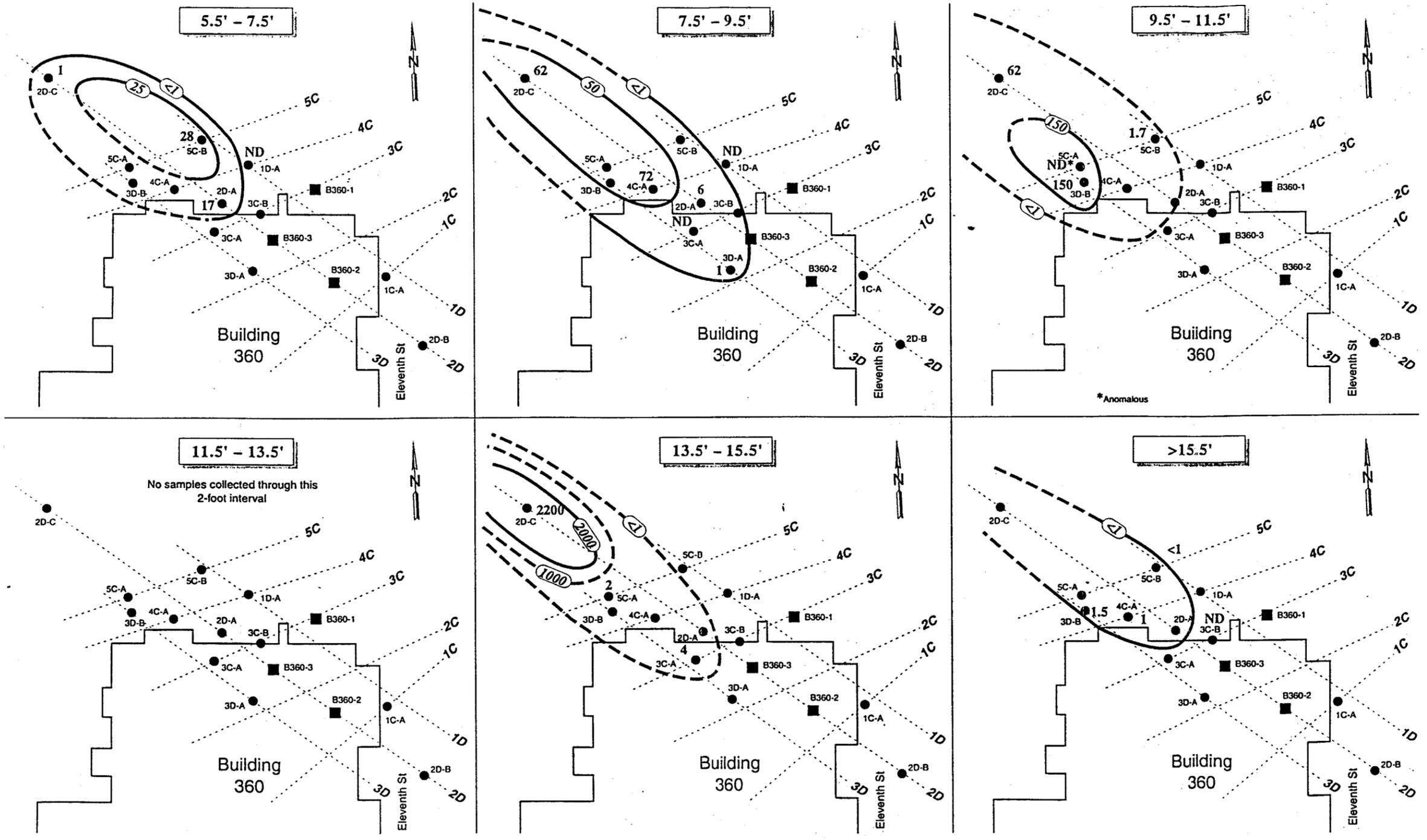


FIGURE 2-5
SITE 4 - 1,2-DCE CONCENTRATIONS IN GROUNDWATER
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 3b, May 1997.

Explanation

■ BERC - Soil Boring Location	28	Chemical Concentration in µg/L (ppb)
● BERC - Water Sample Location	ND	Not Detected
	—	2- Foot Interval
	-----	Transect Lines

0 125 FT



Explanation
 ■ BERC - Soil Boring Location
 ● BERC - Water Sample Location
 28 Chemical Concentration in $\mu\text{g/L}$ (ppb)
 ND Not Detected
 — 2-Foot Interval
 - - - - - Transect Lines

0 125 FT

FIGURE 2-6
 SITE 4 - VINYL CHLORIDE CONCENTRATIONS IN GROUNDWATER
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 3a, May 1997.

110 µg/L and 38 µg/L, respectively. Additionally, 1,2-DCE, TCE, and vinyl chloride were reportedly below detection limits in several groundwater samples collected at parcel 134. This information is also useful when evaluating the observed distribution of contamination. The extent of chlorinated solvents in groundwater at depths between 5 and 10 feet bgs was adequately delineated during the March 1997 groundwater investigation at Site 4. The groundwater samples collected during the EBS were collected at depths between 5 and 10 feet bgs and, therefore, do not appear to add information on the observed distribution of the chlorinated solvent plume at Site 4.

Based on the information collected during the March 1997 groundwater investigation, it appears that the chlorinated solvent plume is moving vertically as well as laterally. This indicates the possibility of the presence of dense nonaqueous phase liquid (DNAPL). The chlorinated solvent plume remains undefined at depths greater than 15.5 feet bgs and laterally northwest of Site 4, therefore, this investigation will concentrate on assessing the chlorinated solvent plume in groundwater between the depths of 15.5 and 35 feet bgs at Site 4. If during the investigation a separate and distinctive plume is encountered, this plume will be investigated in the same manner.

2.4 DATA QUALITY OBJECTIVES

This investigation will collect data to (1) evaluate the vertical and lateral extent of the chlorinated solvent plume in groundwater, (2) develop a conceptual model of contaminant distribution, and (3) gather subsurface information for the RI/FS.

Sampling for Site 4 has been designed such that depth-discrete groundwater samples can be collected in areas where data gaps are present (such as at depths greater than 15 feet bgs). The boring locations, from which the samples will be collected, have been laid out in a grid pattern. Sample locations were chosen to provide an overall characterization of the chlorinated solvent distribution. If chlorinated solvents are detected in the samples collected from the borings located at the outer limits of the grid, north-south and east-west grid lines will be added in order to assess the extent of the chlorinated solvent plume.

The decision to continue sampling will be based on the analytical results of previous groundwater samples. The initial sampling locations are provided in Table 2-1. The decision rules for lateral sample collection during this sampling event are as follows:

TABLE 2-1
SITE 4 - INITIAL SAMPLING DEPTHS
ALAMEDA POINT, ALAMEDA, CALIFORNIA

Boring Number	Sample Depth Interval (feet)								
	5.5-7.5	7.5-9.5	9.5-11.5	11.5-13.5	13.5-15.5	15.5-20.0	20.0-25.0	25.0-30.0	30.0-35.0
1-1									
1-2	X								
1-3						X			
1-4									
1-5									
1-6									
2-1	X								
2-2		X							
2-3	X	X	X						
2-4						X	X	X	X
2-5									
2-6									
3-1	X				X	X			
3-2		X	X	X			X	X	X
3-3	X	X		X			X	X	X
3-4			X				X	X	X
3-5					X	X			
3-6									
4-1									
4-2	X			X					
4-3			X	X			X	X	X
4-4									
4-5									
4-6									
5-1									
5-2									
5-3					X	X			
5-4									
5-5									
5-6									

Notes:

- 1-1 This boring number refers to the intersection of the transect lines where the boring was advanced. This boring was advanced at the intersection of east-west transect line 1 and north-south transect line 1. (2-1 refers to east-west transect line 2 and north-south transect line 1)

- The initial sampling locations were based on the results of the Navy's 1997 groundwater investigation and the following decision rules.
- If the concentration of chlorinated solvents detected in the current sample is greater than or equal to 1 mg/L, then sampling of the nearest boring locations will be omitted and the next samples will be collected from the second closest boring locations. The decision to omit sample locations is based on professional experience with groundwater plume characteristics. If the concentration in a sample is greater than or equal to 1 mg/L, the chemical generally will disperse (based on concentration gradients and advection) greater than 150 feet unless a hydraulic barrier is present.
- If the concentration of chlorinated solvents detected in the current sample is greater than or equal to 100 µg/L and less than or equal to 1 mg/L, then the next samples will be collected from the nearest boring locations.
- If the concentration of chlorinated solvents detected in the current sample is approximately 10 percent of the concentration of chlorinated solvents detected in the previous boring location and the concentration of chlorinated solvents in the previous boring location is greater than or equal to 100 µg/L and less than or equal to 1 mg/L, then no further samples will be collected in the direction of that boring.
- If the concentration of chlorinated solvents detected in the current sample is less than or equal to 50 µg/L, then no further sample will be collected in the direction of that boring.
- In the event that the intersection of a north-south transect line and an east-west transect line is located in an area where a boring cannot be advanced, the boring location will be moved along the transect line to the nearest location a boring can be advanced. Several factors can affect the location of a boring, including underground utilities, overhead obstacles, and proximity to a building or other structure.

These decision rules will also be used for each vertical sampling interval. If during this investigation, the observed distribution of the chlorinated solvent plume extends in the direction of the samples collected at parcel 134 during the EBS investigation, the analytical results of the EBS samples will be used to evaluate the location of additional samples collected during this investigation.

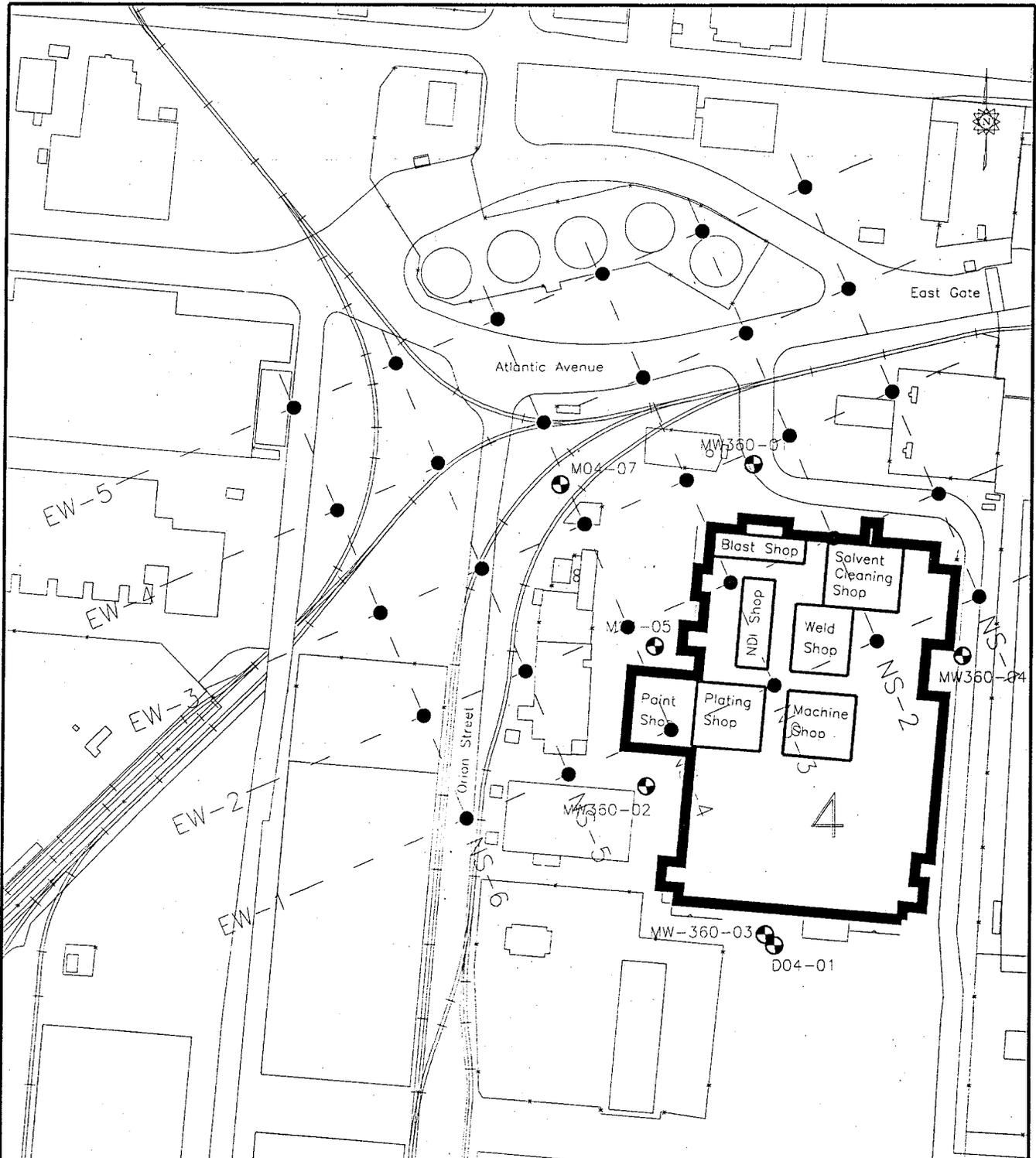
The soil boring identification will reference the two transects that the boring intersects. The first number will be the number of the east-west transect line, the second number will be the north-south transect line, and the third will be the depth at which the sample was collected. For example, the soil boring identification 3-4-5.5 would indicate that the boring is located at the intersection of the third east-west transect and the fourth north-south transect and the sample was collected at a depth of 5.5 feet bgs.

2.5 GROUNDWATER GEOCHEMICAL PROFILING PROGRAM

Groundwater geochemical profiling will be completed through depth-discrete sampling using the Waterloo Drive Point Profiler (see Appendix B). The Waterloo Drive Point Profiler is a well point with screened ports located at the tip of the tool. The ports are connected to an internal tube that extends up through the direct push rods to ground surface. During sampling, the profiler is advanced and deionized water is simultaneously pumped out the sampling ports to prevent them from clogging. Once a desired depth is reached, the flow of the pump is reversed and groundwater from the aquifer is extracted. Once the sample is collected, the profiler is again advanced and simultaneously purged with deionized water until the next desired sampling depth is reached. If hydrogeologic conditions are such that the permeability of the aquifer is not sufficient to produce the required amount of groundwater (to retrieve a sample), a temporary groundwater sampling point will be installed. The groundwater sample will then be collected the following day.

Figure 2-7 shows the approximate locations of soil borings from which groundwater samples will be collected. Five east-west transect lines and six north-south transect lines will be arranged to begin the grid pattern and one soil boring will be advanced as close to the intersection of each transect as practical. An east-west transect line will be placed every 150 feet beginning at the northeastern corner of Building 360 and a north-south transect line will be placed every 150 feet beginning at the northeastern corner of Building 360. The modification (addition of transect lines in either the east-west or north-south directions) of this grid pattern will depend on the decision rules discussed in Section 2.4. Any changes in transect locations or sampling locations will be discussed among the subcontractor's on-site geologist, the Navy's field oversight task manager, and, if necessary, the Navy's project manager. The QAPP in Appendix A provides a detailed description of sample collection and analytical methodologies.

At each specific location, groundwater samples may be collected from any of the following discrete depths (between 5.5 and 7.5 feet bgs, 7.5 and 9.5 feet bgs, 9.5 and 11.5 feet bgs, 11.5 and 13.5 feet bgs, 13.5 and 15.5 feet bgs, 15.5 and 20.0 feet bgs, 20.0 and 25.0 feet bgs, 25.0 and 30.0 feet bgs, 30.0 and 35.0 feet bgs, and greater than 35.0 feet bgs). The initial sampling depths are listed in Table 2-1. The collection of additional groundwater samples will depend on the decision rules discussed in Section 2.4. The results will be recorded on geologic cross sections as work progresses, so the dimensions of the plume will become apparent during the course of field work.



LEGEND

- Proposed Groundwater Sampling Location
- - - Transect Line
- ⊕ Groundwater Monitoring Well
- EW-1 East-West Transect Line
- NS-1 North-South Transect Line

0 200 400

APPROXIMATE SCALE
1" = 200'

FIGURE 2-7

SITE 4
PROPOSED GROUNDWATER SAMPLING LOCATIONS
ALAMEDA POINT
ALAMEDA, CALIFORNIA

To assess the lateral extent of the chlorinated solvent plume at Site 4, groundwater samples will be collected northwest of Building 360 beyond the limits of Site 4. Based on the decision rules discussed in Section 2.4, soil borings may be advanced at EBS parcels. The EBS parcels that may be included in this investigation are 122, 123, 124, 125, 126, 127, 128, 134 and 136. Parcels not listed may be included depending on the migratory patterns of the chlorinated solvent plume. Currently, the Navy is conducting risk assessments to evaluate if risks to human health or the environment exist at these parcels. If any of these parcels are included in this investigation, only information necessary to assess the chlorinated solvent plume, currently detected in the groundwater at Site 4, will be collected.

2.6 GROUNDWATER MONITORING WELL PLACEMENT AND INSTALLATION

Once the laboratory results of the samples collected during this investigation are received, an in-depth evaluation of the chlorinated solvent plume will be conducted. This evaluation will include data obtained from this investigation, all previous investigations, and the EBS. One portion of the evaluation will be to assess the appropriate locations for additional groundwater monitoring wells.

Groundwater monitoring wells will be necessary to monitor the movement of chlorinated solvents at discrete depths throughout the aquifer. The placement of each monitoring well will depend on the results of geochemical profiling. Currently, a sufficient number of groundwater monitoring wells are screened between 5 feet and 15 feet bgs in the vicinity of Site 4, however, the results of the Navy's 1997 groundwater investigation indicate that the chlorinated solvent plume is moving downward in the aquifer. Any additional groundwater monitoring wells will be installed near the downgradient edge of the plume at the particular depth of interest. By locating the groundwater monitoring wells at the downgradient edge of the plume, both the flow rate and concentration of the chemicals can be monitored. In addition, wells that are placed at the leading edge of the plume can assist in evaluating the efficiency of treating groundwater during remediation, if necessary.

Groundwater monitoring wells will be installed in accordance with TtEMI's standard operating procedure (SOP) for monitoring well installation (Appendix C). At each groundwater monitoring well location, an 8-inch diameter soil boring will be drilled using a drill rig equipped with continuous-flight, hollow-stem augers to the depth specified by the Navy's on-site geologist. A 2-inch diameter groundwater monitoring well assembly will be installed in the center of each boring. The groundwater

monitoring well assembly will consist of Schedule 40 polyvinyl chloride (PVC) pipe with a maximum of 10 feet of slotted PVC screen, a PVC end cap, and a locking well cap.

Once this assembly is lowered to the depth specified by the Navy's on site geologist, a sand filter pack will be placed into the annular space surrounding the well. The filter pack will be placed in the boring from the bottom of the boring to approximately two feet above the top of the screened interval. A 2-foot layer of bentonite chips will be placed in the annular space above the sand filter pack and charged with distilled water. A cement slurry will be placed in the annular space from the top of the bentonite chips to approximately 1 foot below the top of the well assembly. A traffic-rated well vault will then be placed in the boring surrounding the well assembly and cemented into place. This vault will be placed such that water will drain away from the well assembly (slightly above ground surface).

3.0 SITE 5 INVESTIGATION

This section describes the events leading up to this investigation and the DQOs and field sampling program necessary to delineate the chlorinated solvent plume at Site 5. In addition, a discussion on the observed distribution of chemicals in groundwater is presented.

3.1 DESCRIPTION AND HISTORY

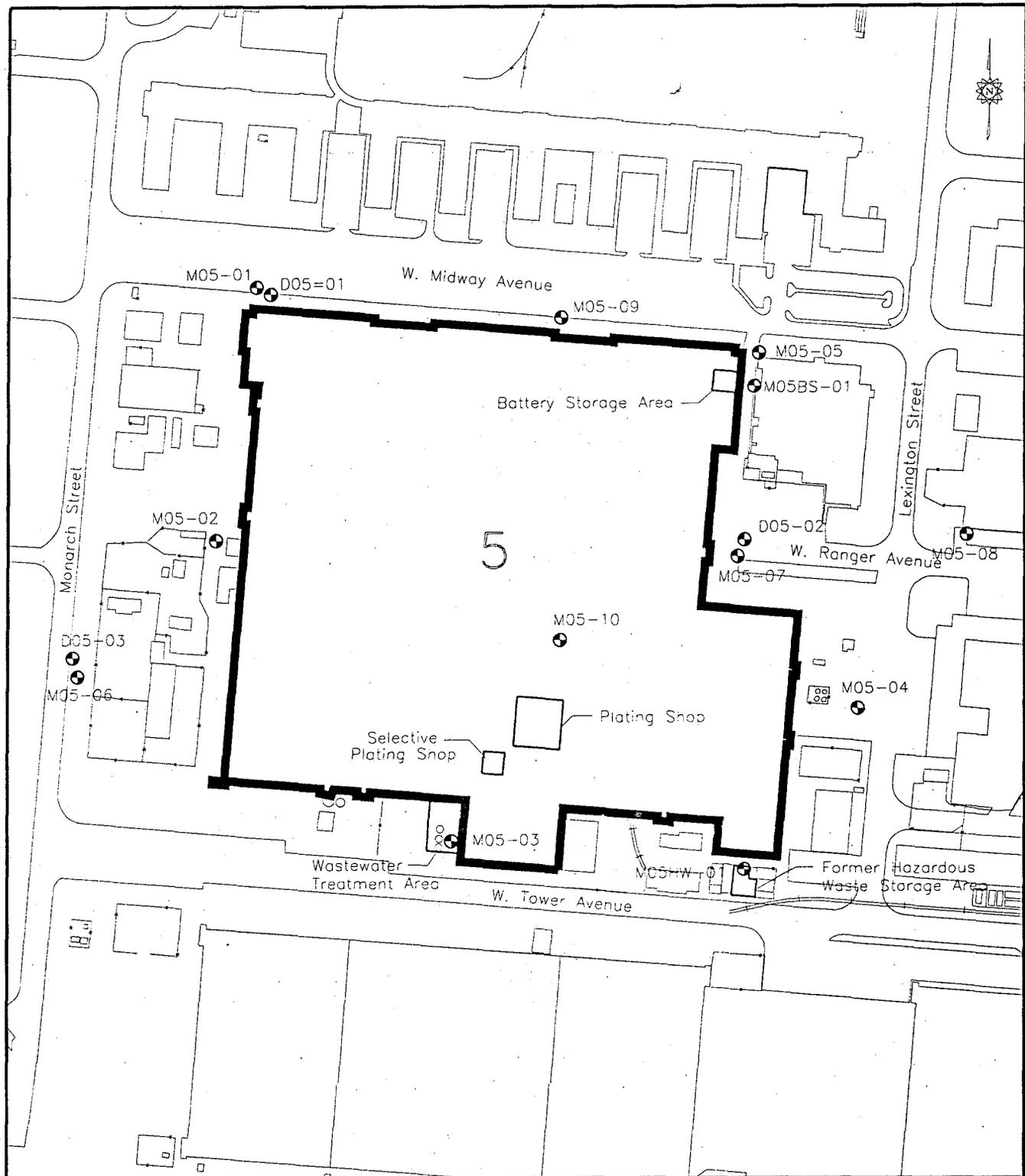
Site 5 consists of Building 5 and is located between Monarch and Lexington Streets and W. Midway and W. Tower Avenues (Figure 3-1). The building is the largest on base and covers approximately 18.5 acres. From 1942 through 1996, Building 5 was used for manufacturing, cleaning, and reworking of metal parts; tool maintenance; and plating and painting operations. A wastewater treatment area and a battery storage area were also located on site. The site also contained a hazardous waste storage area that was closed in 1988. The hazardous waste storage area stored drummed hydraulic fluid and lubricating oils.

Processes in the plating shop included degreasing, caustic and acid etching, metal stripping and cleaning, and chrome, nickel, silver, cadmium, and copper plating. Both cyanide and chromium processes were used in the plating shop. The wastewater treatment area contained sumps that stored cyanide- and chrome-containing wastewater from the plating shop prior to pretreatment. The cyanide wastewater stream was treated in a cyanide destruction unit.

Additionally, an underground storage tank (UST) was located just east of Site 5 on West Ranger Avenue. The tank contained kerosene-range petroleum hydrocarbons used for processes in Building 5. This tank was removed in June 1997.

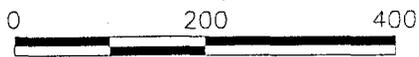
The following environmental studies have been conducted at Site 5:

- In 1991, the Navy conducted a RI/FS that included a surface geophysical survey, surface soil sampling, geotechnical analysis, and 13 soil borings, 5 of which were converted to monitoring wells. The results of the 1991 investigation are presented in the DSR Phases 2B and 3 (PRC and JMM 1992). The purpose of this investigation was to determine if the industrial sewer lines are acting as a possible conduit for contaminants. VOCs and polycyclic aromatic hydrocarbons (PAHs) were detected in the Site 5 soil. Additionally, elevated concentrations of metals were detected in soil samples collected from borings



LEGEND

⊕ Groundwater Monitoring Well



APPROXIMATE SCALE
1" = 200'

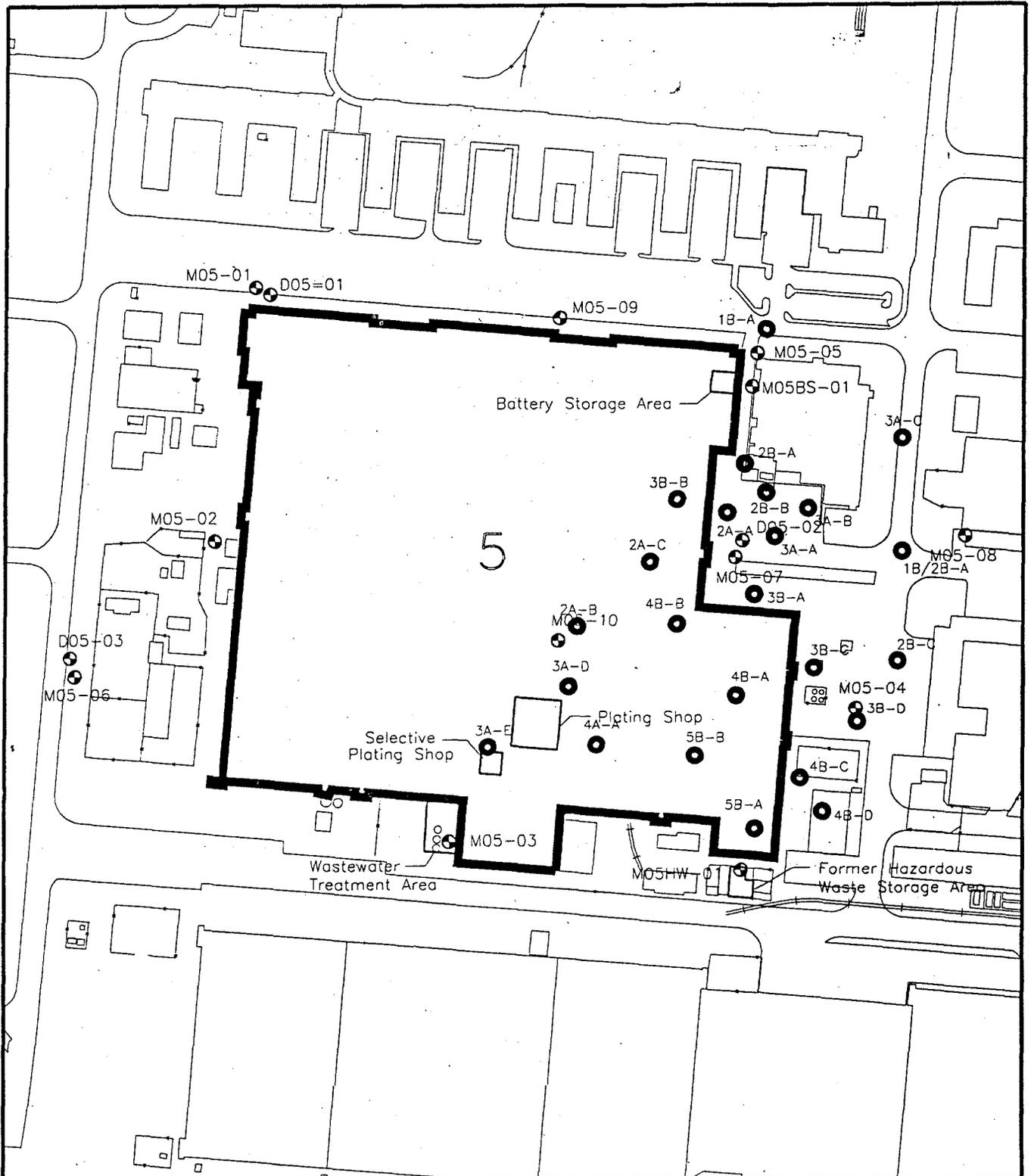
FIGURE 3-1
SITE 5
SITE PLAN
ALAMEDA POINT
ALAMEDA, CALIFORNIA

located on the western and southern sides of Building 5. VOCs were detected in the groundwater samples collected from the wells located on the eastern and northeastern sides of Building 5. The conclusion of this investigation was that there appeared to be multiple sources for the presence of VOCs in groundwater. Installation of additional monitoring wells on the eastern and northern sides of Building 5 was recommended.

- In 1992 and 1993, the Navy conducted additional investigations in and around five areas at Site 5: the plating shop, the selective plating shop, the wastewater treatment area, the former hazardous waste storage area, and the battery storage area. The results of the 1992 and 1993 investigations are presented in the DSR Background and Tidal Influence Studies and Additional Work at Sites 4 and 5 (PRC and MW 1995) and the Additional Site Investigation, Site 5 Plating Shop Report (PRC 1995). These investigations included soil borings and soil sampling, grab groundwater sampling, wipe or scrape sampling in the plating shop, and monitoring well installation and sampling. The analytical results indicated that metals and VOCs were detected in the shallow soil samples in the vicinity of the plating shop and selective plating shop; and elevated levels of metals and VOCs were detected in groundwater samples collected from borings in the vicinity of the plating shop, selective plating shop, and wastewater treatment area. VOCs were also detected in relatively low concentrations in the groundwater samples collected from the vicinity of the battery storage area and former hazardous waste storage area.
- In 1994 and 1995, the Navy conducted an additional investigation that included the installation of 10 groundwater monitoring wells, groundwater sample collection using a HydroPunch, collection of soil and groundwater samples, and CPT. The results of the 1994 and 1995 investigation are presented in the RI/FS data transmittal memorandum (PRC 1996). The analytical results indicated that low levels of VOCs were detected in the groundwater samples collected from wells located on the northern (M05-09), western (M05-06), and northwestern (M05-01) sides of Building 5. Elevated concentrations of VOCs, SVOCs, aluminum, lead and nickel were detected in groundwater samples collected from wells located south, east, and northeast of Building 5. The conclusions and recommendations from this investigation included: that (1) the nature and extent of chemicals in soils appear to have been adequately evaluated, and (2) additional characterization of the VOCs in groundwater north and east of Building 5 is needed.
- In 1997, the Navy collected 68 grab groundwater samples (see Figure 3-2 for boring locations). The results of the 1997 investigation were presented in the Geochemical Profiling for Definition of Chlorinated Solvent Plumes, Sites 4 and 5 report (OGISO 1997), further discussed in Section 3.3 of this work plan, and will be presented in-depth in the OU-2 RI report. Elevated levels of chlorinated solvents (1,700 µg/L of TCE, 5,500 µg/L of vinyl chloride and 29,000 µg/L of 1,2-DCE) were detected between 5.5 feet and 15.5 feet bgs.

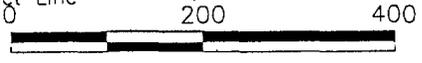
3.2 GEOLOGY AND HYDROGEOLOGY

Material underlying Site 5 can be divided into two groups: artificial fill material and Bay sediments. The ground surface is covered by asphalt or concrete, from ½- to 1-foot thick. Artificial fill material underlies the site from below the asphalt or concrete to approximately 12 to 16 feet bgs. The artificial



LEGEND

- March 1997 Groundwater Sampling Locations
(Approximate locations, based on OGISO Figure 7c.b, March 1997)
- ⊙ Groundwater Monitoring Well
- Transect Line



APPROXIMATE SCALE
1" = 200'

FIGURE 3-2

SITE 5

MARCH 1997 GROUNDWATER SAMPLING LOCATIONS
ALAMEDA POINT
ALAMEDA, CALIFORNIA

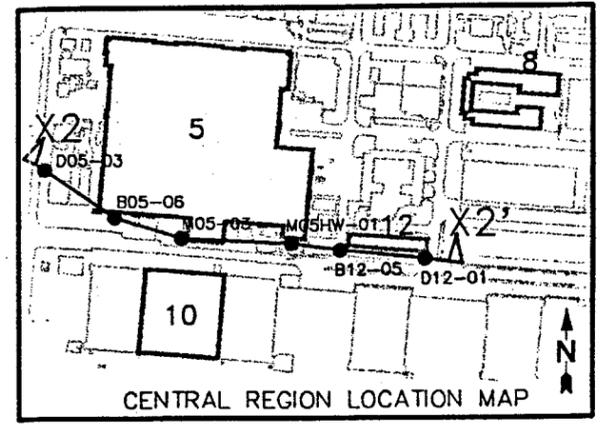
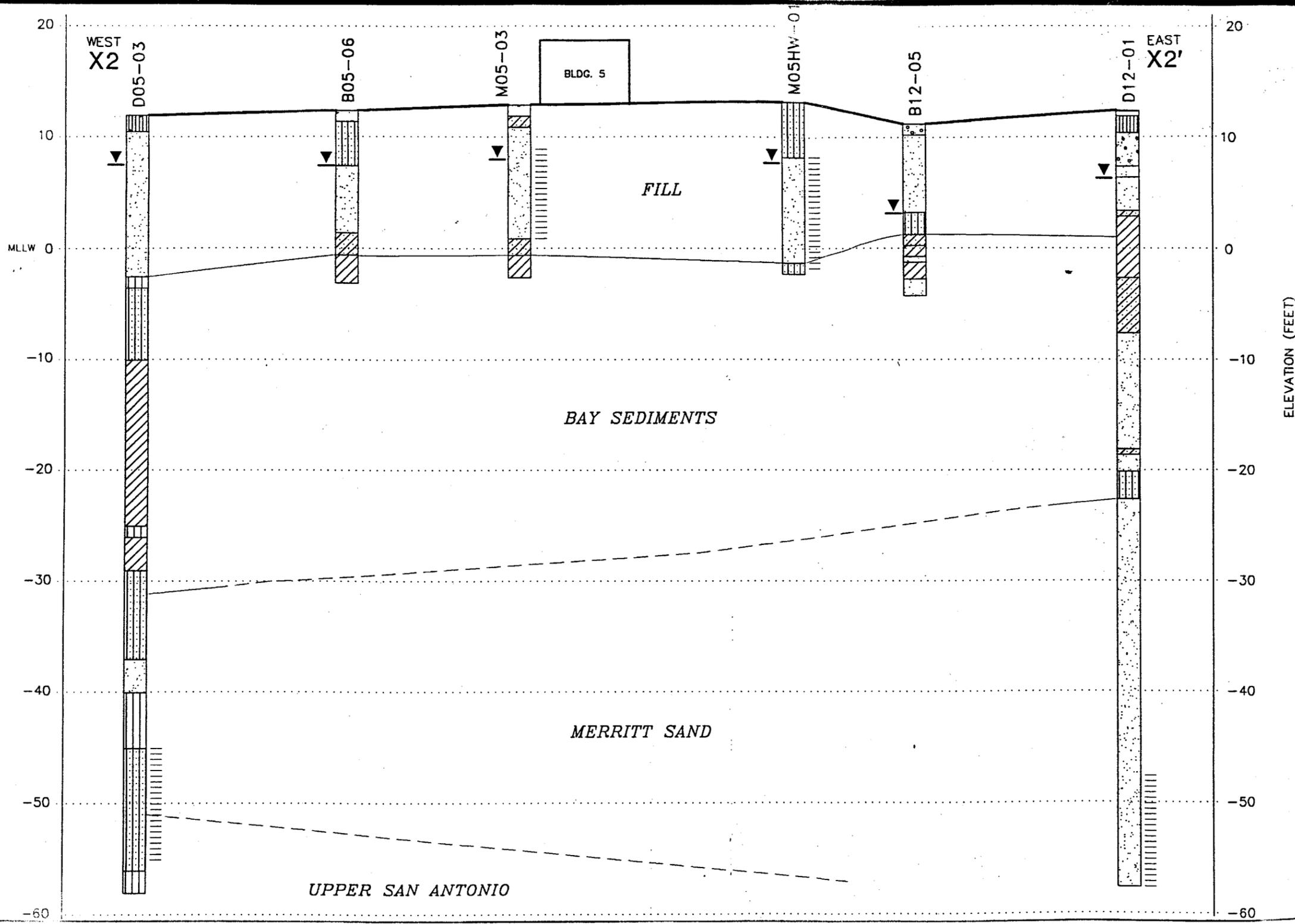
fill material at Site 5 consists of interbedded fine sands (well sorted), silty sands (moderately well sorted), and gravelly sands. The Bay sediment consists of silty clay to sandy clay, which is interpreted to be the Holocene Bay Mud deposits. Figures 3-3 and 3-4 show geologic cross sections of Site 5.

Based on the June 1997 groundwater monitoring event, the depth to groundwater in the Site 5 monitoring wells ranged between 4.21 feet and 6.11 feet below mean low low water level (MLLW). The shallow groundwater appears to flow northerly, away from Building 5; however, the hydraulics beneath Building 5 are difficult to understand. The difficulty is due to several factors that appear to influence groundwater flow in the vicinity of Site 5. These factors include (1) the presence of sheet pilings located on the northern side of the Seaplane Lagoon (located south of Building 5); (2) the presence of water bodies north, south, and west of the site; (3) potentially leaking water supply, sanitary, and storm sewer lines creating local areas of elevated water table; and (4) the utility trenches beneath and adjacent to Building 5 intercept the shallow groundwater, thereby providing a path of preferential flow. The groundwater in the second water bearing zone (SWBZ) appears to converge along an axis coinciding with the approximate location of an east to west trending paleochannel. Additionally, groundwater in the first water bearing zone (FWBZ) and SWBZ near the southern portion of Site 5 appears to be tidally influenced based on the fluctuations in static groundwater levels in the monitoring wells. The time for a rise in the static groundwater level of Site 5 wells is delayed, probably due to the presence of the sheet pilings.

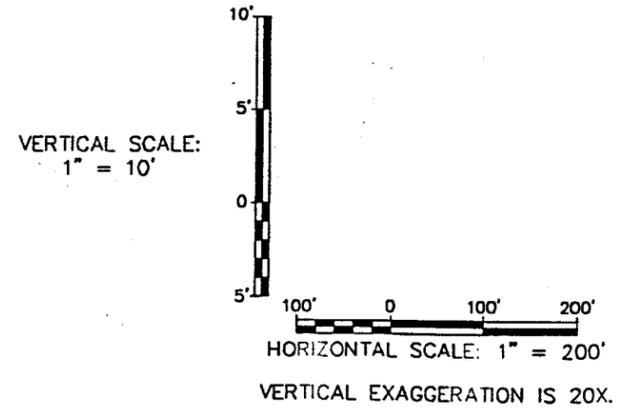
In situ permeability tests (slug tests) were also conducted in the monitoring wells at Site 5. The hydraulic conductivities, as determined by rising head tests (Bouwer and Rice 1976; Bouwer 1989), ranged from $1.7E-03$ centimeters per second (cm/sec) to $2.6E-04$ cm/sec.

3.3 OBSERVED DISTRIBUTION OF CONTAMINATION

At Site 5, the upper 35 feet of vadose zone and saturated zone will be investigated. Investigations conducted prior to 1997 detected a chlorinated solvent plume east of Building 5. A monitoring well located on the eastern side of Building 5 has exhibited elevated chlorinated solvent contamination during several quarterly groundwater sampling events. Although this well is in close proximity to the former underground storage tank, the chemicals that have been detected in this well are not representative of kerosene range petroleum hydrocarbons. Concentrations of 1,1,1-trichloroethane (1,1,1-TCA) in samples from this well have been as high as 9,000 $\mu\text{g/L}$, and 1,1-dichloroethane has been as high as



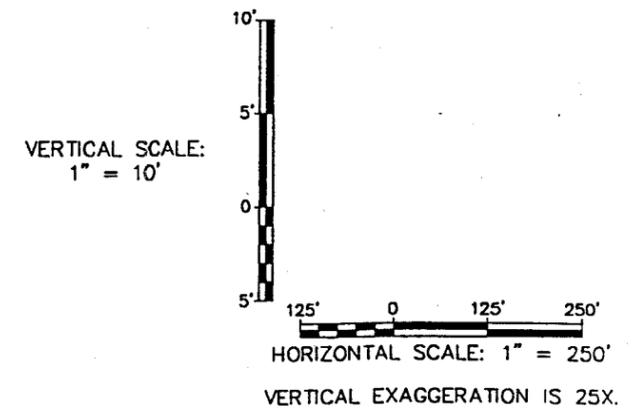
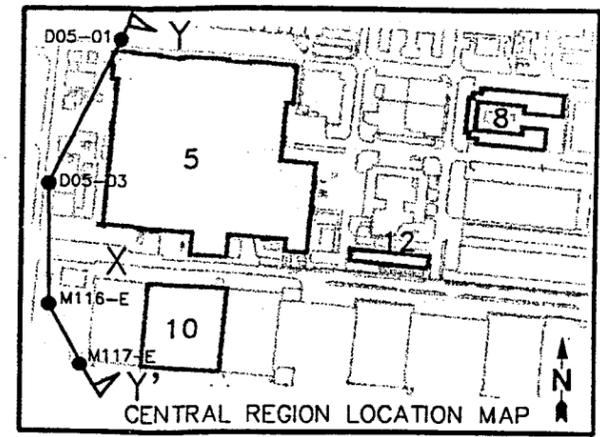
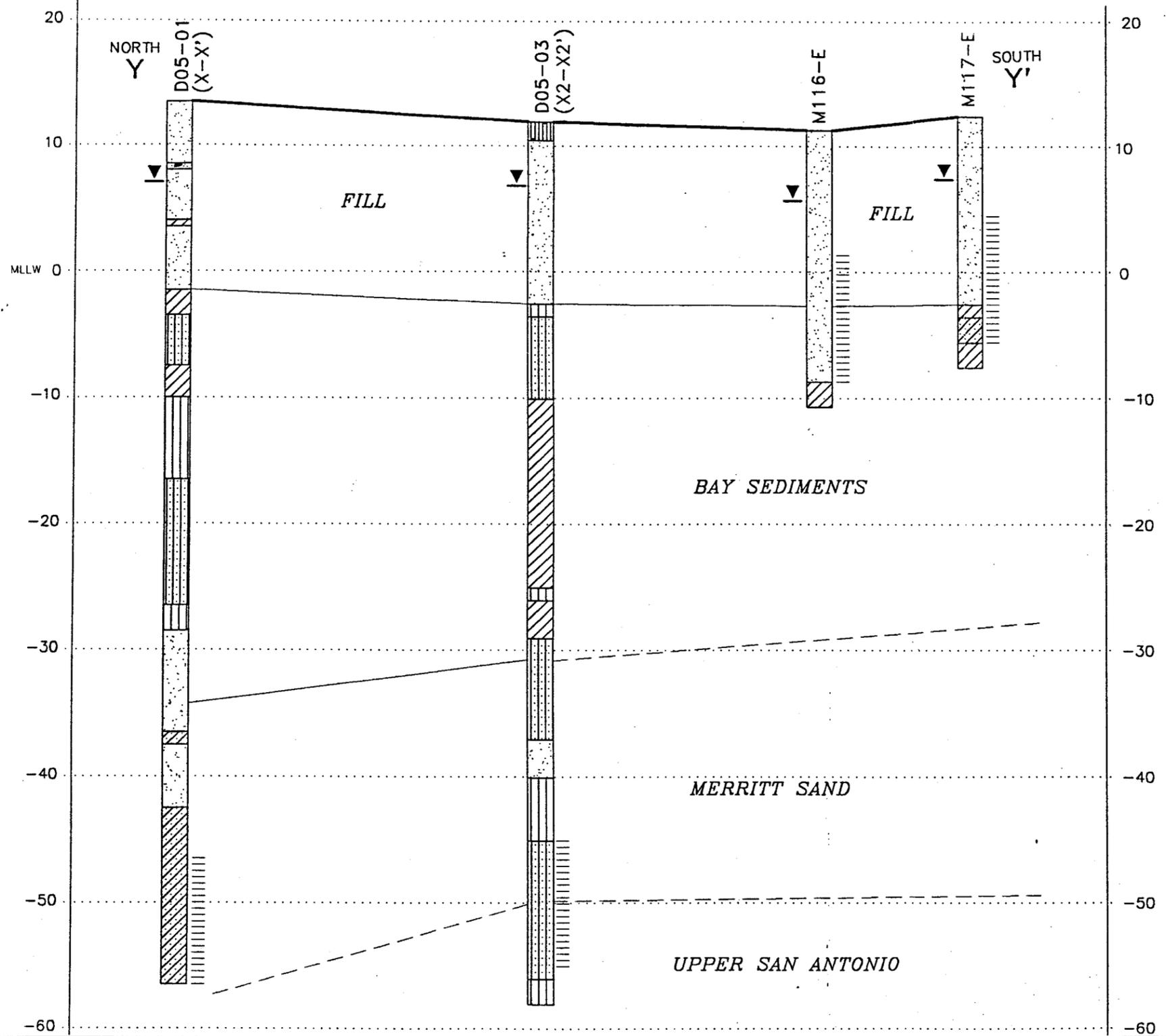
ELEVATION (FEET)



LEGEND

	CN - CONCRETE		SP - POORLY-GRADED SANDS		CL - SANDY CLAYS, SILTY CLAYS
	GW - WELL-GRADED GRAVELS		SM - SILTY SANDS		CONTACT
	GM - SILTY GRAVELS		SC - CLAYEY SANDS		INFERRED CONTACT
	SW - WELL-GRADED SANDS		ML - SANDY SILTS, SILTY CLAYS		APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES

FIGURE 3-3
SITE 5 - GEOLOGIC CROSS SECTION X2-X2'
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 7c.a, May 1997.



LEGEND

- | | | | | | |
|--|----------------------------|--|-------------------------------|--|---|
| | GP - POORLY-GRADED GRAVELS | | SM - SILTY SANDS | | CONTACT |
| | GM - SILTY GRAVELS | | SC - CLAYEY SANDS | | INFERRED CONTACT |
| | SP - POORLY-GRADED SANDS | | ML - SANDY SILTS, SILTY CLAYS | | APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES |
| | | | CL - SANDY CLAYS, SILTY CLAYS | | |

FIGURE 3-4
SITE 5 - GEOLOGIC CROSS SECTION Y-Y'
ALAMEDA POINT, ALAMEDA, CALIFORNIA

Source: OGISO Environmental Figure 7c.a, May 1997.

41,000 µg/L in one sample. Other constituents detected included 1,1-DCE, 1,2-DCE, chloroethane, and TCE. Monitoring wells north, east, and south of this well exhibited much lower concentrations of chlorinated solvents.

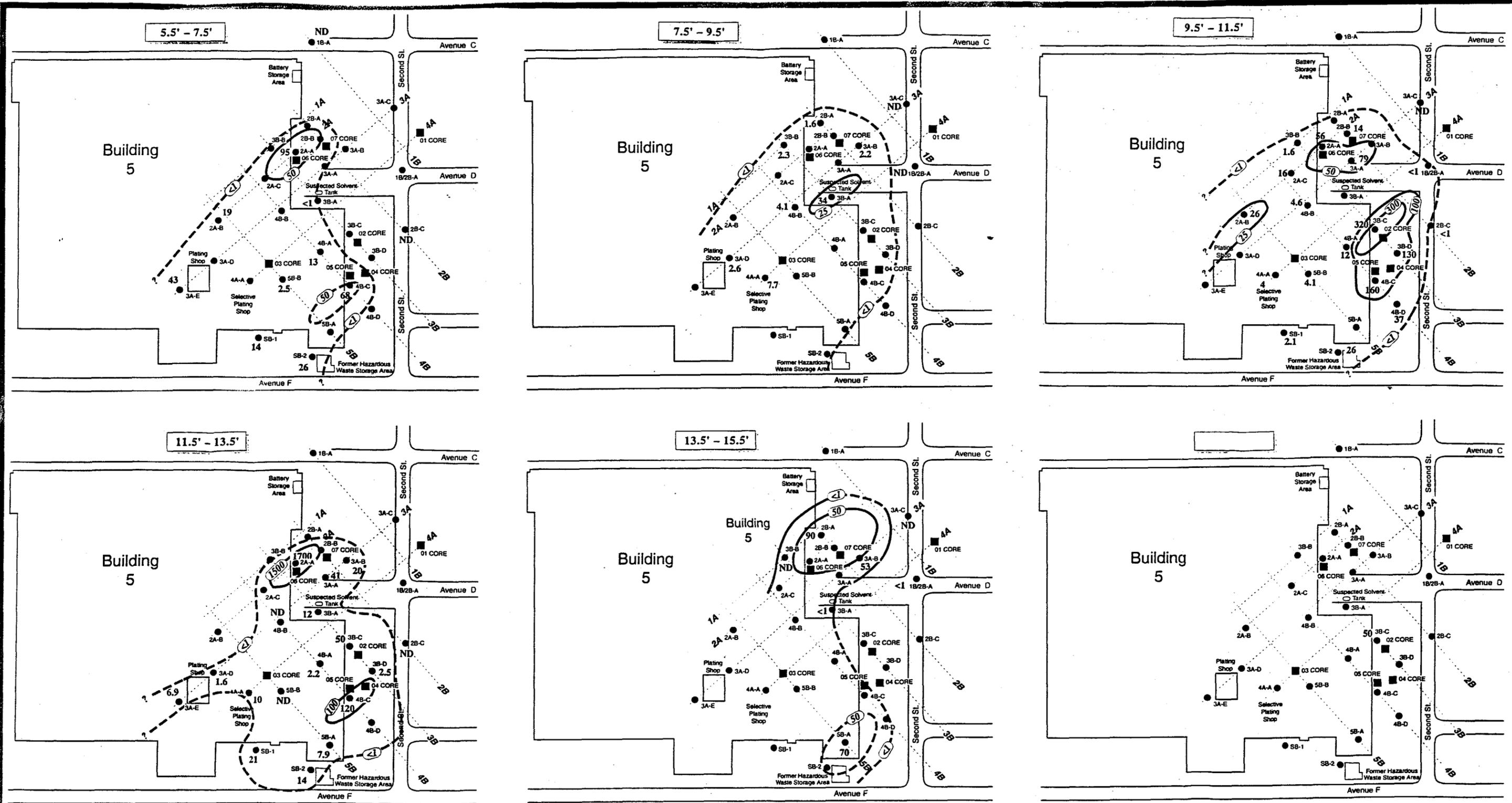
In March 1997, the chlorinated solvent plume was further analyzed at Site 5 during the Navy's groundwater investigation. All of the samples collected during the 1997 investigation were analyzed for chlorinated solvents. Three analytes, TCE, cis-1,2-DCE, and vinyl chloride, were chosen to represent the chlorinated solvent plume.

During the past year, the Navy has completed an EBS on parcels not currently included in the IR program. This investigation included the collection of several groundwater samples in the vicinity of Site 5. These samples were analyzed for many different chemicals to evaluate if any of the parcels pose a risk to human health or the environment.

Groundwater samples were collected from parcels 45, 51, 52, 53, 57 and 59. For consistency, the analytical results of chemicals TCE, 1,2-DCE, and vinyl chloride in the groundwater samples were used to represent the chlorinated solvent distribution in groundwater. The results of the groundwater samples collected during the EBS investigation at these parcels indicated (1) low levels of TCE (9 µg/L) were detected at parcels 51, 52, and 53; (2) 1,2-DCE, TCE, and vinyl chloride were detected at parcel 45 at concentrations up to 320 µg/L, 4 µg/L, and 79 µg/L, respectively; and (3) 1,2-DCE, TCE, and vinyl chloride were detected at parcel 57 at concentrations up to 580 µg/L, 10 µg/L, and 11 µg/L, respectively. All of these groundwater samples were collected from depths ranging from 10 feet to 11 feet bgs.

TCE. Figure 3-5 shows the estimated TCE plumes for each depth interval at Site 5 based solely on the 1997 groundwater investigation (OGISO 1997). The concentration of TCE generally increases to a maximum concentration at the depth interval of 11.5 to 13.5 feet bgs. The maximum concentration of TCE (1,700 µg/L) was detected in the 11.5 to 13.5 feet bgs groundwater sample collected from boring 2A-A, located beneath the northeast portion of Building 5. The concentrations of TCE generally decreased with depths greater than 13.5 feet bgs.

1,2-DCE. Figure 3-6 shows the estimated 1,2-DCE plumes for each depth interval at Site 5 based solely on the 1997 groundwater investigation (OGISO 1997). Elevated concentrations of 1,2-DCE were detected in groundwater samples from 5.5 to 15.5 feet bgs in the eastern-southeastern portion of Site 5.

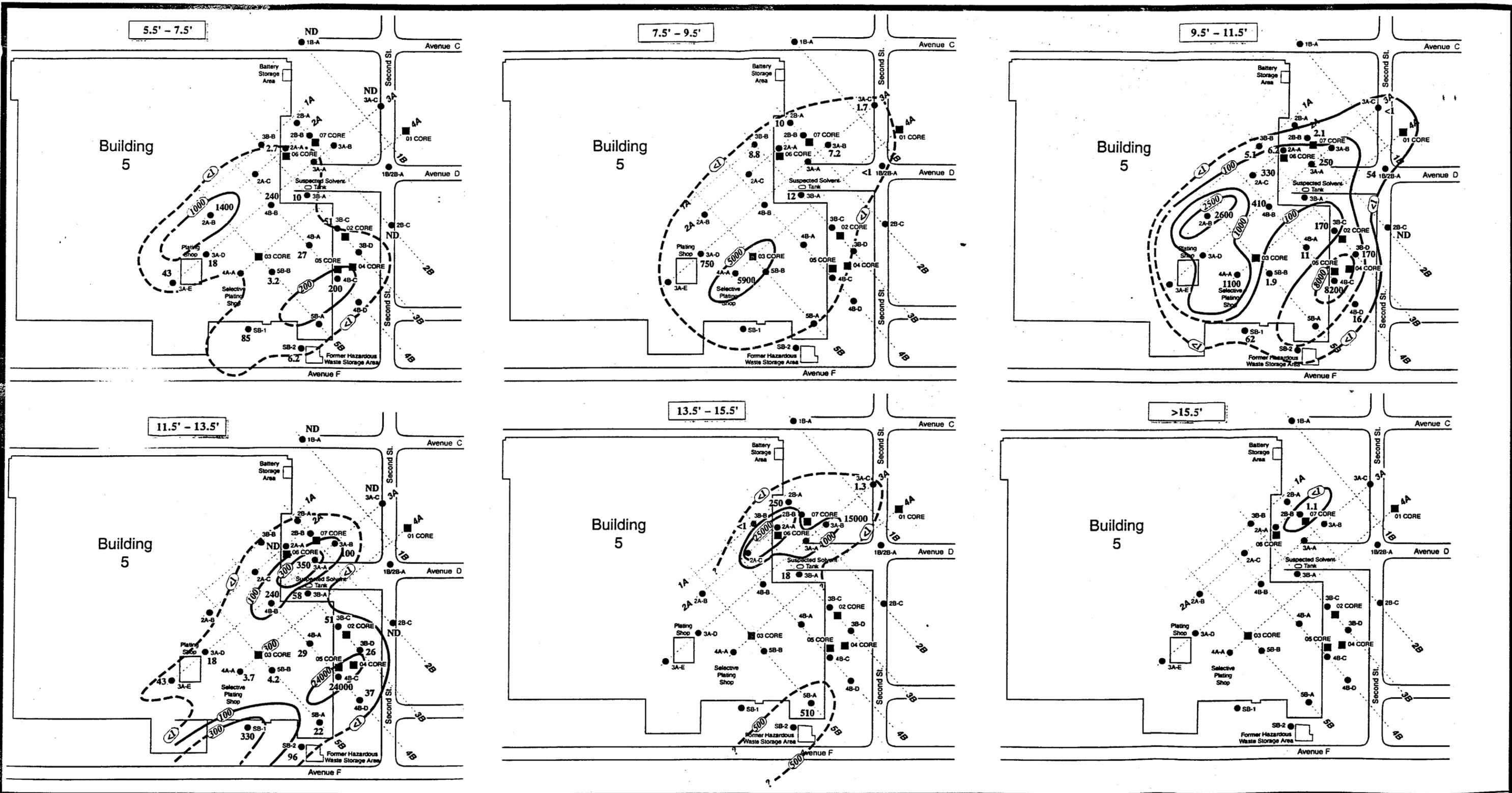


Explanation

- BERC - Soil Boring Location
- BERC - Water Sample Location
- 28 Chemical Concentration in µg/L (ppb)
- ND Not Detected
- 2- Foot Interval
- Transect Lines

0 125 FT

FIGURE 3-5
 SITE 5 - TCE CONCENTRATIONS IN GROUNDWATER
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 7c.a, May 1997.



Explanation
 ■ BERC - Soil Boring Location
 ● BERC - Water Sample Location
 28 Chemical Concentration in $\mu\text{g/L}$ (ppb)
 ND Not Detected
 — 2-Foot Interval
 - - - - - Transect Lines

0 125 FT

FIGURE 3-6
SITE 5 - 1,2-DCE CONCENTRATIONS IN GROUNDWATER
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 5b.a, May 1997.

The maximum concentration of 1,2-DCE (29,000 µg/L) was detected in the 13.5 to 15.5 feet bgs groundwater sample collected from boring 2A-A, located beneath the northeastern portion of Building 5. Additional information collected from depths greater than 15.5 feet bgs is necessary to adequately assess the vertical extent of 1,2-DCE.

Vinyl Chloride. Figure 3-7 shows the estimated vinyl chloride plumes for each depth interval based solely on the 1997 groundwater investigation (OGISO 1997). The concentration of vinyl chloride generally increases to a maximum concentration at the depth interval of 13.5 to 15.5 feet bgs. The maximum concentration of vinyl chloride (5,500 µg/L) was detected in the 13.5 to 15.5 feet bgs groundwater sample collected from boring 2B-A, located beneath the northeastern portion of Building 5. Additional information collected from depths greater than 15.5 feet bgs is necessary to adequately assess the vertical extent of vinyl chloride.

Based on the information collected during the March 1997 groundwater investigation, the extent of the chlorinated solvent plume remains undefined at depths greater than 15.5 feet bgs and laterally north and south of Building 5.

This investigation will concentrate on assessing the chlorinated solvent plume in groundwater between the depths of 15.5 and 35 feet bgs at Site 5. Additional groundwater samples will also be collected north and south of Site 5 to further assess the lateral extent of the chlorinated solvent plume. If during the investigation, a separate and distinctive plume is encountered, this plume will be investigated similar to the chlorinated solvent plume at Site 5.

3.4 DATA QUALITY OBJECTIVES

This investigation will collect data to (1) evaluate the vertical and lateral extent of the chlorinated solvent plume in groundwater, (2) develop a conceptual model of contaminant distribution, and (3) gather subsurface information to incorporate into the feasibility study.

Sampling for Site 5 has been designed such that depth-discrete groundwater samples can be collected in areas where data gaps are present (such as at depths greater than 15 feet bgs). The sample locations have been laid out in a grid pattern. Sample locations were chosen to provide an overall characterization of the chlorinated solvent distribution. If chlorinated solvents are detected in the samples collected from

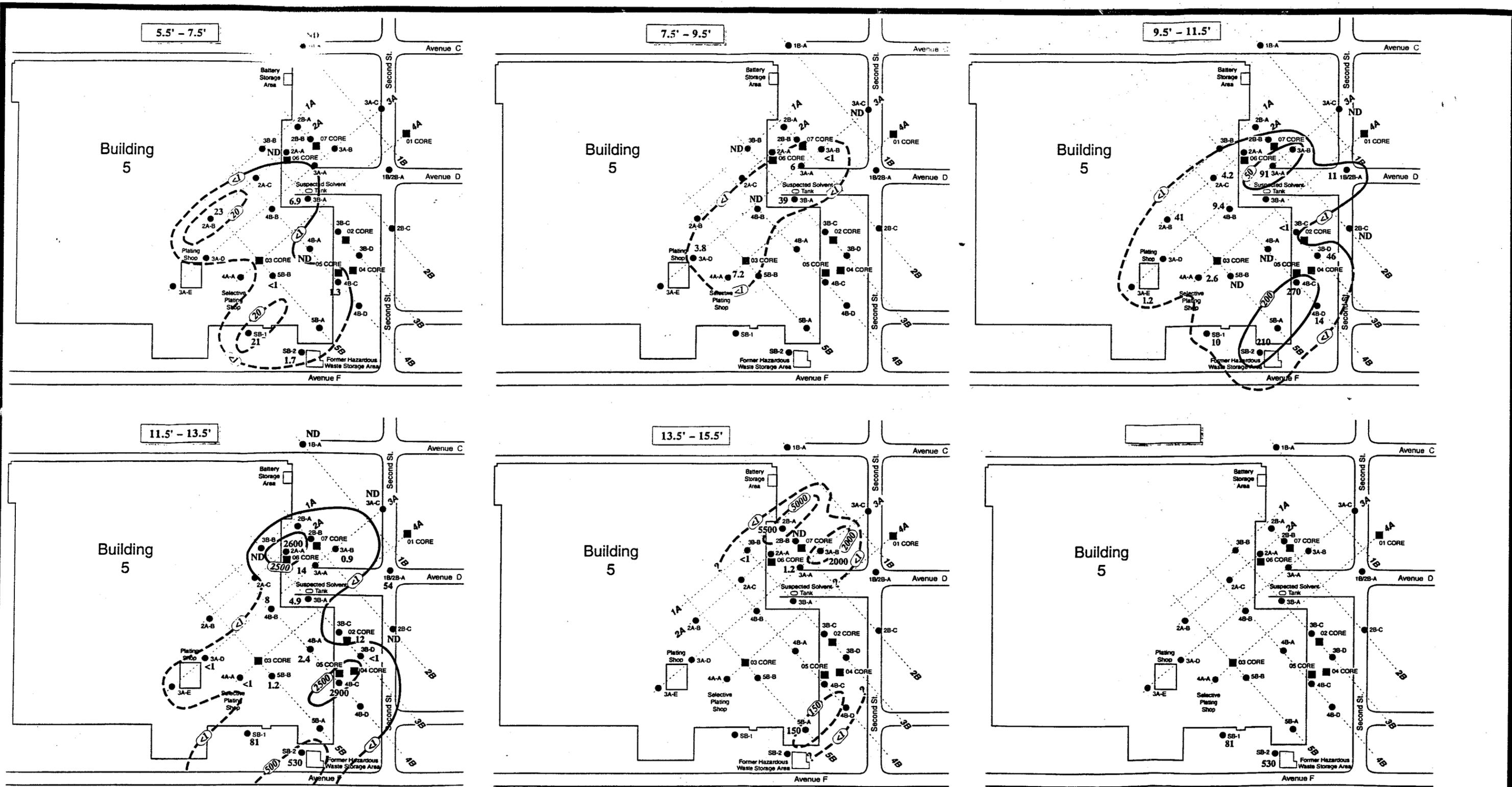


FIGURE 3-7
 SITE 5 - VINYL CHLORIDE CONCENTRATIONS IN GROUNDWATER
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 7a.a, May 1997.

Explanation

■ BERC - Soil Boring Location	28	Chemical Concentration in $\mu\text{g/L}$ (ppb)
● BERC - Water Sample Location	ND	Not Detected
	—	2- Foot Interval
	-----	Transect Lines

0 125 FT

the borings at the outer limits of the grid, north-south and east-west grid lines will be added to assess the extent of the chlorinated solvent plume.

The decision to continue sampling will be based on the analytical results of previous groundwater samples. The initial sampling locations are provided in Table 3-1. The decision rules for lateral sample collection during this sampling event are as follows:

- The initial sampling locations were based on the results of the Navy's 1997 groundwater investigation and the following decision rules.
- If the concentration of chlorinated solvents detected in the current sample is greater than or equal to 1 mg/L, then sampling of the nearest boring locations will be omitted and the next samples will be collected from the second closest boring locations. The decision to omit sample locations is based on professional experience with groundwater plume characteristics. If the concentration in a sample is greater than or equal to 1 mg/L, the chemical generally will disperse (based on concentration gradients and advection) greater than 150 feet unless a hydraulic barrier is present.
- If the concentration of chlorinated solvents detected in the current sample is greater than or equal to 100 µg/L and less than or equal to 1 mg/L, then the next samples will be collected from the nearest boring locations.
- If the concentration of chlorinated solvents detected in the current sample is approximately 10 percent of the concentration of chlorinated solvents detected in the previous boring location and the concentration of chlorinated solvents in the previous boring location is greater than or equal to 100 µg/L and less than or equal to 1 mg/L, then no further samples will be collected in the direction of that boring.
- If the concentration of chlorinated solvents detected in the current sample is less than or equal to 50 µg/L, then no further sample will be collected in the direction of that boring.
- Based on the information provided in the cross sections for Site 5 (Figures 3-3 and 3-4), the Merritt Sand layer is encountered at approximately 35 feet bgs. Since chlorinated solvents have not been detected in any of the groundwater samples collected from the wells screened in the second water bearing zone at Site 5, the Bay sediments unit overlying the Merritt Sand layer will not be fully penetrated. The deepest samples collected during this investigation will be collected at a depth of 30 feet bgs. If chlorinated solvents are detected in the soil samples collected from the 30 foot bgs interval, the Navy will determine the need to penetrate the Bay sediments unit and collect samples in the Merritt Sand layer.
- In the event that the intersection of a north-south transect line and an east-west transect line is located in an area where a boring cannot be advanced, the boring location will be moved along the transect line to the nearest location a boring can be advanced. Several factors can affect the location of a boring, including underground utilities, overhead obstacles, and proximity to a building or other structure.

TABLE 3-1 (Cont.)
SITE 5 - INITIAL SAMPLING DEPTHS
ALAMEDA POINT, ALAMEDA, CALIFORNIA

Boring Number	Sample Depth Interval (feet)							
	5.5-7.5	7.5-9.5	9.5-11.5	11.5-13.5	13.5-15.5	15.5-20.0	20.0-25.0	25.0-30.0
5-7								
6-1				X	X			
6-2	X			X		X		
6-3	X			X				
6-4	X							
6-5			X					
6-6								
6-7								
7-1								
7-2					X			
7-3					X			
7-4								
7-5								
7-6								
7-7								
8-1								
8-2								
8-3								
8-4								
8-5								
8-6								
8-7								
9-1								
9-2								
9-3								
9-4								
9-5								
9-6								
9-7								

Notes:

- 1-1 This boring number refers to the intersection of the transect lines where the boring was advanced. This boring was advanced at the intersection of east-west transect line 1 and north-south transectline 1. (2-1 refers to east-west transect line 2 and north-south transect line 1)

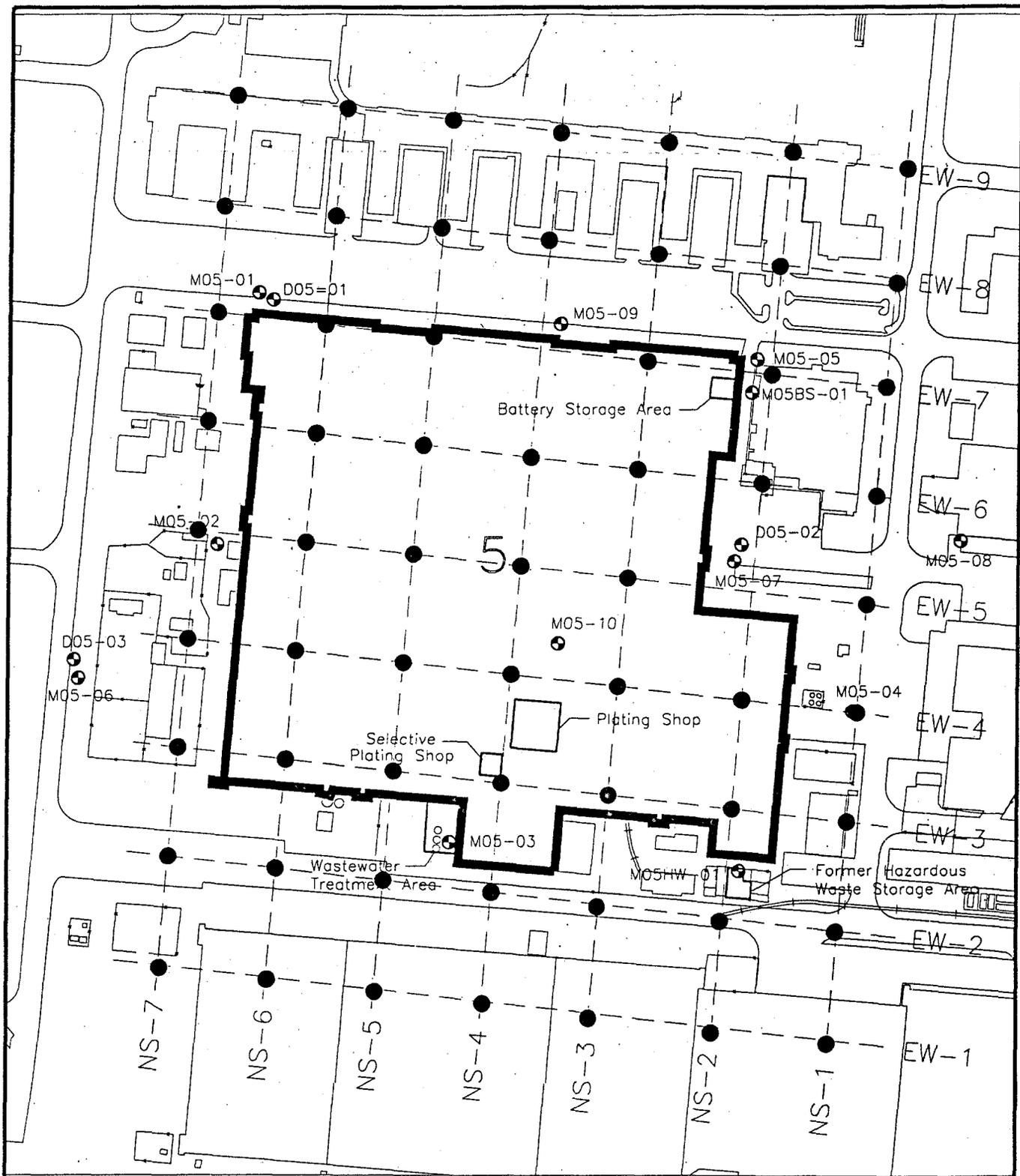
These decision rules will also be used for each vertical sampling interval. If during this investigation, the observed distribution of the chlorinated solvent plume extends in the direction of the samples collected at during the EBS investigation, the analytical results of the EBS samples will be used to evaluate the location of additional samples collected during this investigation.

The soil boring identification will reference the two transects that the boring intersects. The first number will be the number of the east-west transect line, the second number will be the north-south transect line, and the third will be the depth at which the sample was collected. For example, the soil boring identification 3-4-5.5 would indicate that the boring is located at the intersection of the third east-west transect and the fourth north-south transect and the sample was collected at a depth of 5.5 feet bgs.

3.5 GROUNDWATER GEOCHEMICAL PROFILING PROGRAM

Groundwater geochemical profiling will be completed through depth-discrete sampling using the Waterloo Drive Point Profiler (see Appendix B). The Waterloo Drive Point Profiler is a well point with screened ports located at the tip of the tool. The ports are connected to an internal tube that extends up through the direct push rods to ground surface. During sampling, the profiler is advanced and deionized water is simultaneously pumped out the sampling ports to prevent them from clogging. Once a desired depth is reached, the flow of the pump is reversed and groundwater from the aquifer is extracted. Once the sample is collected, the profiler is again advanced and simultaneously purged with deionized water until the next desired sampling depth is reached. If hydrogeologic conditions are such that the permeability of the aquifer is not sufficient to produce the required amount of groundwater (to retrieve a sample), a temporary groundwater sampling point will be installed. The groundwater sample will then be collected the following day.

Figure 3-8 shows the approximate locations of soil borings from which groundwater samples will be collected. There are two distinct areas where data gaps are present at Site 5. Nine east-west transect lines and seven north-south transect lines will be arranged to begin the grid pattern and one soil boring will be advanced as close to the intersection of each transect as practical. An east-west transect line will be placed every 150 feet beginning south of W. Tower Avenue and a north-south transect line will be placed every 150 feet beginning at the centerline of Lexington Street. The modification (addition of transect lines in either the east-west or north-south directions) of this grid pattern will depend on the



LEGEND

- Proposed Groundwater Sampling Location
 - - - Transect Line
 - ⊙ Groundwater Monitoring Well
 - EW-1 East-West Transect Line
 - NS-1 North-South Transect Line
- 0 200 400
- APPROXIMATE SCALE
1" = 200'

FIGURE 3-8

SITE 5
PROPOSED GROUNDWATER SAMPLING LOCATIONS
ALAMEDA POINT
ALAMEDA, CALIFORNIA

decision rules discussed in Section 3.4. Any changes in transect locations or sampling locations will be discussed among the on-site subcontractor's geologist, the Navy's field oversight task manager, and, if necessary, the Navy's project manager. The QAPP in Appendix A provides a detailed description of sample collection and analytical methodologies.

At each specific location, groundwater samples may be collected from any of the following at discrete depths (between 5.5 and 7.5 feet bgs, 7.5 and 9.5 feet bgs, 9.5 and 11.5 feet bgs, 11.5 and 13.5 feet bgs, 13.5 and 15.5 feet bgs, 15.5 and 20.0 feet bgs, 20.0 and 25.0 feet bgs, and 25.0 and 30.0 feet bgs). The initial sampling depths are listed in Table 3-1. The collection of additional groundwater samples will depend on the decision rules discussed in Section 3.4. The results will be recorded on geologic cross sections as work progresses so the dimensions of the plume will become apparent throughout the course of field work.

To assess the lateral extent of the chlorinated solvent plume at Site 5, groundwater samples will need to be collected north and south of Building 5, beyond the limits of Site 5. Based on the decision rules discussed in Section 3.4, soil borings may be advanced at EBS parcels. The EBS parcels that may be included in this investigation are 45, 51, 52, 53, 56, 57, 58 and 59. Parcels not listed may be included depending on the migratory patterns of the chlorinated solvent plume. Currently, the Navy is conducting risk assessments to assess if a risk to human health or the environment exists at any of these parcels. If any of these parcels are included in this investigation, only information necessary to characterize the chlorinated solvent plume, currently detected in the groundwater at Site 5, will be collected.

3.6 GROUNDWATER MONITORING WELL PLACEMENT AND INSTALLATION

Once the laboratory results of the samples collected during this investigation are received, an in-depth evaluation of the chlorinated solvent plume will be conducted. This evaluation will include data obtained from this investigation, all previous investigations, and EBS. One portion of the evaluation will be to evaluate appropriate locations for additional groundwater monitoring wells.

Groundwater monitoring wells will be necessary to monitor the movement of chlorinated solvents at discrete depths throughout the aquifer. The placement of each monitoring well will depend on the results of geochemical profiling. A sufficient number of groundwater monitoring wells are screened between 5

feet and 15 feet bgs in the vicinity of Site 5, however, the results of the Navy's 1997 groundwater investigation indicated that the chlorinated solvent plume is moving downward in the aquifer. Any additional groundwater monitoring wells installed will be located near the downgradient edge of the plume at the particular depth of interest. By locating the groundwater monitoring wells at the downgradient edge of the plume, both the flow rate and concentration of the chemicals can be monitored. In addition, wells that are placed at the leading edge of the plume can assist in evaluating the efficiency of treating groundwater during remediation, if necessary.

One of the considerations at Site 5 is that two separate water bearing zones are present within the first 35 feet of the subsurface. When installing groundwater monitoring wells, the need to penetrate the confining layer between the first and second water bearing zones will be evaluated by the Navy's on-site geologist.

Groundwater monitoring wells will be installed in accordance with TtEMI's standard operating procedure for monitoring well installation (Appendix C). At each groundwater monitoring well location, an 8-inch diameter soil boring will be drilled using a drill rig equipped with continuous-flight, hollow-stem augers to the depth specified by the Navy's on-site geologist. A 2-inch diameter groundwater monitoring well assembly will be installed in the center of each boring. The groundwater monitoring well assembly will consist of Schedule 40 PVC pipe with a maximum of 10 feet of slotted PVC screen, a PVC end cap, and a locking well cap.

Once this assembly is lowered to the depth specified by the Navy's on-site geologist, a sand filter pack will be placed into the annular space surrounding the well. The filter pack will be placed in the boring from the bottom of the boring to approximately 2 feet above the top of the screened interval. A 2-foot layer of bentonite chips will be placed in the annular space above the sand filter pack and charged with distilled water. A cement slurry will be placed in the annular space from the top of the bentonite chips to approximately 1 foot below the top of the well assembly. A traffic-rated well vault will then be placed in the boring surrounding the well assembly and cemented into place. This vault will be placed such that water will drain away from the well assembly (slightly above ground surface).

4.0 SITE 14 INVESTIGATION

This section describes the events leading up to this investigation and the DQOs and field sampling program necessary to evaluate if the existing sump at Site 14 has contaminated the soil and groundwater. Based on previous investigations, the only area that has not been investigated at Site 14 is the area surrounding the sump. No investigations have been completed to evaluate the structural integrity of the sump. If the structural integrity of the sump has been diminished, potential soil and groundwater contamination may exist.

4.1 DESCRIPTION AND HISTORY

Site 14, the Fire Training Area, consists of a concrete pad surrounded on three sides by an earthen berm (Figure 4-1). The site is located on Perimeter Road near Building 443. The containment berm was constructed between 1973 and 1979 (Perry 1991). The site has been used as a fire extinguisher discharge point and a fire fighting and rescue training area. Ansulite fire-fighting foam was mixed in a nearby tank and used to extinguish training fires. A sump is located in the northeastern corner of the pad. Based on field observations during the initial Phases 2B and 3 investigation, the sump has been used for the collection of runoff from fire training activities.

The following environmental studies have been conducted at Site 14:

- In 1991, the Navy conducted a RI/FS that included a geophysical survey, a soil gas survey, and three soil borings, which were converted to monitoring wells. The results of the 1991 investigation are presented in the Data Summary Report RI/FS Phases 2B and 3 (PRC 1992). The soil gas survey indicated elevated concentrations of benzene, toluene, ethylbenzene, and total xylenes (BTEX). Acetone was also detected at low concentrations in the soil. Low levels of VOCs and elevated levels of chromium were detected in groundwater samples.
- In 1994 and 1995, the Navy conducted an additional investigation that included CPT, groundwater sampling using a Hydropunch, 10 soil borings, and the installation of 1 deep monitoring well. The results of the 1994 and 1995 investigations are presented in the RI/FS Data Transmittal Memorandum (PRC 1996). Elevated levels of total purgeable petroleum hydrocarbons (TPPH), total extractable petroleum hydrocarbons (TEPH), pesticides, polychlorinated biphenyls (PCBs) (Arochlor-1260), and dioxins were detected in soil samples. Low levels of VOCs were detected in the groundwater samples collected from the first and second water bearing zones.



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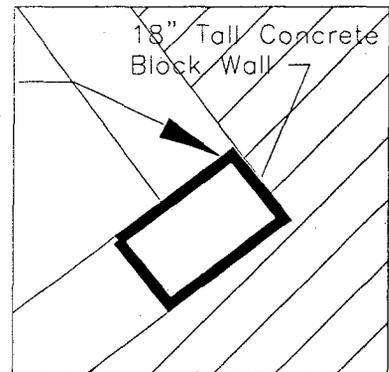
M14-02
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M14-01
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SUMP
(See Insert)

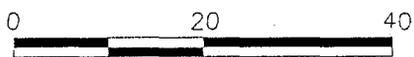
SITE 14
FIRE TRAINING
AREA

M14-03
⊕
D14-01
⊕



LEGEND

⊕ Groundwater Monitoring Well



APPROXIMATE SCALE
1" = 20'

FIGURE 4-1

SITE 14
SITE PLAN
ALAMEDA POINT
ALAMEDA, CALIFORNIA

Based on the results of these investigations, the nature and extent of chemicals in soils and groundwater appear to have been adequately evaluated. However, since the sump has not been investigated, this investigation will collect additional soil samples (and groundwater samples, if encountered) around the sump.

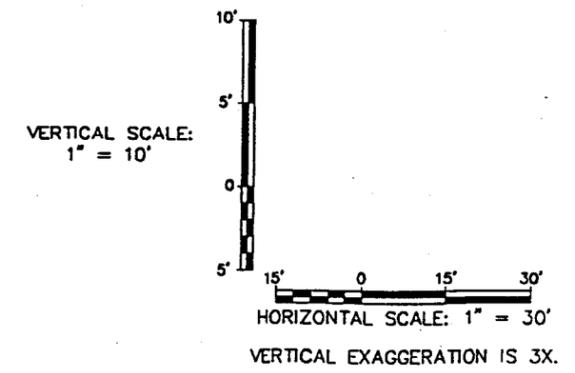
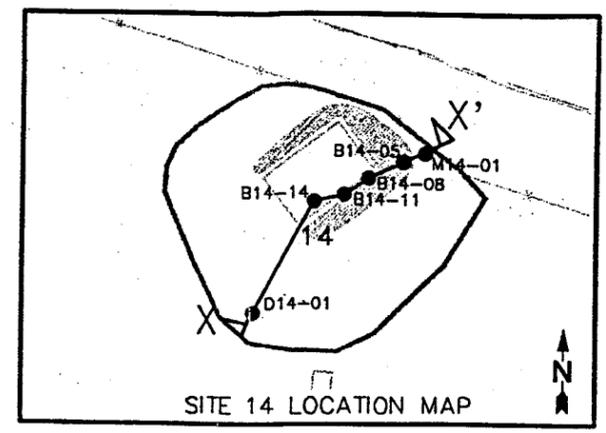
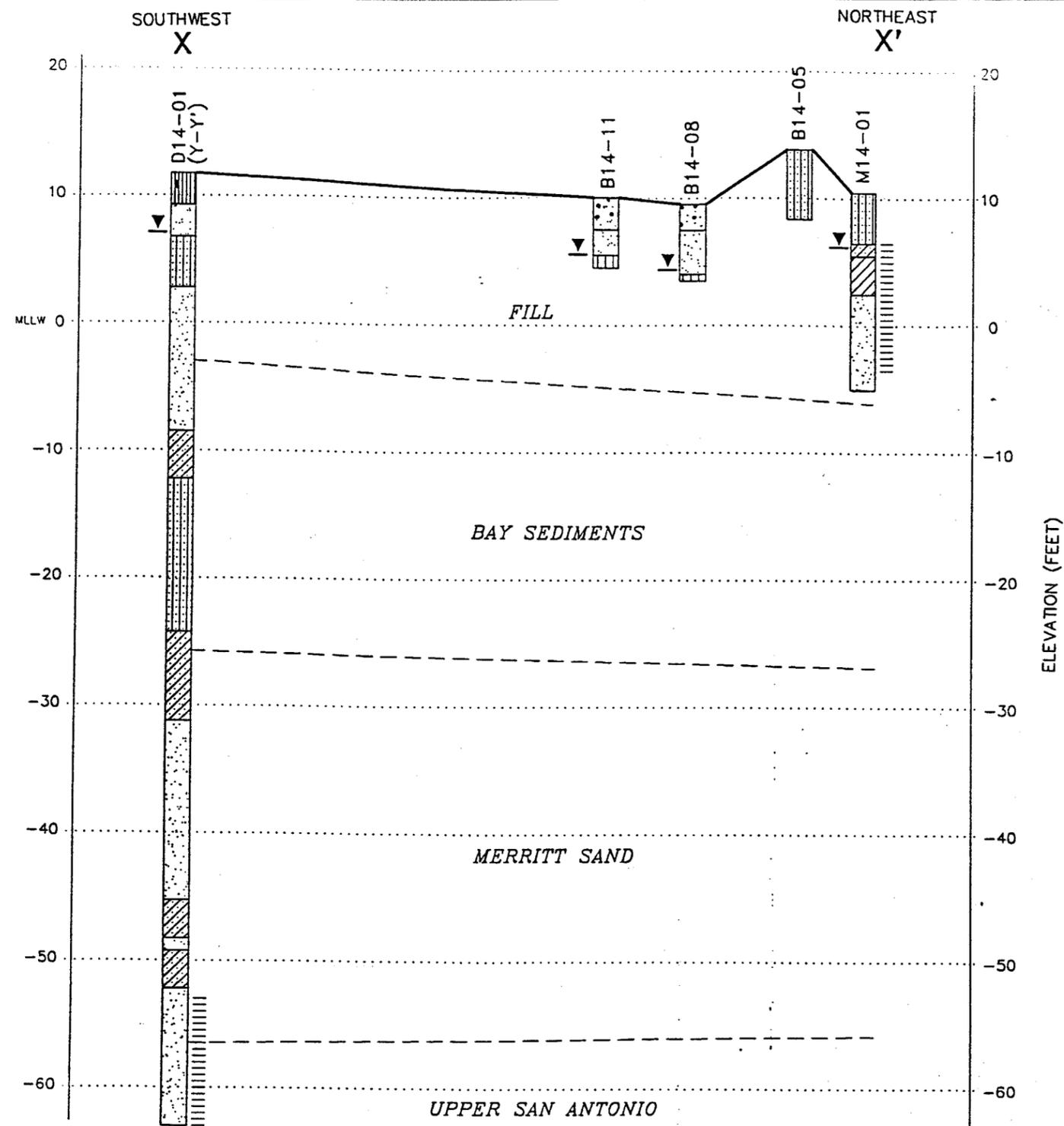
4.2 GEOLOGY AND HYDROGEOLOGY

Site 14 consists of a relatively fine-grained fill material to the total depth explored (15 feet bgs). Based on previous investigations, the depth to native soil, marked by a shell-rich clay, is approximately 30 feet (PRC and JMM 1992). The fill consists primarily of silty sands and clays. Locally, the fill contains clean sands, gravel, and asphalt. Trace shell and clay fragments found throughout the fill indicate that it may be dredging spoils or other marine-derived material. The sediments are primarily sands and clayey sands with vertical permeabilities, as determined by the falling head method, ranging from $3.53E-04$ to $4.87E-05$. Figures 4-2 and 4-3 show geologic cross sections for Site 14.

During a tidal influence study conducted by the Navy in late January and early February 1992, water levels in all wells at Site 14 fluctuated in response to tidal activity in the adjacent Oakland Inner Harbor (PRC and MW 1995). The lag time between the Inner Harbor and the wells varied from approximately 1 hour in wells M14-01 and M14-02 to 1.5 to 2 hours in well M14-03. During periods of low tide, the groundwater flow direction at Site 14 is toward the Inner Harbor with a hydraulic gradient of approximately 0.0012 feet per foot (fpf). During periods of high tide, the groundwater flow direction at Site 14 is away from the Inner Harbor with a hydraulic gradient of approximately 0.013 fpf. The average groundwater flow direction at Site 14 is southwest (away from the Inner Harbor) with a hydraulic gradient of approximately 0.00068 fpf (nearly flat).

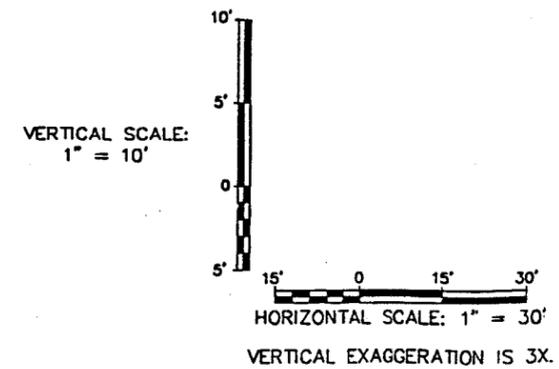
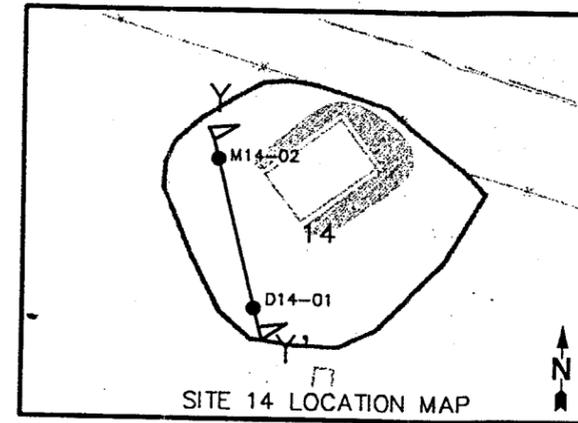
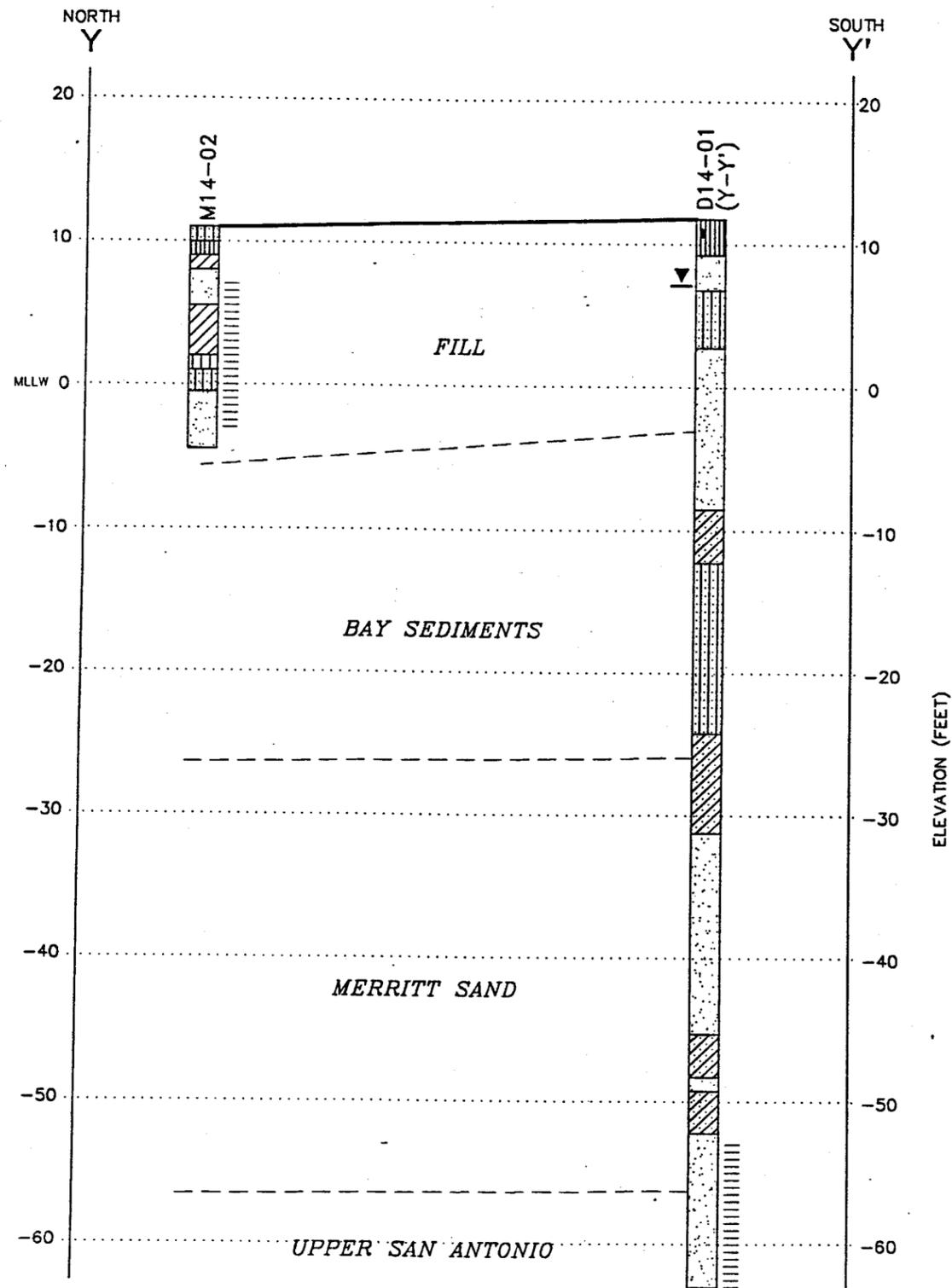
4.3 OBSERVED DISTRIBUTION OF CONTAMINATION

Investigations conducted at Site 14 have identified low concentrations of petroleum hydrocarbons, ethylbenzene, total xylenes, and dioxins and furans in soil samples and low concentrations of VOCs in one groundwater sample. Petroleum hydrocarbons, ethylbenzene, and total xylenes were detected from the surface to approximately 5 feet bgs in soil samples collected from beneath the concrete pad as well as within the bermed area. Pesticides, PCBs, and dioxins and furans were detected in surface soil samples outside the bermed area.



LEGEND			
	GM - SILTY GRAVELS		SM - SILTY SANDS
	SW - WELL-GRADED SANDS		SC - CLAYEY SANDS
	SP - POORLY-GRADED SANDS		ML - SANDY SILTS, SILTY CLAYS
			CL - SANDY CLAYS, SILTY CLAYS
			CONTACT
			INFERRED CONTACT
			APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES

FIGURE 4-2
SITE 14 - GEOLOGIC CROSS SECTION X-X'
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 7a.c, May 1997.



- LEGEND**
- | | | | |
|--|-------------------------|--|---|
| | GM - SILTY GRAVELS | | ML - SANDY SILTS, SILTY CLAYS |
| | SP - POORLY-GRADED SAND | | CL - SANDY CLAYS, SILTY CLAYS |
| | SM - SILTY SANDS | | CONTACT |
| | SC - CLAYEY SANDS | | INFERRED CONTACT |
| | | | APPROXIMATE WATER LEVEL MEASURED DURING DRILLING ACTIVITIES |

FIGURE 4-3
SITE 14 - GEOLOGIC CROSS SECTION Y-Y'
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 Source: OGISO Environmental Figure 7a.c, May 1997.

Four groundwater monitoring wells have been installed at Site 14. Only one groundwater sample (collected from the northeast corner of the fire training area) had detectable levels of 1,2-DCE. Based on the investigations conducted at Site 14, this is the only chemical detected in the groundwater.

A sample of the sediment in the sump was collected during previous investigations and analyzed for VOCs, SVOCs, total metals, total extractable petroleum hydrocarbons and total purgeable petroleum hydrocarbons. Based on the analytical results of this sample, lead and total extractable petroleum hydrocarbons as motor oil were detected at elevated levels.

4.4 DATA QUALITY OBJECTIVES

This investigation will collect data to evaluate the impact, if any, that the existing sump at Site 14 may have had on the surrounding soils and groundwater.

In order to determine if the existing sump has had an impact on the surrounding soil, a total of six soil samples will be collected. Two soil samples will be collected from beneath the sump, and one soil sample will be collected from each side of the sump at a depth of approximately 5 feet bgs. If a drain for the sump exists, one additional soil sample will be collected from the surface soil just below the drain outfall. If groundwater is encountered, one groundwater sample will be collected from directly beneath the sump. The QAPP (Appendix A) provides a detailed description of sample collection and analytical methodologies.

4.5 SOIL SAMPLING IN THE VICINITY OF THE EXISTING SUMP

The sump at Site 14 is currently surrounded by piles of asphalt and an 18-inch high wall of concrete blocks. The blocks and asphalt will be moved away from the sump and any overgrowth will be cut down prior to investigating the sump. Once the sump is accessible but prior to sampling around the sump, the existing grate covering the sump will be removed and the groundwater and sediment (currently in the sump) will be pumped out and disposed of at an appropriate disposal facility.

Once the sump has been cleaned out, it will be inspected to see if cracks or holes are present that may be conduits for leakage to the subsurface. If cracks or holes are detected in the sump, a soil sample will be collected directly beneath the defect.

In addition, the cleaning of the sump will reveal if a drain exists at the bottom of the sump. If a drain exists, the drain cover, if any, will be removed and a temporary plug will be inserted approximately 1 foot into the drain pipe. The drain outfall will be located, if possible, and investigated. If the outfall opens directly to the atmosphere, a sample will be collected from just below the outfall.

A total of six soil samples will be collected from the vicinity of the sump (see Figure 4-4). One soil sample will be collected from beneath the sump at each end (total of 2), and one soil sample will be collected from the soil just beyond the limits of the sump on each side (total of 4) at a depth of approximately 5 feet bgs. The soil samples from the soil beneath the sump will be collected by using a concrete corer to penetrate the concrete sump and reveal the soil. A slide hammer will be used to advance a 2-inch diameter by 6-inch long brass tube into the soil. The soil borings along the side of the sump will be advanced using a direct push sampling apparatus. All soil samples will be immediately covered with Teflon sheets and capped with plastic covers. A sample label will be affixed to the tube. To obtain the most representative samples, care will be taken to minimize the amount of soil disturbance during sampling, thus avoiding loss of volatile constituents. The QAPP (Appendix A) provides a detailed description of sample collection and analytical methodologies.

If groundwater is encountered during drilling, a groundwater sample will be collected using a disposable Teflon bailer. Appendix A provides a detailed description of sample collection and analytical methodologies. If a groundwater sample cannot be collected using a bailer, a groundwater sample will be collected using the Waterloo Drive Point Profiler.

The soil sample identification will reference the site number, the location, and the depth at which the sample was collected. The first number will be the site number, the second number will be the location of the boring, and the third will be the depth at which the sample was collected. For example, the soil boring identification S14-WS-5.5 would indicate that the boring is located at Site 14, west of the sump and the sample was collected at a depth of 5.5 feet bgs.

After collecting the soil samples, all of the borings and core locations will be filled with cement to prevent further disturbance of the subsurface. If the sump has cracks/holes or if the grate is destroyed during removal, the top of the sump will be covered with a steel plate and then cemented closed to prevent groundwater runoff from entering the sump. Otherwise, the existing grate will be replaced.

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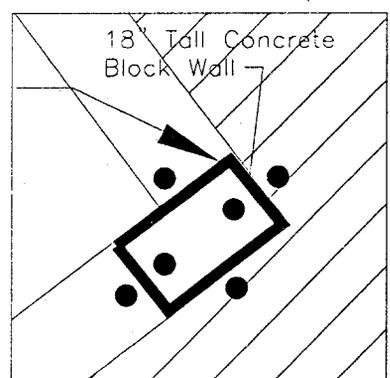
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SUMP
(See Insert)

SITE 14
FIRE TRAINING
AREA

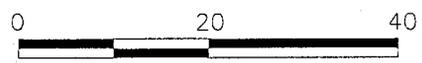
M14-03
⊕
D14-01
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LEGEND



- ⊕ Groundwater Monitoring Well
- Proposed Soil Sample Location



APPROXIMATE SCALE
1" = 20'

FIGURE 4-4

SITE 14
PROPOSED SOIL SAMPLING LOCATIONS
ALAMEDA POINT
ALAMEDA, CALIFORNIA

5.0 HEALTH AND SAFETY

All work will be conducted in accordance with the Navy CLEAN Health and Safety Program (PRC 1995) and with the Alameda Point Basewide Health and Safety Plan (PRC 1997). A Health and Safety Plan for the Alameda Point groundwater investigation and sump investigation will be provided by the subcontractor. The plan shall conform to the requirements of 29CFR 1910.120 (b) (4), the Engineer Manual (EM 385-1-1, Safety and Health Requirements, US Army Corps of Engineers (USACE) (September 3, 1996) and Navy Health and Safety Plan Review guidance (Navy Environmental Health Center, Environmental Programs Directorate, February, 1996).

Prior to investigation activities, underground utilities, including electrical, sewer, and water lines, and any other buried features that may affect drilling, will be identified.

6.0 SURVEYING

Following the closure of the soil borings at Sites 4, 5, and 14, a State of California licensed, professional land surveyor will provide the elevation and coordinates of each soil boring. The elevations will be surveyed relative to the 1929 USGS MLLW datum. To remain consistent with standard survey practices used by Alameda Point Facilities Management Office, a baseline of 100 feet will be added to the MLLW datum to remove the possibility of negative elevations. The soil borings will be surveyed using the State Plane Coordinate System.

7.0 CHEMICAL ANALYSIS

This section describes the chemical analyses that will be conducted on the groundwater samples collected from Sites 4 and 5 and the soil and groundwater samples collected from Site 14. Appendix A provides a detailed description of sample collection and analytical methodologies.

7.1 SITES 4 AND 5

Groundwater samples will be analyzed by an on-site mobile laboratory. The use of an on-site laboratory allows the subcontractor and the Navy task manager to determine the location and depths of further samples. A detailed description of the mobile laboratory is provided in Appendix A. Each groundwater sample collected during this investigation will be analyzed by the mobile laboratory using EPA Method 8260 for the following VOCs:

- **Volatile Aromatic Hydrocarbons:** Benzene, toluene, ethyl benzene, and total xylenes
- **Volatile Chlorinated Hydrocarbons:** Tetrachloroethene, TCE, 1,1,1-TCA, 1,1-DCE, cis and trans-1,2-DCE, 1,2,-DCE, chloroethane, and vinyl chloride

7.2 SITE 14

Soil samples and groundwater samples (if collected) will be analyzed by a state-certified laboratory. Each soil and groundwater sample collected during this investigation will be analyzed using CLP procedures for the following chemical classes:

- VOC
- SVOC
- Total purgeable and total extractable petroleum hydrocarbons
- Total metals
- Dioxins (soil only)
- Pesticides/PCBs

8.0 INVESTIGATION-DERIVED WASTE

It is assumed that one drum of soil and one drum of decontamination water from Site 14; and two drums of soil and 12 drums of decontamination water from Sites 4 and 5, will be generated during the field activities. The waste will be placed in a Department of Transportation (DOT) 17H 55-gallon drums, and the drums will be stored in a dedicated storage facility at Alameda Point prior to disposal. Prior to disposal, the waste soil and water will be fully characterized for chemical contaminants. This waste will then be sent to the appropriate landfills for disposal.

9.0 REFERENCES

- Bouwer and Rice. 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research. V. 12, pp. 423-428.
- Bouwer. 1989. The Bouwer and Rice Slug Test - An Update. Groundwater. V. 27, No.3, pp. 304-309. May-June.
- Canonie Environmental Services, Inc. (Canonie). 1990. Remedial Investigation/Feasibility Study Sampling Plan. February.
- Environmental Research Group. 1982. Revised Group. Prepared for the Navy PWC. September 17.
- OGISO Environmental. 1997. Geochemical Profiling for Chlorinated Solvent Plume, Sites 4 and 5. Final. May 27.
- Perry. 1991. Personal communication from Fire Chief Perry, NAS Alameda, Alameda, California to Rich Halket of James M. Montgomery Consulting Engineers, Inc. (JMM).
- PRC Environmental Management, Inc. (PRC) and JMM. 1992. NAS Alameda, Alameda, California, Data Summary Report RI/FS Phases 2B and 3, Final. October 27.
- PRC and Montgomery Watson (MW). 1993a. Naval Air Station, Alameda, Alameda, California, Remedial Investigation/Feasibility Study Work Plan Addendum Draft. September.
- PRC and MW. 1993b. Data Summary Report RI/FS Phases 1 and 2A, Final. August 25.
- PRC and MW. 1995. Data Summary Report Background and Tidal Influence Studies and Additional Work at Sites 4 and 5. NAS Alameda, Alameda, California. October.
- PRC. 1995. Additional Site Investigation Site 5, Plating Shop. October 16. (Note: this letter report was included as an appendix in PRC 1995b.)
- PRC. 1996. Remedial Investigation/Feasibility Study Data Transmittal Memorandum Sites 4, 5, 8, 10A, 12, 14. Final. April.

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 122

Navy Remedial Project Manager: Teresa Bernhard

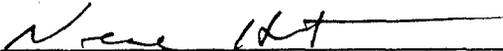
PRC Project Manager: Neal Hutchison

NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA

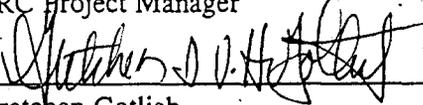
SITE 4 AND 5 CHLORINATED SOLVENT PLUME DEFINITION
AND SITE 14 SUMP INVESTIGATION
QUALITY ASSURANCE PROJECT PLAN

REVIEWS AND APPROVALS

Prepared by:


Date: 12/11/97

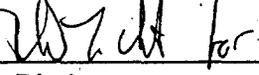
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ABBREVIATIONS AND ACRONYMS

CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CRDL	contract-required detection limit
CRQL	contract-required quantitation limit
COC	chain-of-custody
CTO	contract task order
DOT	Department of Transportation
DQO	data quality objectives
DTSC	California Department of Toxic Substances Control
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FTL	field team leader
GC/MS	gas chromatograph/mass spectrometer
IDW	Investigative Derived Waste
LCS	laboratory control sample
LUFT	leaking underground fuel tank
MS/MSD	matrix spike/matrix spike duplicate
NAS	Naval Air Station
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PRC	PRC Environmental Management, Inc.
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
QCSR	quality control summary report
RPD	relative percent difference
RWQCB	San Francisco Bay Regional Water Quality Control Board
SDG	sample delivery group
SOW	statement of work
SVOC	semivolatile organic compound
SWRCB	California State Water Resources Control Board
TEPH	total extractable petroleum hydrocarbons
TPPH	total purgeable petroleum hydrocarbons
VOC	volatile organic compound

1.0 INTRODUCTION

This quality assurance project plan (QAPP) specifies the procedures, and quality assurance/quality control (QA/QC) requirements necessary to collect environmental data of sufficient quantity and quality to meet the project objectives identified for the additional groundwater investigation of Sites 4 and 5, and the investigation of the water collection sump at Site 14, at NAS Alameda. The QAPP specifies how QA/QC activities will be planned, implemented, and assessed for the duration of the project.

This QAPP has been prepared in accordance with the U.S. Environmental Protection Agency's (EPA) guidance document "Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5 (EPA 1994a). EPA QA/R-5 states that the requirements for a QAPP are that (1) data quality objectives (DQO) are identified, (2) the intended measurements and data acquisitions are appropriate, (3) the QA/QC is sufficient for confirming the quality of data, and (4) limitations on the use of the data can be identified. These QAPP requirements have been presented as four components: (1) quality objectives and criteria for measurement data, (2) documentation and records, (3) measurement and data acquisition, and (4) assessment and oversight.

2.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Data quality objectives (DQO) are qualitative and quantitative statements developed by data users to specify the quality of data needed from a particular data collection activity to support specific decisions or regulatory actions. The DQOs developed for the additional groundwater investigation of Sites 4, and 5 and the water collection sump at Site 14, determine whether analytical data will be one of two data categories: screening or definitive. Each of these categories is defined by specific QA/QC procedures using a wide range of analytical methods. Following selection of the data category, the appropriate analytical method is selected and measurement objectives are defined.

Measurement objectives are described as the critical indicator parameters of data quality, and are precision, accuracy, representativeness, completeness, and comparability (PARCC). The following subsections discuss and provide definitions for the data categories, PARCC parameters, and quantitation limits.

2.1 SITE BACKGROUND AND DATA QUALITY OBJECTIVES

The history of Sites 4, 5, and 14 at Naval Air Station (NAS) Alameda, and all previous investigations, are explained in the work plan and are not repeated in this QAPP.

For Sites 4 and 5, the Navy is conducting the groundwater investigation to collect discrete chemical data that will show the characteristics, locations, and dimensions of chlorinated solvent plumes caused by past releases at Site 4 and Site 5. The Navy will use the data from this investigation to determine the applicability of bioremediation of chlorinated solvents in groundwater at NAS Alameda and to perform a human health and environment risk assessment.

The investigation in the vicinity of the water collection sump at Site 14 is being performed to assess the impact of previous fire fighting training activities on the surrounding soil and groundwater. The Navy is conducting this investigation to collect information needed to adequately assess if a risk to human health and/or the environment exists at Site 14.

Sampling objectives and design are presented in Section 4.0 of the work plan. Based on the sampling objectives and design, screening level data and definitive data will be collected to support the Sites 4 and 5 groundwater investigation and definitive data, only, will be collected to support the investigation of the water collection sump at Site 14.

2.2 DATA CATEGORIES

The following definitions for screening data and definitive data are from "Data Quality Objectives Process for Superfund Interim Final Guidance" (EPA 1993).

Screening Data

Screening data are data generated by rapid, less precise methods of analysis with less rigorous sample preparation. Screening data provides rapid results for decision making in the field. Screening data provide analyte identification and quantification, although quantification may be relatively imprecise. At least 10 percent of the screening data are confirmed using analytical methods and QA/QC

procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality. The minimum QA/QC elements required for the screening data are:

- Sample documentation (location, date and time collected, batch, etc.).
- Chain of custody (when appropriate).
- Sampling design approach (systematic, simple or stratified random, judgmental, etc.).
- Initial and continuing calibration.
- Determination and documentation of detection limits.
- Analyte(s) identification.
- Analyte(s) quantitation.

- Analytical error determination or duplicate precision: an appropriate number of replicate aliquots, as specified in the QAPP and FSPs, are taken from at least one thoroughly homogenized sample, the replicate aliquots are analyzed, and standard laboratory QC parameters (such as variance, mean, and coefficient of variation or relative percent difference) are calculated and compared to method-specific performance requirements specified in the QAPP.

- Definitive confirmation: at least 10 percent of the screening data must be confirmed with definitive data as described below. As a minimum, at least three screening samples reported above the action level (if any) and three screening samples reported below the action level (or as non-detects, ND) should be randomly selected from the appropriate group and confirmed.

For the Sites 4 and 5 groundwater profiling, a modified version of EPA method 8260A (EPA 1986) will be used to analyze water samples for chlorinated volatile organic compounds (VOC). Performance criteria for this EPA protocol have been modified for implementation in the field. The modified performance criteria for screening data are described in Section 4 of this QAPP.

Definitive Data

Definitive data are data generated using rigorous analytical methods, such as approved EPA reference methods. Definitive data provide defensible data useable for characterization and assessment purposes. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data in the form of paper printouts or computer-generated electronic files. Data may be

generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined. QA/QC elements required for definitive data include the following:

- Sample documentation (location, date and time collected, batch, etc.)
- Chain-of-custody (when appropriate)
- Sampling design approach (systematic, simple or stratified random, judgmental)
- Initial and continuing calibration
- Determination and documentation of detection limits
- Analyte identification
- Analyte quantitation
- QC blanks (trip, method, rinsate)
- Matrix spike recoveries
- Performance evaluation samples (when specified)

- Matrix duplicate. For two or more aliquots this is also referred to as the analytical error determination (measures precision of analytical method): an appropriate number of replicate aliquots, as specified in the QAPP, are taken from at least one thoroughly homogenized sample, the replicate aliquots are analyzed, and standard laboratory QC parameters are calculated and compared to method-specific performance requirements defined in the QAPP.

- Field duplicates or total measurement error determination (measures overall precision of measurement system, from sample acquisition through analysis): an appropriate number of co-located samples are independently collected from the same location and analyzed following standard operating procedures. The variance, mean, coefficient of variation, or relative percent difference are calculated for specific matrices.

Analytical methods for the collection of definitive data are described in Section 4 of this QAPP.

2.3 PARCC CRITERIA

PARCC are critical indicators of project data quality (EPA 1987a). Measurement objectives for these indicator parameters were developed based on past experience of the project, limitations of the analytical methods, and on the project DQOs. The following sections describe the PARCC parameters.

2.3.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under prescribed similar conditions. For duplicate measurements, precision is expressed as the relative percent difference (RPD) of the pair and is calculated using the following:

$$RPD = \frac{|D_1 - D_2|}{\frac{1}{2}(D_1 + D_2)} \times 100\%$$

where: D_1 = Concentration of analyte in original sample
 D_2 = Concentration of analyte in duplicate sample

The precision of chemical analyses or analytical methods will be assessed through the analysis of matrix spike/matrix spike duplicate (MS/MSD) samples and matrix duplicate samples. Each QC sample type will provide unique information regarding the precision of the laboratory programs, as described below:

- MS/MSD samples: Laboratory analytical precision for organic analyses
- Matrix duplicate samples: Laboratory analytical precision for inorganic/physical parameters

Precision acceptance criteria for duplicate and MS/MSD samples for all analytical methods are presented in Section 4 of this QAPP. Due to the non-homogeneous nature of soil samples, collection of field duplicate samples is not planned for soil samples collected at Site 14.

The precision for field measurements will be evaluated based on the results of duplicate measurements. At least 10 percent of the field screening measurements will be obtained in duplicate. In addition, confirmation samples (definitive data confirming field screening data) will be collected at the frequency of at least 10 percent of the samples collected as screening data.

The precision between confirmation data and screening data is limited to the precision of the selected screening method, since the screening data have the least stringent QA/QC criteria and confirmation data have the most stringent QA/QC criteria. However, if the precision between confirmation data and

screening data is determined to be outside the acceptance criteria, the screening data may still be useful. For example, there may be a useful correlation between confirmation sample results with screening results; even if the screening results are discovered to be consistently biased high (or low). In these cases, the DQO for the screening data will be considered as to whether the screening data can be used in the absence of good precision with confirmation data.

When analytes are present in samples either near the method detection limit or substantially above the detection limit, the precision objectives for MS/MSD analyses may not be appropriate. If precision objectives are not met, other QC data will be evaluated to determine the validity of the data.

2.3.2 Accuracy

Accuracy refers to the degree to which a measurement agrees with its true value. The accuracy of an analytical measurement is impacted by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques. Sampling accuracy will be evaluated based on the analytical results of the field blanks, trip blanks, and equipment rinsate blanks. To evaluate laboratory accuracy, a program of sample spiking will be conducted by the analytical laboratory. This program includes the analysis of MS/MSD samples, laboratory control samples (LCS) or blank spikes, and surrogate standards. MS/MSD samples are analyzed at a frequency of 5 percent; LCS or blank spike at a frequency of 5 percent; and surrogate standards, where applicable, are added to every sample analyzed for organic constituents.

Accuracy is expressed in terms of percent recovery and is calculated by the following equation:

$$\text{Percent Recovery} = \frac{(\text{Measured Spike Value} - \text{Unspiked Value})}{(\text{Known Spiked Value})} \times 100\%$$

The results of spiked samples are expressed as percent recovery and will provide information on positive and negative bias. Accuracy goals for each specific method are presented in Section 4 of this QAPP.

2.3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, parameter variations at a sampling point, or an environmental condition they are intended to represent. Representativeness is a qualitative parameter; hence, no specific criteria must be met. For this project, representative data will be obtained through the careful selection of sampling locations and analytical parameters, the proper collection and handling of samples to avoid interferences and minimize sample contamination and loss of analytes, and the use of standardized field and laboratory procedures and their consistent application. To aid in the evaluation of the representativeness of each sample, field- and laboratory-required blank samples are evaluated for the presence of contaminants. Method blank samples will be considered in evaluating the validity of the data when there are problems with contamination in any samples.

2.3.4 Completeness

Completeness is defined as the percentage of measurements that are judged valid. The project completeness value will be determined at the conclusion of the data validation phase and will be calculated by dividing the number of complete, valid sample results by the total number of sample analyses planned for the project. The data validation process will determine whether a particular data point is a valid result that is acceptable for all uses, an estimated result that is acceptable for limited uses, or a rejected result that is unacceptable for any use. Complete results are defined as results that are considered valid and include estimated results. Sample results that are considered rejected, unacceptable, and unusable when compared to QC criteria are listed as incomplete. The completeness objective for both the groundwater investigation at Sites 4 and 5 and the investigation of the water collection sump at Site 14 is 95 percent for definitive data and field screening data. For the groundwater investigation at Sites 4 and 5, field screening samples will be used to select confirmation samples. However, if a screening sample cannot be analyzed by the field technique due to interferences in the sample matrix or some other problem, a sample for definitive data will be collected.

2.3.5 Comparability

Comparability is a qualitative parameter that expresses the confidence with which one data set may be compared to another. This goal is achieved through the use of standardized techniques to collect samples, the use of standardized analytical methods, and the use of appropriate units to report analytical results. All analytical laboratories performing work for the Navy must comply with PRC's Comprehensive Long-term Environmental Action Navy (CLEAN) II laboratory services statement of work (SOW) (PRC 1995), which specifies analytical protocols, QC criteria, and standard deliverables, promoting comparable data.

2.4 DETECTION AND QUANTITATION LIMITS

The instrument detection limit is the minimum concentration of an analyte that can be distinguished from the normal electronic "noise" of an analytical instrument, and is statistically determined. The quantitation limit is the lowest concentration at which an analyte can be accurately and reproducibly quantified. Quantitation limits vary depending on instrument sensitivity and sample matrix effects. Contract-required detection limits (CRDL) and contract-required quantitation limits (CRQL) are the minimum quantitation limits that are contractually required for analyses performed under EPA CLP protocols. Lead analyzed using the CLP method is required to be reported to the CRDL. PCBs analyzed by the CLP method are required to be reported to the CRQL. All CRQLs, CRDLs, and quantitation limits are reported based on the dry weight of the sample. In other words, quantitation limits are adjusted based on moisture content of the soil. Detection limits and quantitation limits for each specific method are presented in Section 4 of this QAPP.

3.0 DOCUMENTATION AND RECORDS

This section describes the field documentation requirements for the proposed field activities for the Sites 4,5, and 14 investigations and includes the overall sample handling process.

3.1 SAMPLE IDENTIFICATION

Samples will be identified to provide a means of tracking each sample from collection through analysis, data reduction, reporting, and validation. A field identification system and a laboratory identification

system have been established for NAS Alameda to efficiently manage sample tracking and referencing and to provide a means of submitting blind samples to the laboratory. The following subsections describe sample identification procedures in detail.

3.1.1 Field Identification System

All samples collected will be assigned a field number on the basis of an alphanumeric code that will be unique and easily transcribed. Samples collected at Sites 4 and 5 will be identified with a three-part identification code consisting of site number, boring number, and sample depth as follows:

<u>Site Number</u>	<u>Boring Number</u>	<u>Sample Depth</u>
S04	1-2	5.5

The site number designates which site the sample was collected. The boring number designates the push-sampling location within the site as presented in Tables 5-1 and 5-2 in the work plan. The sample depth indicates the top depth in feet at which the sample was collected.

Samples collected at Site 14 will be identified with a three-part identification code consisting of site number, sample number, and depth as follows:

<u>Site Number</u>	<u>Sample Number</u>	<u>Sample Depth</u>
S14	Sump-01	0.0

The site number designates which site the sample was collected. The sample number represents a discrete identification for each soil sample collected from around the excavated sump. The sample depth indicates the top depth in feet at which the sample was collected.

3.1.2 Laboratory Identification System

Each sample will be assigned a unique identifier, apart from the field identification number, to provide a means of submitting the samples blind to the laboratory. The number will be based on a three-part alphanumeric code, as follows:

<u>CTO Number</u>	<u>Site Code</u>	<u>Sample Number</u>
122	S04	001

The "122" represents CLEAN II contract task order (CTO) number 122, under which the field work and sample analyses will be performed. The "S04" references the site from which the samples are collected. The last set of numbers represent an arbitrary sample number, sequentially assigned to each sample, including any field QC samples. This number will be used to cross-reference the field identification number.

Because the sampling design described in Section 4 of the work plan requires decision making in the field with respect to where samples will be collected and at what depth, Table A-1 presents only the field and laboratory identification numbers for the initial samples to be collected for the Sites 4 and 5 groundwater profiling. Additional sampling may be required based on field data from the initial samples; therefore, Table A-1 will be updated with additional sample information throughout the project. Corresponding field identification numbers and the analytical methods to be performed for each sample are also given. Field and laboratory identification numbers, the corresponding field identification numbers and, the analytical methods to be performed for all soil samples to be collected at Site 14 are presented in Table A-2

**TABLE A-1
FIELD AND LABORATORY IDENTIFICATION NUMBERS
FOR SOIL, GROUNDWATER, AND QUALITY CONTROL SAMPLES
FOR SITES 4 AND 5, NAS ALAMEDA**

Laboratory Identification	Field Identification	Matrix	VOC Field-Lab Analysis	VOC Fixed-Lab Analysis*	Field Duplicate
122-S04-001	S04-1-1-5.5	Water	x		x
122-S04-002	S04-1-3-15.5	Water	x		
122-S04-003	S04-2-1-5.5	Water	x		
122-S04-004	S04-2-2-7.5	Water	x		
122-S04-005	S04-2-3-5.5	Water	x		
122-S04-006	S04-2-3-7.5	Water	x		
122-S04-007	S04-2-3-9.5	Water	x		
122-S04-008	S04-2-4-15.5	Water	x		
122-S04-009	S04-2-4-20	Water	x		
122-S04-010	S04-2-4-25	Water	x	x	

TABLE A-1 (continued)
 FIELD AND LABORATORY IDENTIFICATION NUMBERS
 FOR SOIL, GROUNDWATER, AND QUALITY CONTROL SAMPLES
 FOR SITES 4 AND 5, NAS ALAMEDA

Laboratory Identification	Field Identification	Matrix	VOC Field-Lab Analysis	VOC Fixed-Lab Analysis*	Field Duplicate
122-S04-011	S04-2-4-30	Water	x		x
122-S04-012	S04-3-1-5.5	Water	x		
122-S04-013	S04-3-1-13.5	Water	x		
122-S04-014	S04-3-1-15.5	Water	x		
122-S04-015	S04-3-2-7.5	Water	x		
122-S04-016	S04-3-2-9.5	Water	x		
122-S04-017	S04-3-2-11.5	Water	x		
122-S04-018	S04-3-2-20	Water	x		
122-S04-019	S04-3-2-25	Water	x		
122-S04-020	S04-3-2-30	Water	x	x	
122-S04-021	S04-3-3-5.5	Water	x		x
122-S04-022	S04-3-3-7.5	Water	x		
122-S04-023	S04-3-3-11.5	Water	x		
122-S04-024	S04-3-3-20	Water	x		
122-S04-025	S04-3-3-25	Water	x		
122-S04-026	S04-3-3-30	Water	x		
122-S04-027	S04-3-4-9.5	Water	x		
122-S04-028	S04-3-4-20	Water	x		
122-S04-029	S04-3-4-25	Water	x		
122-S04-030	S04-3-4-30	Water	x	x	
122-S04-031	S04-3-5-13.5	Water	x		x
122-S04-032	S04-3-5-15.5	Water	x		
122-S04-033	S04-4-2-5.5	Water	x		
122-S04-034	S04-4-2-11.5	Water	x		
122-S04-035	S04-4-3-9.5	Water	x		
122-S04-036	S04-4-3-11.5	Water	x		
122-S04-037	S04-4-3-20	Water	x		
122-S04-038	S04-4-3-25	Water	x		
122-S04-039	S04-4-3-30	Water	x		
122-S04-040	S04-5-3-13.5	Water	x	x	
122-S04-041	S04-5-3-15.5	Water	x		x

TABLE A-1 (continued)
FIELD AND LABORATORY IDENTIFICATION NUMBERS
FOR SOIL, GROUNDWATER, AND QUALITY CONTROL SAMPLES
FOR SITES 4 AND 5, NAS ALAMEDA

Laboratory Identification	Field Identification	Matrix	VOC Field-Lab Analysis	VOC Fixed-Lab Analysis*	Field Duplicate
122-S04-042	Rinsate-01	Water	x		
122-S04-043	Rinsate-02	Water	x		
122-S04-044	Rinsate-03	Water	x		
122-S04-045	Rinsate-04	Water	x		
122-S04-046	Rinsate-05	Water	x	x	
122-S04-047	Trip Blank-01	Water		x	
122-S04-048	Trip Blank-02	Water		x	
122-S04-049	Trip Blank-03	Water		x	
122-S04-050	Trip Blank-04	Water		x	
Site 4 sample numbers to be continued as necessary based on field decisions					
122-S05-001	S05-1-1-11.5	Water	x		x
122-S05-002	S05-1-1-13.5	Water	x		
122-S05-003	S05-1-1-15.5	Water	x		
122-S05-004	S05-1-2-11.5	Water	x		
122-S05-005	S05-1-2-13.5	Water	x		
122-S05-006	S05-1-2-15.5	Water	x		
122-S05-007	S05-1-2-20	Water	x		
122-S05-008	S05-1-2-25	Water	x		
122-S05-009	S05-1-2-30	Water	x		
122-S05-010	S05-1-3-20	Water	x	x	
122-S05-011	S05-1-3-25	Water	x		x
122-S05-012	S05-1-3-30	Water	x		
122-S05-013	S05-2-1-7.5	Water	x		
122-S05-014	S05-2-1-11.5	Water	x		
122-S05-015	S05-2-1-13.5	Water	x		
122-S05-016	S05-2-1-15.5	Water	x		
122-S05-017	S05-2-3-7.5	Water	x		
122-S05-018	S05-2-3-11.5	Water	x		
122-S05-019	S05-2-3-13.5	Water	x		
122-S05-020	S05-2-3-15.5	Water	x	x	
122-S05-021	S05-3-2-5.5	Water	x		x

TABLE A-1 (continued)
FIELD AND LABORATORY IDENTIFICATION NUMBERS
FOR SOIL, GROUNDWATER, AND QUALITY CONTROL SAMPLES
FOR SITES 4 AND 5, NAS ALAMEDA

Laboratory Identification	Field Identification	Matrix	VOC Field-Lab Analysis	VOC Fixed-Lab Analysis ^a	Field Duplicate
122-S05-022	S05-3-2-7.5	Water	x		
122-S05-023	S05-3-2-11.5	Water	x		
122-S05-024	S05-3-2-15.5	Water	x		
122-S05-025	S05-3-2-25	Water	x		
122-S05-026	S05-3-3-5.5	Water	x		
122-S05-027	S05-3-3-7.5	Water	x		
122-S05-028	S05-3-3-9.5	Water	x		
122-S05-029	S05-3-3-13.5	Water	x		
122-S05-030	S05-3-3-20	Water	x	x	
122-S05-031	S05-4-2-5.5	Water	x		x
122-S05-032	S05-4-2-7.5	Water	x		
122-S05-033	S05-4-2-9.5	Water	x		
122-S05-034	S05-4-2-13.5	Water	x		
122-S05-035	S05-4-2-20	Water	x		
122-S05-036	S05-4-3-5.5	Water	x		
122-S05-037	S05-4-3-7.5	Water	x		
122-S05-038	S05-4-3-11.5	Water	x		
122-S05-039	S05-4-3-15.5	Water	x		
122-S05-040	S05-4-3-25	Water	x	x	
122-S05-041	Rinsate-01	Water	x		x
122-S05-042	Rinsate-02	Water	x		
122-S05-043	Rinsate-03	Water	x		
122-S05-044	Rinsate-04	Water	x		
122-S05-045	Rinsate-05	Water	x	x	
122-S05-046	Trip Blank-01	Water		x	
122-S05-047	Trip Blank-02	Water		x	
122-S05-048	Trip Blank-03	Water		x	
122-S05-049	Trip Blank-04	Water		x	
Site 5 sample numbers to be continued as necessary based on field decisions					

Notes:

- a
- VOC Field Lab Analysis - Fixed laboratory analysis performed at a rate of 10 percent
- VOC Fixed Lab Analysis - volatile organic compounds by EPA method 8260A modified for field
- volatile organic compounds by CLP

TABLE A-2
FIELD AND LABORATORY IDENTIFICATION NUMBERS
FOR SOIL, GROUNDWATER, AND QUALITY CONTROL SAMPLES
FOR SITE 14, NAS ALAMEDA

Laboratory Identification	Field Identification	Matrix	VOC	SVOC	PEST / PCB	TPPH	TEPH	METALS	DIOXINS	FIELD DUP
122-S14-001	Sump-01	Soil	x	x	x	x	x	x	x	x
122-S14-002	Sump-02	Soil	x	x	x	x	x	x	x	
122-S14-003	Sump-03	Soil	x	x	x	x	x	x	x	
122-S14-004	Sump-04	Soil	x	x	x	x	x	x	x	
122-S14-005	Sump-05	Soil	x	x	x	x	x	x	x	
122-S14-006	Sump-06	Soil	x	x	x	x	x	x	x	
122-S14-007	IDW-01	Soil	x	x	x	x	x	x	x	
122-S14-008	IDW-02	Water	x	x	x	x	x	x	x	
122-S14-009	Rinsate-01	Water	x	x	x	x	x	x	x	
122-S14-009	Trip Blank-01	Water	x							

Notes:

VOC - Volatile organic compounds
SVOC - Semivolatile organic compounds
PEST/PCB - Organochlorine pesticides and polychlorinated biphenyls
TPPH - Total purgeable petroleum hydrocarbons
TEPH - Total extractable petroleum hydrocarbons

METALS - Total metals
DIOXINS - Polychlorinated dioxins and furans
FIELD DUP - Field Duplicate
IDW - Investigative Derived Waste

3.2 SAMPLE HANDLING

Sample collection methods are described in the work plan. Sample handling procedures are described in the following sections.

3.2.1 Sample Containers and Labels

Soil and groundwater samples will be containerized as described in the work plan. The contracted laboratory will provide clean containers with caps, which meet EPA CLP container guidelines for CLP methods. A sample label will be affixed to each sample container sent to the laboratory. The sample label will be completed in indelible ink and include the following information:

- Project name and location: NAS Alameda
- Site name: S14
- Laboratory identification number: 122-S14-001
- Date of sample collection: x/xx/97
- Preservative used: N/A
- Sampler's initials: XXX
- Sample type: Soil/Water
- Analyses requested: VOCs

After the label has been affixed to the sample container, the label will be covered with a wide strip of clear strapping tape to protect it from moisture damage during shipment and storage.

3.2.2 Custody Seals

To ensure that no tampering occurs, PRC will place custody seals on each cooler used to ship samples. Custody seals used during the course of the project will consist of security tape with the date and initials of the sampler. Two seals will be placed on each cooler so that they must be broken to gain access to the contents. Clear tape will be placed over the custody seals to protect them from accidental breakage.

3.2.3 Chain-of-Custody

Chain-of-custody (COC) procedures provide an accurate written record that traces the possession of individual samples from the time of field collection through laboratory analysis. A sample is considered in custody if it meets one of the following criteria:

- In a person's possession
- In view after having been in physical custody
- In a secure area after having been in physical custody
- In a designated secure area to which access is restricted to authorized personnel

A COC record will be used to document the samples collected and the analyses requested. Information that field personnel will record on the COC record includes the following:

- Project name and number
- Name and signature of sampler(s)
- Destination of samples (name of laboratory)
- Laboratory identification number
- Date and time of collection
- Sample designation (grab or composite)
- Sampling location
- Signatures of personnel involved in custody transfer
- Date and time of all transfers
- Air bill number, if applicable
- Number and size of containers
- Preservatives used, if any
- Sample matrix
- Analyses required
- Contract number (in upper left corner)

Unused lines on the COC record will be crossed out. COC records initiated in the field will be signed, placed in a plastic resealable bag, and taped to the inside of the shipping container used for sample

transport. Signed air bills will serve as evidence of custody transfer between the field sampler and courier, and between the courier and the laboratory. Copies of the COC record and the air bill will be retained and filed by the sampler prior to shipment.

Upon receipt of an ice chest or shipping container, laboratory personnel will review the contents and will sign and retain the COC record and the air bill. Information that will be recorded on the COC record in the remarks column, or on another appropriate document, at the time of sample receipt will include the following, as appropriate:

- Status of custody seals
- Temperature of ice chest upon receipt
- Identification number of broken sample containers, if any
- Description of discrepancies between the COC record, sample labels, and requested analyses
- Observations of visible headspace in sample bottles, indicating inadequate sample collection

Laboratory personnel will contact the PRC project chemist regarding discrepancies in paperwork and sample preservation, and will document non-conformances and corrective actions in accordance with laboratory standard operating procedures.

After samples have been accepted by the laboratory, checked, and logged in, they will be maintained in a manner consistent with custody and security requirements specified in the EPA CLP SOW.

3.2.4 Sample Preservation and Holding Times

Methods of sample preservation are relatively limited and are generally intended to (1) retard biological degradation, (2) retard chemical degradation, and (3) reduce container adsorption effects. The proposed soil samples will be preserved by refrigeration to 4 °C, in accordance with EPA CLP protocols for CLP methods.

Upon receipt of the samples from the shipping company, the laboratory will make every effort to analyze all samples within the specified holding times for each analytical method. The field team will coordinate all sample shipments with the laboratory to reduce the possibility of these analyses exceeding the specified holding times. Holding times are presented in Table A-3.

3.2.5 Sample Packaging and Shipping

All soil samples collected during this project will be identified as environmental samples for the purpose of shipment. Environmental samples are defined as soil, water, or sediment that is not saturated with product material. All Department of Transportation (DOT) regulations will be followed for packaging and shipment. The following procedures, which are taken from EPA guidance on field operations methods (EPA 1987b), meet these DOT requirements.

- An ice chest will be lined with a large plastic bag. After the bag is in place, the ice chest will be filled with sample bottles that have been wrapped in bubble-wrap plastic. Any additional space between bottles will be filled with styrofoam, starch peanuts, or shredded paper. Sufficient packing material will be used to prevent sample containers from making contact during shipment. Sufficient bagged ice or blue ice will be added to the samples to maintain the ice chest at a temperature of 4°C during shipping. The large plastic bag will be securely taped shut to prevent leakage.
- COC records will be sealed in plastic bags and taped to the inside of the ice chest lid.
- The ice chest will be closed and taped shut with filament-type strapping tape on both ends. If the ice chest contains a drain, the drain will be taped closed both inside and outside.
- The ice chest will be custody-sealed by placing a short length of custody tape across the opening of the ice chest lid at two places—one on the front and one on the side of the ice chest. The custody tape will then be signed and dated.
- An air bill will be prepared and affixed to the lid of the ice chest. The ice chest may then be handed over to the specified overnight carrier, such as Federal Express or United Parcel Service, for shipment.

No samples will be held on site for more than 24 hours, except when weekend sampling occurs. Samples collected on weekends will be refrigerated and shipped on the next available working day.

TABLE A-3
CONTAINERS, PRESERVATION, AND HOLDING TIME REQUIREMENTS
FOR SOIL, WATER, AND QUALITY CONTROL SAMPLES
NAS ALAMEDA

Parameter	Matrix	EPA Method	Sample Container	Number of Containers	Preservative	Holding Time
VOCs	Soil	CLP	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	14 days
	Water		40mL vials with Teflon-lined cap	3	HCL to pH < 2, Cool, 4°C	14 days
SVOCs	Soil	CLP	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	14 days to extraction; additional 40 days to analysis
	Water		1-liter Amber glass bottle with Teflon-lined cap	2	Cool, 4°C	7 days to extraction; additional 40 days to analysis
Organochlorine pesticides and PCBs	Soil	CLP	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	14 days to extraction; additional 40 days to analysis
	Water		1-liter Amber glass bottle with Teflon-lined cap	2	Cool, 4°C	7 days to extraction; additional 40 days to analysis
TPPH	Soil	8015M	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	14 days
	Water		40mL vials with Teflon-lined cap	3	Cool, 4°C	14 days
TEPH	Soil	8015M	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	14 days to extraction; additional 40 days to analysis
	Water		1-liter Amber glass bottle with Teflon-lined cap	2	Cool, 4°C	7 days to extraction; additional 40 days to analysis
Metals	Soil	CLP	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	Mercury 28 days; all others 6 months
	Water		1-liter polyethylene bottle	1	HNO ₃ to pH < 2 Cool, 4°C	Mercury 28 days; all others 6 months
Polychlorinated Dioxins and Furans	Soil	8280	6-inch tube with Teflon-lined cap or 16-oz glass jar	1	Cool, 4°C	30 days to extraction; completely analyzed within 45 days of extraction
	Water		1-liter Amber glass bottle with Teflon-lined cap	2	Cool, 4°C	

Notes:

CLP U.S. EPA Contract Laboratory Program
 SVOC Semivolatile organic compounds
 TPPH Total purgeable petroleum hydrocarbons
 TEPH Total extractable petroleum hydrocarbons

VOC Volatile organic compounds
 PCB Polychlorinated biphenyls
 HNO₃ Nitric acid
 HCl Hydrochloric acid

3.3

FIELD DOCUMENTATION

Sampling activities during the field work require several forms of documentation to maintain sample identification, COC, and to record significant events or observations. Required documentation will include the use of logbooks and field change request forms.

3.3.1 Logbooks

Logbooks are hardbound notebooks in which all activities associated with the field investigation will be thoroughly described. Logbooks are intended to provide sufficient data to reconstruct events occurring during the field project. A field sampling logbook will be kept by the PRC field team leader (FTL). Information regarding sampling activities will be recorded within the field sampling logbook and will include, at a minimum, the following:

- Personnel on site
- Weather Conditions
- Sampling and shipping summary
 - Air bill number
 - COC number
 - Sample destination
 - Time of pickup
- Stop and start times for sampling activities at each location
- Description of any problems encountered during sampling at each location
- Description of deviations from the work plan

Other appropriate observations may be included.

3.3.2 Field Change Request Forms

Field change request forms provide a written record documenting proposed changes to project plans including the work plan, the health and safety plan, and the QAPP. Any request will include the rationale for the proposed changes and the anticipated impacts of the deviation. The form will be signed by appropriate project personnel, including the PRC field team leader, the PRC health and

safety program officer, and the PRC project manager. Approval of the change by the Navy may be required before any change to the field program is implemented.

3.4 LABORATORY DOCUMENTATION

The laboratory will provide data packages in accordance with the PRC CLEAN II laboratory services SOW (PRC 1995).

The data package will include two copies of a summary data package containing the following:

- Case narrative
- Copies of non-conformance/corrective action forms
- Chain-of-custody forms
- Tracking documents
- Sample results
- QA/QC summaries

The data package will also include requirements for a full data package that includes the following:

- Sample raw data
- QC raw data
- Standard raw data
- Instrument raw data
- Other raw data

3.5 DATA VALIDATION AND QUALITY CONTROL SUMMARY REPORTS

Data validation is the process by which the laboratory data package, or sample delivery group (SDG), is technically evaluated by a party independent of the laboratory.

The laboratory will analyze samples in SDGs that consist of no more than 20 samples each. The validation reviewer will prepare a validation narrative for each SDG. Each validation narrative will contain a list of the samples in the SDG, the analyses performed, the identity of the samples receiving full validation, and the results of validation for each methodology.

During data validation, the validation reviewer will complete worksheets that document the criteria reviewed. These worksheets will be used to generate the validation narrative. The worksheets are part of the complete data validation report that will be kept on file in PRC's Sacramento office.

Once the analytical data have been received from the laboratory and the data validation has been performed, a quality control summary report (QCSR) will be prepared. The QCSR summarizes the data validation reports, the project goals, the PARCC criteria, and evaluates the ability of the analytical data to support the project DQOs. The QCSR will include the following information:

- Tabulated, validated data tables
- Data validation narratives
- Evaluation of PARCC criteria

The QCSR is intended to provide a general overview of data quality and the data validation reports. Specific details may be found in the data validation narratives which are included in the appendix of the QCSR.

4.0 MEASUREMENT AND DATA ACQUISITION

The following sections describe the field and laboratory methods and QA/QC requirements associated with sampling and analyses of soil and groundwater samples collected during the project.

4.1 FIXED LABORATORY ANALYSES

Soil and groundwater samples sent to the fixed laboratory for analysis of VOCs, SVOCs, Pest/PCBs, and Metals will be analyzed using EPA CLP methods. For organic analyses, samples will be analyzed according to the CLP SOW OLM03.1 protocol (EPA 1994b). For metals analyses, samples will be analyzed according to the CLP SOW ILM04.0 protocol (EPA 1995). Samples submitted to the laboratory for analysis of polychlorinated dioxins and furans will be analyzed using EPA method 8280 (EPA 1986).

Total petroleum hydrocarbons in soil and water samples will be analyzed in accordance with the *Leaking Underground Fuel Tank (LUFT) Field Manual* (California State Water Resources Control Board [SWRCB] 1988) and by EPA Method 8015 (EPA 1986), modified for both purgeable and extractable petroleum hydrocarbons. The calibration fuel for purgeable petroleum hydrocarbons will be gasoline. The calibration fuel for extractable petroleum hydrocarbons will be diesel No.2 and motor oil. In accordance with the PRC SOW for laboratory services (PRC 1995), the laboratory will appropriately flag any chromatographic patterns for samples not conforming to specific retention time windows or pattern recognition criteria for the calibration fuels.

Table A-4 presents the fixed laboratory analytical parameters and methods that will be used for the analysis of samples collected at NAS Alameda.

**TABLE A-4
FIXED LABORATORY
ANALYTICAL PARAMETERS AND METHODS
NAS ALAMEDA**

Parameter	Method
Volatile organic compounds	CLP SOW ^a
Semivolatile organic compounds	CLP SOW ^a
Organochlorine pesticides and polychlorinated biphenyls	CLP SOW ^a
Metals	CLP SOW ^b
Total extractable petroleum hydrocarbons	3550/8015-modified ^c
Total purgeable petroleum hydrocarbons	5030/8015-modified ^c
Polychlorinated dioxins and furans	8280 ^c

Notes:

- a Contract Laboratory Program Statement of Work for Organics Analyses, OLM03.1, August 1994
- b Contract Laboratory Program Statement of Work for Inorganics Analyses, ILM04.0, 1995
- c Test Methods for Evaluating Solid Waste, SW-846, 3rd Edition, 1986

Appropriate QA requirements are listed for all analyses in Tables A-5 through A-8. Contract required quantitation limits for CLP methods are presented in Table A-9. Quantitation limits for polychlorinated dioxins and furans are presented in Table A-10. Additional regional quantitation limits for NAS Alameda are presented in Table A-11. Quantitation limits for all other analyses shall be reported by the laboratory as required in the PRC SOW (PRC 1995) or EPA SW-846 methods manual (EPA 1986), which ever is appropriate.

TABLE A-5
 VOLATILE ORGANIC COMPOUNDS - CLP METHOD
 MATRIX SPIKE AND SURROGATE SPIKE RECOVERY LIMITS
 NAS ALAMEDA

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
1,1-Dichloroethene	61-145	14	59-172	22
Trichloroethene	71-120	14	62-137	24
Chlorobenzene	75-130	13	60-133	21
Toluene	76-125	13	59-139	21
Benzene	76-127	11	66-142	21

System Monitoring Compound	Water	Soil
	% Recovery	% Recovery
Toluene-d8	88-110	84-138
Bromofluorobenzene	86-115	59-113
1,2-Dichloroethane-d4	76-114	70-121

Note:

RPD Relative Percent Difference

TABLE A-6
SEMIVOLATILE ORGANIC COMPOUNDS - CLP METHOD
MATRIX SPIKE AND SURROGATE SPIKE RECOVERY LIMITS
NAS ALAMEDA

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Phenol	12-110	42	26-90	35
2-Chlorophenol	27-123	40	25-102	50
1,4-dichlorobenzene	36-97	28	28-104	27
N-nitroso-di-n-propylamine	41-116	38	41-126	38
1,2,4-Trichlorobenzene	39-98	28	38-107	23
4-Chloro-3-methylphenol	23-97	42	26-103	33
Acenaphthene	46-118	31	31-137	19
4-Nitrophenol	10-80	50	11-114	50
2,4-Dinitrotoluene	24-96	38	28-89	47
Pentachlorophenol	9-103	50	17-109	47
Pyrene	26-127	31	35-142	36

Surrogate Spike Compound	Water	Soil
	% Recovery	% Recovery
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
Terphenyl-d14	33-141	18-137
Phenol-d5	10-110	24-113
2-Fluorophenol	21-100	25-121
2,4,6-Tribromophenol	10-123	19-122
2-Chlorophenol-d4	33-110	20-130
1,2-Dichlorobenzene-d4	16-110	20-130

Note:

RPD Relative Percent Difference

TABLE A-7
 ORGANOCHLORINE PESTICIDES/PCBs - CLP METHOD
 MATRIX SPIKE AND SURROGATE SPIKE RECOVERY LIMITS
 NAS ALAMEDA

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Gamma-BHC (Lindane)	56-123	15	46-127	50
Heptachlor	40-131	20	35-130	31
Aldrin	40-120	22	34-132	43
Dieldrin	52-126	18	31-134	38
Endrin	56-121	21	42-139	45
4,4'-DDT	38-127	27	23-134	50

Surrogate Spike Compound	Water	Soil
	% Recovery	% Recovery
Tetrachloro-m-xylene	60-150	60-150
Decachlorobiphenyl	60-150	60-150

Note:

RPD Relative Percent Difference

TABLE A-8
CLP INORGANICS AND OTHER MISCELLANEOUS ANALYTES
ACCURACY AND PRECISION LIMITS
NAS ALAMEDA

Matrix Spike Analyte	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Metals	75-125	25	75-125	35
Total Purgeable Petroleum Hydrocarbons (TPPH)	60-140	50	60-140	50
Total Extractable Petroleum Hydrocarbons (TEPH)	40-140	50	40-140	50
Polychlorinated Dioxins and Furans (all compounds)	40-120	40	40-120	40

Surrogate Spike Compound	Water	Soil
	% Recovery	% Recovery
Surrogate Spike Compound (TPPH)	75-125	75-125
Surrogate Spike Compound (TEPH)	60-140	60-140
C ¹³ -2,3,7,8-TCDD (dioxin/furan)	40-120	40-120
C ¹³ -2,3,7,8-TCDF (dioxin/furan)	40-120	40-120
C ¹³ -1,2,3,6,7,8-HxCDD (dioxin/furan)	40-120	40-120
C ¹³ -1,2,3,4,6,7,8-HpCDF (dioxin/furan)	40-120	40-120
C ¹³ -OCDD (dioxin/furan)	40-120	40-120

Note:

RPD Relative Percent Difference
C¹³ Carbon-13
TCDD Tetrachlorodibenzo-*p*-dioxin
TCDF Tetrachlorodibenzofuran
HxCDD Hexachlorodibenzo-*p*-dioxin
HpCDF Heptachlorodibenzofuran
OCDD Octachlorodibenzo-*p*-dioxin

TABLE A-9
CLP CONTRACT REQUIRED REPORTING LIMITS
NAS ALAMEDA

Volatile Organic Compounds by CLP SOW Contract Required Quantitation Limits		
Analyte	Water ($\mu\text{g/L}$)	Soil ($\mu\text{g/kg}$)
Chloromethane	2	10
Bromomethane	2	10
Vinyl chloride	0.5	10
Chloroethane	2	10
Methylene chloride	2	10
Acetone	2	10
Carbon disulfide	2	10
1,1-Dichloroethene	2	10
1,1-Dichloroethane	2	10
1,2-Dichloroethene	2	10
Chloroform	2	10
1,2-Dichloroethane	0.5	10
2-Butanone	2	10
1,1,1-Trichloroethane	2	10
Carbon tetrachloride	0.5	10
Bromodichloromethane	2	10
1,2-Dichloropropane	2	10
cis-1,3-Dichloropropene	2	10
Trichloroethene	2	10
Dibromochloromethane	2	10
1,1,2-Trichloroethane	2	10
Benzene	1 ^a	10
trans-1,3-Dichloropropene	0.5	10
Bromoform	2	10
4-Methyl-2-pentanone	2	10
2-Hexanone	2	10
Tetrachloroethene	2	10
Toluene	2	10
1,1,2,2-Tetrachloroethane	2	10
Chlorobenzene	2	10
Ethylbenzene	2	10
Styrene	2	10
Total xylenes	2	10

TABLE A-9 (continued)
 CLP CONTRACT REQUIRED REPORTING LIMITS
 NAS ALAMEDA

Semivolatile Organic Compounds by CLP SOW Contract Required Quantitation Limits		
Analyte	Water ($\mu\text{g/L}$)	Soil ($\mu\text{g/kg}$)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	5	330
1,4-Dichlorobenzene	5	330
1,2-Dichlorobenzene	5	330
2-Methylphenol	10	330
2,2'-oxybis(1-Chloropropane)	10	330
4-Methylphenol	10	330
N-nitroso-di-n-propylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	25	800
2-Chloronaphthalene	10	330
2-Nitroaniline	25	800
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	25	800
Acenaphthene	10	330
2,4-Dinitrophenol	25	800
4-Nitrophenol	25	800

TABLE A-9 (continued)
 CLP CONTRACT REQUIRED REPORTING LIMITS
 NAS ALAMEDA

Semivolatile Organic Compounds by CLP SOW Contract Required Quantitation Limits		
Analyte	Water ($\mu\text{g/L}$)	Soil ($\mu\text{g/kg}$)
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl-phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	25	800
4,6-Dinitro-2-methylphenol	25	800
N-Nitrosodiphenylamine	10	330
4-Bromophenyl-phenyl ether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	25	800
Phenanthrene	10	330
Anthracene	10	330
Carbazole	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330
3,3'-Dichlorobenzidine	10	330
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	4	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenzo(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

TABLE A-9 (continued)
 CLP CONTRACT REQUIRED REPORTING LIMITS
 NAS ALAMEDA

Organochlorine Pesticides and PCBs by CLP SOW Contract Required Quantitation Limits		
Analyte	Water ($\mu\text{g/L}$)	Soil ($\mu\text{g/kg}$)
α -BHC	0.05	1.7
β -BHC	0.05	1.7
δ -BHC	0.05	1.7
γ -BHC (Lindane)	0.05	1.7
Heptachlor	0.05	1.7
Aldrin	0.05	1.7
Heptachlor epoxide	0.05	1.7
Endosulfan I	0.05	1.7
Dieldrin	0.1	3.3
4,4'-DDE	0.1	3.3
Endrin	0.1	3.3
Endosulfan II	0.1	3.3
4,4'-DDD	0.1	3.3
Endosulfan sulfate	0.1	3.3
4,4'-DDT	0.1	3.3
Methoxychlor	0.5	17
Endrin ketone	0.1	3.3
α -Chlordane	0.05	1.7
γ -Chlordane	0.05	1.7
Toxaphene	5	170
Aroclor 1016	1	33
Aroclor 1221	2	67
Aroclor 1232	1	33
Aroclor 1242	1	33
Aroclor 1248	1	33
Aroclor 1254	1	33
Aroclor 1260	1	33

TABLE A-9 (continued)
CLP CONTRACT REQUIRED REPORTING LIMITS
NAS ALAMEDA

Metals by CLP-SOW Contract Required Detection Limits		
Analyte	Water ($\mu\text{g/L}$)	Soil ($\mu\text{g/kg}$)
Aluminum	50 ^b	5
Antimony	6 ^b	2
Arsenic	10	2
Barium	200	40
Beryllium	4 ^b	1
Cadmium	5	1
Calcium	5,000	1,000
Chromium	10	2
Cobalt	50	10
Copper	4.9 ^b	1
Iron	100	20
Lead	3	1
Magnesium	5,000	1,000
Manganese	15	3
Mercury	0.025 ^b	0.1
Molybdenum	10	2
Nickel	8.3 ^b	2
Potassium	5,000	1,000
Selenium	5	1
Silver	2.3 ^b	1
Sodium	5,000	1,000
Thallium	2 ^b	1
Vanadium	50	10
Zinc	20	4

Notes:

^a CRQL of 1.0 $\mu\text{g/L}$ was requested by the California Department of Toxic Substances Control (DTSC) to meet current California and San Francisco Bay area water quality standards.

^b CRDLs were requested by the California DTSC and the San Francisco Bay Regional Water Quality Control Board (RWQCB) to meet current California and San Francisco Bay area water quality standards.

$\mu\text{g/L}$	micrograms per liter	SOW	Statement of work
$\mu\text{g/kg}$	micrograms per kilogram	CRQL	Contract Required Quantitation Limit
CLP	Contract Laboratory Program	CRDL	Contract Required Detection Limit

TABLE A-10
SW-846 CONTRACT REQUIRED REPORTING LIMITS
NAS ALAMEDA

Polychlorinated Dioxins and Furans by EPA Method 8280 Quantitation Limits		
Analyte	Water (ng/L)	Soil (ug/kg)
Tetrachloro Dioxin and Furan	10	1.0
Pentachloro Dioxin and Furans	25	2.5
Hexachloro Dioxins and Furans	25	2.5
Heptachloro Dioxin and Furans	25	2.5
Octachloro Dioxin and Furan	50	5.0

Notes:

ng/L nanograms per liter
 ug/kg micrograms per kilogram

TABLE A-11
DTSC AND RWQCB REQUIRED REPORTING LIMITS AND
LABORATORY DETECTION LIMITS
NAS ALAMEDA

Analyte	DTSC/RWQCB Required Detection Limits Water (ug/L)	Representative Laboratory Detection Limits ^a Water (ug/L)
Aluminum	50	20
Antimony	6	60
Beryllium	4	0.7
Copper	4.9	4.0 ^b
Mercury	0.025	0.2 ^b
Nickel	8.3	9.0 ^b
Silver	2.3	1.0
Thallium	2	3.0 ^b
Benzene	1	0.5

Notes:

a Instrument detection limits are generated quarterly; therefore, actual detection limits reported for this project may vary.

b At this time, the requested detection limits are very close to the absolute instrument detection limits achievable by current industry standards; therefore, actual detection limits may not meet the current water quality standards.

ug/L micrograms per liter

4.2

GC/MS FIELD ANALYSIS

As described in Section 5 of the work plan, groundwater samples collected at Sites 4 and 5 will be analyzed on site using a mobile laboratory. The mobile laboratory will employ a gas chromatograph/mass spectrometer (GC/MS) to perform a modified EPA method 8260A for chlorinated and aromatic VOCs. The objective of the on-site laboratory is to provide screening level analytical data (Level 2). Ten percent of the samples analyzed in the field by this method will be sent to a fixed laboratory for confirmational analysis.

The field laboratory will analyze the groundwater samples for the following VOCs:

Volatile Aromatic Hydrocarbons: Benzene, toluene, ethyl benzene, and total xylenes

Volatile Chlorinated Hydrocarbons: Tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, 1,1-dichloroethene, cis and trans-1,2-dichloroethene, 1,2-dichloroethane, chloroethane, and vinyl chloride

Data quality objectives for this project require modified Level 2 analytical data. The data will be used as a screening tool to guide the investigation; however, due to the nature of the contaminants at Sites 4 and 5, positive identification of the specified compounds will be required. The data will not be used for risk assessment purposes. The following section describes specific deviance's from the method that will simplify the field implementation of EPA method 8260A.

EPA Method 8260A with Purge and Trap Sample Preparation. The Subcontractor will follow all procedures and QC criteria specified in EPA method 8260A (EPA 1986) with the following exceptions:

1. For water samples, a three point calibration for all specified analytes is required at concentrations of 2 $\mu\text{g/L}$, 10 $\mu\text{g/L}$, and 100 $\mu\text{g/L}$ (based on a 5.0 milliliter sample size). All analytes must have a relative standard deviation (RSD) of less than 50 percent for the average response factors (RF).
2. An initial calibration verification (ICV) standard prepared from a separate source is required at the mid-point concentration. All analytes must have a percent difference (%D) for the ICV RFs of less than 35 percent.

3. A one-time 0.5 $\mu\text{g/L}$ sensitivity check standard containing all specified analytes is required prior to analyzing any samples. The laboratory must demonstrate the ability for the GC/MS system to identify and quantitate all compounds at this concentration. Recovery for all analytes should be between 30 - 150 percent. The laboratory will report this concentration as the detection limit (DL) for all analytes.
4. A continuing calibration check is required at the beginning and end of each 18 hour period of operation. All analytes must have a %D less than 50 percent. If the %D is greater than 50 percent for any compound, the laboratory will regenerate the calibration curve.
5. A bromofluorobenzene (BFB) performance check is required once per day prior to analyzing standards. The instrument must pass the BFB performance criteria with the following exceptions: (1) the spectra may be averaged over the whole BFB peak if necessary; (2) if the BFB tune criteria are not met, the PRC representative may determine that the deficiencies are not sufficient to hinder proper performance of the method and can instruct laboratory personnel to continue without further modification of the system.
6. Internal standard (IS) area counts and surrogate standard (SS) recoveries will be monitored for each analysis. Three IS compounds and three SS compounds are required. IS area counts for each analysis must be within 30 - 200 percent of the IS area counts for the continuing calibration standard. If IS recoveries are outside the 30 - 200 percent range, the system will be considered unstable and analysis will be discontinued until the problem is rectified. SS recoveries must be within 50 - 150 percent for each analysis unless recovery problems are attributed to matrix interference problems. SS recoveries outside of the 50 - 150 percent range will be evaluated by a PRC representative on a sample-by-sample basis.
7. One matrix spike is required for each 18 hour period of operation. The concentration of the matrix spike shall be 10 $\mu\text{g/l}$ for water samples and will contain all specified analytes.
8. The laboratory will not be required to perform matrix duplicate analyses. The field sampling team leader will provide the laboratory with field duplicate samples for analysis. Table A-1 provides a list of designated samples.

4.3 QUALITY CONTROL REQUIREMENTS AND FREQUENCY

QC checks are instituted to obtain accurate and precise data and to document the quality of the data. These checks cover the field sampling effort and the laboratory analytical work. This section discusses the required QC checks and their frequency.

4.3.1 Field Quality Control Samples

Field QC samples will be collected for field and fixed laboratory analysis to check sampling and

analytical accuracy and precision. These samples are consistent with guidelines presented in the Navy QA requirements (Naval Energy and Environmental Support Activity 1988). Table A-12 summarizes all field and laboratory QC samples.

**TABLE A-12
FIELD AND LABORATORY QC SAMPLES
NAS ALAMEDA**

Sample Type	Frequency of Analysis
Matrix Spike/Matrix Spike Duplicate Pair (organics)	5 percent ^a
Matrix Spike (inorganics)	5 percent ^b
Matrix Duplicate (inorganics)	5 percent ^c
Field Blank Sample	One sample analyzed per event
Equipment Rinsates	One rinsate analyzed per day per equipment

Notes:

- a At least one MS/MSD pair will be included with each analytical batch. The sample selected for the MS/MSD pair will be chosen by the field personnel and submitted to the laboratory in triplicate.
- b At least one MS will be included with each analytical batch. The sample selected for the MS will be chosen by the field personnel and submitted to the laboratory in duplicate.
- c At least one matrix duplicate (MD) will be analyzed with each analytical batch. The sample selected for the MD will be chosen by the laboratory.

4.3.1.1 Field Blank Samples

Field blank samples consist of the source water used for the final rinsing of sampling equipment during decontamination. The water used will be deionized or distilled and will be obtained in 5-gallon plastic carboys from a reliable vendor. The field blank samples will be analyzed for all analyses in which a decontamination procedure was used. The results of the field blank samples will provide information on the potential for contamination of field samples and will be used to qualify data on the basis of blank contamination. One field blank sample will be collected during the soil sampling.

4.3.1.2 Equipment Rinsate Samples

Equipment rinsate samples are used to evaluate the decontamination procedures and the resulting cleanliness of the sampling equipment. The rinsate samples will be collected after a sample collection device is subjected to standard decontamination procedures. Deionized or distilled source water will be poured over or through the sampling device after decontamination and will be collected in the appropriate containers for analysis. The equipment rinsate samples will be packaged with the field samples and shipped blind to the laboratory for the specified analyses. One equipment rinsate sample per sampling device per day will be sampled and submitted for the appropriate analyses.

4.3.2 Fixed Laboratory Quality Control Parameters

Fixed laboratory QC samples and procedures will be performed at the frequency specified in the referenced method, and as required by the laboratory's specific QA/QC program. These QC samples and procedures may include the following:

- Method blanks
- MS/MSDs
- Matrix duplicates
- Laboratory control samples
- Interference check samples
- Post-digestion spike samples
- Instrument performance check samples
- Internal standards
- Surrogate standards

4.4 INSTRUMENT AND EQUIPMENT TESTING, INSPECTIONS, AND MAINTENANCE REQUIREMENTS

The fixed laboratory will perform instrument and equipment testing, inspections, and maintenance at the frequency specified in the referenced method, and as required by the laboratory's specific QA/QC program.

4.4.1 Instrument Calibration and Frequency

For all analytical laboratory procedures, the analytical instruments must be calibrated within the analytical method requirements specified in the laboratory's standard operating procedures and, in addition, the PRC SOW. All calibration information, including date and time, will be logged on the appropriate form, logbook, document, and electronic format. The analytical laboratories will perform and retain documentation of calibration and maintenance of all instruments used for the analysis of samples.

4.4.2 Inspection and Acceptance Requirements for Supplies and Consumables

Supplies and consumables to be used in the field will be ordered from Hazco, Inc., PRC's equipment supplier. Prior to use in the field, the items will be inspected and tested. Any defective material will be replaced prior to the onset of the sampling event.

All sample containers with the appropriate preservation are prepared by the analytical laboratory following laboratory procedures, and meet EPA specifications for certified clean containers. All containers and coolers are inspected prior to use for packing and shipping samples. Prior to use in the field, containers will be inspected. Any defective material will be replaced prior to the onset of the sampling event.

Appropriate materials (such as bubble-wrap, plastic bags, and tape) will be available for packing samples to avoid breakage during transportation.

4.5 DATA ACQUISITION REQUIREMENTS

Data acquired through the analyses of samples will be reported following formats established by the CLP method and the PRC SOW, and will be reported within the required deliverable schedule. All data from analytical laboratories will be presented in a CLP hardcopy or equivalent data package and in the electronic data deliverable format detailed in the PRC SOW (PRC 1995).

The electronic data deliverable (EDD) is an ASCII file of the results and sample identification information downloaded into a specific file structure from the laboratory information management system. The EDD is imported into the NAS Alameda database. All data and QC information in the file must be within the limits established by the PRC SOW for correct transfer of the data from the laboratory. If an EDD is incorrectly structured, the laboratory is required to resubmit the data file.

All field data will be recorded on the appropriate field forms for data entry into the NAS Alameda database. All data entered into the database, either from field forms or imported from an EDD, will be reviewed for accuracy.

4.6 DATA MANAGEMENT

The following sections outline the project data management scheme.

4.6.1 Field Data Management

The PRC project manager will be responsible for the review, transfer, and storage of all data collected in the field for the Sites 4,5, and 14 investigations. Field activities will be documented by the PRC FTL as described in Section 4.0. All field change request forms and daily field sampling reports will be filed by the PRC project manager and copies will be included as an appendix to the final QCSR.

4.6.2 Laboratory Data Management

Upon the receipt of the samples by the laboratory, the laboratory sample custodian will reconcile the information on the COC forms with the sample bottles received. The sample custodian will document any anomalies and report these to the laboratory project manager. Anomalies will be resolved with the PRC project chemist. The information on the COC forms will then be entered into the laboratory's information management system along with the analyses being requested. The proper sample container labels will be generated and attached to the containers.

Data acquired through the sample preparation, analysis, and reporting processes are tracked using the laboratory's information management system. Data are either transferred from the instrumentation

electronically to the laboratory's information management system or qualified personnel enter the data through terminals. The laboratory is responsible for tracking all QC measurements along with the specific sample results on a batch basis. Any QC measurements that exceed the specified QC limits for the project are documented. QC problems which directly impact data quality are immediately communicated to the PRC project chemist. The laboratory will implement necessary corrective action which also will be appropriately documented. After all data are collected, reviewed, and approved, the laboratory will generate an EDD and a CLP data package from the laboratory's information management system and deliver them to the PRC project chemist.

The laboratory project manager is responsible for proper sample handling and documentation that will allow for the tracking of individual samples from the time of receipt to the submittal of the final data package and electronic deliverable to the PRC project chemist. Laboratory sample receipt deficiency reports and non-conformance memos will be used by the laboratory to document and disseminate non-conformance information to the PRC project chemist.

The laboratory is required to maintain the analytical records for a period of 10 years. Data can be stored in a number of ways, usually including a combination of hard copy and computer tape backups.

4.6.3 PRC Data Management

The laboratory is responsible for sending a hard copy of the CLP data package and an EDD on computer diskette to the PRC project chemist. Upon the receipt of the data package, the EDD is imported into PRC's database. The importing program checks the format and content of the EDD for compliance with PRC specifications. Any errors reported by the importing program are thoroughly investigated. If necessary, the laboratory is requested to regenerate the deliverable. The EDD, as well as the hard copy data package, are also checked for completeness. Any missing information in either the EDD or the hard copy is immediately requested from the laboratory.

Data tables are printed from the database and copies of both the data tables and the hard copy data package are sent to an outside party for data validation as described in Section 5.4. The validator then applies qualifiers or comment codes, as appropriate, to data and marks the data tables for input into the database. The validator prepares a data validation report and returns the data package, marked tables, and data validation report to the PRC project chemist.

The PRC project chemist performs a technical review of the data validation report as described in Section 5.1.3. The data tables are submitted to a data entry person for input into the database. The final version of the data validation report is generated complete with the analytical tables containing the appropriate qualifiers and comment codes. This complete data validation package is stored with the raw analytical data. Copies of all validation report narratives are submitted with the QCSR.

The PRC project chemist is responsible for the proper handling of the data. At the conclusion of the project, the PRC project chemist will prepare a QCSR in support of the report which summarizes the overall quality of the data and also determines whether the DQOs were achieved. All hard copy data packages are stored in an off-site storage facility and the final versions of the electronic data tables are archived onto electronic data diskettes for permanent storage.

5.0 ASSESSMENT AND OVERSIGHT

An assessment evaluates the capability and performance of a measurement system or its components and identifies problems warranting correction. This section presents the activities for assessing the effectiveness of the implementation of the QAPP.

5.1 ASSESSMENT

Assessments planned for the Sites 4, 5, and 14 investigations include the following: (1) performance evaluations, (2) technical systems audits, (3) technical reviews, and (4) field audits.

5.1.1 Performance Evaluations

A performance evaluation includes a review of the existing project and QC data to determine the accuracy of a total measurement system or a component of the system. Laboratory performance evaluations are conducted routinely by the Navy and PRC. Internal performance evaluations or audits for the laboratory are described in the laboratory QA plan.

5.1.2 Technical Systems Audit

A technical systems audit is used to verify adherence to QA policies and standard operating procedures.

This type of audit may consist of an on-site review of measurement systems, including facilities, equipment, and personnel. Additionally, procedures for measurement, QC, and documentation may be evaluated. Technical systems audits are conducted on a regularly scheduled basis, with the first audit conducted shortly after a system becomes operational.

5.1.3 Technical Reviews

Technical reviews are performed on all reports and deliverables, including data validation reports and the QCSR. All data validation reports are reviewed for technical accuracy by a chemist independent from the data validator. The data validation reports are reviewed for consistency within the project as well as the overall remedial investigation.

5.1.4 Field Audits

A field audit involves an on-site visit by the auditor or auditing team. Items to be examined include the availability and implementation of approved work procedures; calibration and operation of equipment; packaging, storage, and shipping of samples; documentation of procedures and instructions; and non-conformance documentation.

5.2 RESPONSE ACTION

An effective QA program requires prompt and thorough correction of non-conformances affecting quality. Rapid and effective corrective action minimizes the possibility of questionable data or documentation. All QA problems and corrective actions will be documented to provide a complete record of QA activities.

5.2.1 Field Corrective Action Procedures

Corrective action procedures will depend on the severity of the non-conformance. In cases where immediate and complete corrective action may be implemented by field personnel, corrective actions will be recorded in the field logbook and summarized in the daily field progress report and site logbook.

Non-conformances identified during an audit that have a substantial impact on data quality require the completion of a corrective action memorandum. This memorandum may be completed by an auditor or any individual who suspects that any aspect of data integrity is being affected by a field non-conformance. The memorandum will include the description of the problem and the required corrective action.

Copies of the corrective action memo will be distributed to the project manager, FTL, the project QA officer, and the project file. The project QA officer will forward the memorandum to the CLEAN II program manager and the QA program manager as appropriate. Key personnel will meet to discuss the following:

- Determine when and how the problem developed
- Assign responsibility for problem investigation and documentation
- Determine the corrective action needed to eliminate the problem
- Design a schedule for completion of the corrective action
- Assign responsibility for implementing the corrective action
- Document and verify that the corrective action has eliminated the problem

The person identified as responsible for implementing the corrective action will also be responsible for completing a follow-up memorandum documenting the completion of the corrective action. The follow-up memorandum will be submitted to the project QA officer to evaluate that the solution has adequately and permanently corrected the problem. The QA program manager can require data acquisition to be limited or discontinued until the corrective action is complete and the non-conformance eliminated. The QA program manager can also request the reanalysis of any or all data acquired since the system was last in control.

5.2.2 Laboratory Corrective Action Procedures

The internal laboratory corrective action procedures and a description of out-of-control situations requiring corrective action are contained in the laboratory QA plan. At a minimum, corrective action will be implemented when control chart warning or control limits are exceeded, method QC requirements are not met, or sample holding times are exceeded. Out-of-control situations will be reported to the project chemist within 2 working days of identification. In addition, a corrective action

report, signed by the laboratory director or project managers and the laboratory QC coordinator, will be provided to the project chemist. The corrective action report will include the description of the problem, the identification of affected samples, and the required corrective action.

The corrective action procedures require that the laboratory identify all out-of-control situations that would result in significant amounts of qualified data and perform a corrective action designed to reduce the amount of qualified data. This corrective action is often the reanalysis of samples once the cause of the out-of-control situation has been identified and corrected.

5.3 REPORTS TO MANAGEMENT

A summary progress report will be prepared on a monthly basis by the project manager and submitted to the Navy. The report may include the following:

- Audit results, if any audit conducted during the reporting period
- Status of the project
- Problems affecting QA and recommended solutions
- Objectives from the previous report that were achieved
- Objectives from the previous report that were not achieved
- Work and objectives planned for the next month

This information will also be required from any subcontractors and will be included in the monthly status report.

5.4 DATA VALIDATION AND USABILITY

This section provides an overview of the data validation process and how data useability is documented. The data validation process ultimately enables the reconciliation with the project objectives.

5.4.1 Data Review, Validation, and Verification Requirements

Through the data validation process, the data will be evaluated for acceptable quality and quantity,

based on the critical indicator parameters of PARCC (EPA 1987a). These parameters are discussed in detail in Section 2.3.

All analytical methods for each SDG will be validated on the basis of the criteria listed in the following:

- “U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review” (EPA 1994c)
- “USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review” (EPA 1994d)

All samples in each SDG will receive a cursory validation review, and, initially, 10 percent of the samples for each of the analyses performed will receive a full validation review. Table A-13 lists the cursory validation criteria and the full validation criteria.

**TABLE A-13
DATA VALIDATION EVALUATION CRITERIA
NAS ALAMEDA**

<u>CLP Inorganics (EPA 1994d)</u>	<u>CLP Organics (EPA 1994c)</u>
*Holding times	*Holding times
*Calibration (initial and continuing)	GC/MS tuning
*Blanks (method, instrument, and preparation blanks)	*Calibration (initial and continuing)
Inductively coupled plasma (ICP) interference check sample	*Blanks (method, instrument, and preparation blanks)
*Laboratory control sample	*Surrogate recovery
*Duplicate sample analysis	*MS/MSD
*MS sample analysis	*Field duplicates
Graphite furnace atomic absorption QC	*Internal standard performance
ICP serial dilution	Target compound identification
Sample result verification	Tentatively identified compounds
*Field duplicates	System performance
*Overall assessment of data for an SDG	*Overall assessment of data for an SDG

Note: All items listed are evaluated during a full validation review. cursory review items are indicated by a single asterisk (*).

After the data have been reviewed, data validation qualifiers will be applied to the analytical results. Data validation qualifiers are alphabetical characters that are placed next to each reported value that corresponds to definitions specified by the functional guidelines. Table A-14 lists data validation qualifiers and their definitions based on functional guidelines (EPA 1994c).

**TABLE A-14
DATA VALIDATION
QUALIFIERS
NAS ALAMEDA**

Data Qualifiers ^a	Definition
U	Compound was analyzed for, but was not detected above the concentration listed; the value listed is the sample quantitation limit.
J	Estimated concentration value; the result is considered qualitatively acceptable but quantitatively unreliable.
UJ	Estimated quantitation limit; the compound was analyzed for but was considered nondetected.
JN	An analyte has been tentatively identified; the associated numerical value represents its approximate concentration.
R	The data are unusable (compound may or may not be present). Resampling and reanalysis are necessary for verification.
No qualifier	The data are acceptable qualitatively and quantitatively.

Note:

^a EPA 1994c

A QCSR will be generated to summarize the project goals stated in the DQOs and the PARCC criteria. The QCSR will summarize how well the analytical data support the DQOs. The QCSR will include the following items:

- Reconciliation with DQOs
- Laboratory data validation summary
- Field screen data summary
- Limitations on the applicability of the data
- Any quality assurance plan modifications from the work plan
- Field audit report
- Any corrective actions performed

The data validation summary includes a brief description of the results of the data validation process for each analytical method; this description consists of the assessment of data quality in terms of the PARCC criteria. The details of the data validation process for each SDG, along with the validated analytical results, are included as data validation narratives in an appendix of the QCSR.

The laboratory will submit analytical reports in hard copy and electronic formats. Both hard copy reports and the electronic database reports will be submitted with laboratory qualifiers that are defined by either the EPA CLP SOW or the laboratory's standard operating procedures. Data submitted with CLP or laboratory-defined qualifiers identify items such as (1) nondetected values, (2) values below the CRQL (considered estimated values), and (3) values with problems during the analysis. Through data validation, these CLP or laboratory-defined data qualifiers are evaluated for appropriateness and replaced, as necessary, by the functional guidelines data validation qualifiers to notify the data user of the validity of the data. A database program created at PRC will be used to transfer data from the laboratory by an ASCII-formatted diskette. This database allows (1) the data validation qualifiers to be substituted as necessary for the original laboratory qualifiers, (2) corrections of detected data errors, (3) other software to be interfaced, and (4) tables to be printed with the validated results in various formats.

In addition to the analytical results with the associated qualifiers, the printed tables will also include a comment column. The comment column is used to provide an explanation for any assigned qualifiers. The alphabetical letters "a" through "h" are used to reference different QC issues that may have affected the analytical results. Table A-15 lists the associated definitions for these comment codes. The comment codes on the analytical tables will provide the reader with an immediate explanation for the qualifier attached to the result. The comment code will also enable the reader to locate a detailed discussion of the QC issue in the appropriate data validation narrative.

**TABLE A-15
DATA VALIDATION
COMMENT CODES
NAS ALAMEDA**

PRC Comment Codes	Definition
a	Surrogate spike recovery problems
b	Blank contamination problems
c	MS recovery problems
d	Duplicate (precision) problems
e	Internal standard problems
f	Calibration problems
g	Quantification below the reporting limit
h	Other problems; refer to data validation narrative

5.4.2 Reconciliation with Data Quality Objectives

The PRC project chemist is responsible for data quality. All data quality issues concerning field sampling efforts, laboratory analysis, data validation, database management, and data reporting will be referred to the project chemist. In addition, the project chemist will be responsible for the following data handling procedures:

- Sorting, binding, and tracking of analytical raw data delivered from the laboratory
- Input of EDD into PRC database and printing of initial result tables
- Reconciliation of sample numbers, field identification numbers, and requested analyses, based on the work plan, COC, and data package
- Preparation and shipment of SDGs to data validation services
- Technical review of data validation reports
- Input of data validation qualifiers into PRC database
- Preparation of final data validation report, including text, supporting documentation, and final result tables
- Preparation of EDD for input into geographical information system

At the conclusion of the project, the PRC project chemist will prepare a QCSR in support of the characterization report, which summarizes the overall quality of the data and also determines whether the DQOs of the project were met. In addition, any tabular results required for the characterization report will be printed and be reviewed for accuracy by the PRC project chemist.

REFERENCES

- California State Water Resources Control Board (SWRCB). 1988. "Leaking Underground Fuel Tank (LUFT) Field Manual." Prepared by the State of California LUFT Task Force. May.
- U.S. Environmental Protection Agency (EPA). 1986. "Test Methods for Evaluating Solid Waste, 3rd Edition." SW-846. Office of Solid Waste and Emergency Response. Promulgated revisions through 1994.
- EPA. 1987a. "Data Quality Objectives for Remedial Response Activities Development Process." Office of Emergency Response and the Office of Waste Programs Enforcement. March.
- EPA. 1987b. "A Compendium of Superfund Field Operations Methods." Office of Emergency and Remedial Response. December.
- EPA. 1993. "Data Quality Objectives Process for Superfund Interim Final Guidance." September.
- EPA. 1994a. "EPA Requirements For Quality Assurance Project Plans For Environmental Data Operations." EPA QA/R-5, Interim Final. May.
- EPA. 1994b. "Contract Laboratory Program (CLP) Statement of Work (SOW) for Organics Analysis, Multi-Media, Multi-Concentration." Document Number OLM03.1. August.
- EPA. 1994c. "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review." February.
- EPA. 1994d. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review." February.
- EPA. 1995. "CLP SOW for Inorganics Analysis, Multi-Media, Multi-Concentration." Document Number ILM04.0.
- PRC Environmental Management, Inc. 1995. "Navy CLEAN II Laboratory Services Statement of Work." June.
- Naval Energy and Environmental Support Activity. 1988. "Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Restoration Program." Prepared by Martin Marietta Energy Systems, Inc. Second Revision. June.

APPENDIX B

**THE WATERLOO DRIVE POINT PROFILER
(Five Pages)**

PRECISION TECHNICAL NOTE No. 5

The Waterloo Profiler™ for Groundwater Sampling

The Waterloo Profiler™ is a new direct-push (DP) groundwater sampling tool developed by researchers at the University of Waterloo in Ontario, Canada¹. The Profiler (patent pending) is the only DP tool designed to collect depth-discrete groundwater samples in a single hole with one probe entry. With the Waterloo Profiler, site investigators can quickly delineate vertical profiles of contaminants dissolved in groundwater.

Why Vertical Profiling is Necessary

Recent long-term natural gradient tracer studies show that in most granular aquifers, very little vertical mixing of contaminants occurs as the groundwater flows along its flow path^{2,3,4,5}. Depth-discrete groundwater sampling (referred to as vertical profiling) at these sites shows that the concentration of dissolved organic compounds often varies by several orders of magnitude over vertical distances of one foot or less. This indicates that significant vertical mixing does not occur in most environments; if it did, the contaminants would be more evenly distributed and concentrations would be more uniform.

Groundwater mixing, also referred to as hydrodynamic dispersion, is a function of the groundwater velocity and the dispersivity (α) of the formation. Numerical simulations of data collected during the natural gradient tracer tests show that vertical dispersivity (α_v), which controls vertical mixing, is much lower than was thought in the 1970s and early 1980s⁶. This explains why very little vertical mixing of contaminants occurs in nature, even in relatively homogeneous materials.

If dissolved contamination is highly stratified, can samples collected from conventional monitoring wells provide an accurate representation of the true concentration and distribution of contaminants in groundwater? The answer is no. When a conventional monitoring well is sampled, clean or slightly-contaminated water is drawn into the well, diluting the sample. Therefore, even with screen lengths as short as 5 or 10 feet, monitoring wells yield samples that are composited over the screened interval. Thus, high concentrations of contaminants present in a thin zone – and even non-aqueous phase liquids

(NAPLs) – are significantly diluted in the process of sampling conventional monitoring wells. In some cases, the contamination can be diluted below the detection limit of the chemical analytical method.

Moreover, for non-biodegradable contaminants (like most chlorinated solvents and MTBE), if significant mixing with clean water does not occur as groundwater flows in the subsurface, the high solute concentrations in the contaminated zone are maintained. Thus, thin zones with high

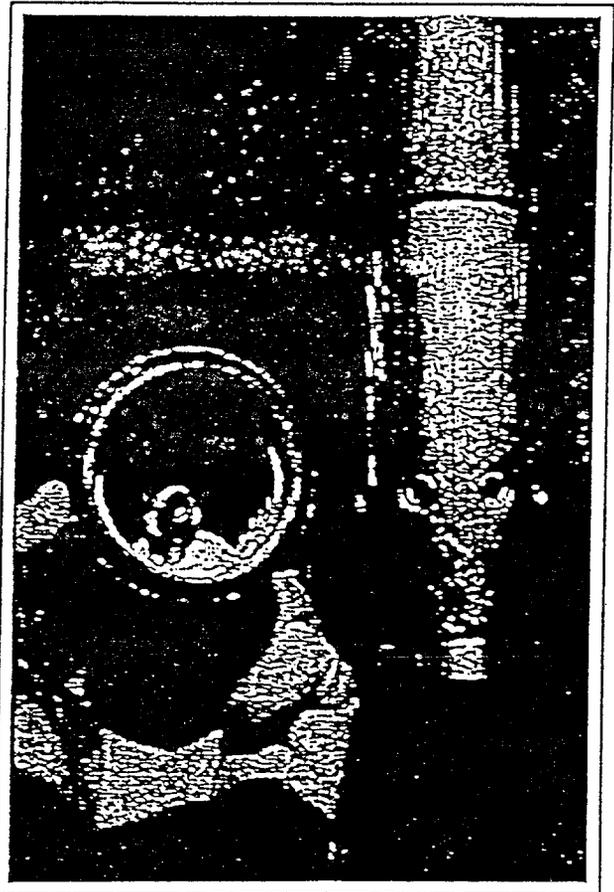


Figure 1. Depth-discrete groundwater samples are drawn through screened ports in the tip of the sampling tool. The ports are connected to an internal fitting inside of the tool (shown at left). Stainless steel or Teflon tubing attached to the internal fitting and running inside of the steel pipe conveys the water sample to the surface.

INNOVATORS IN DIRECT PUSH TECHNOLOGY

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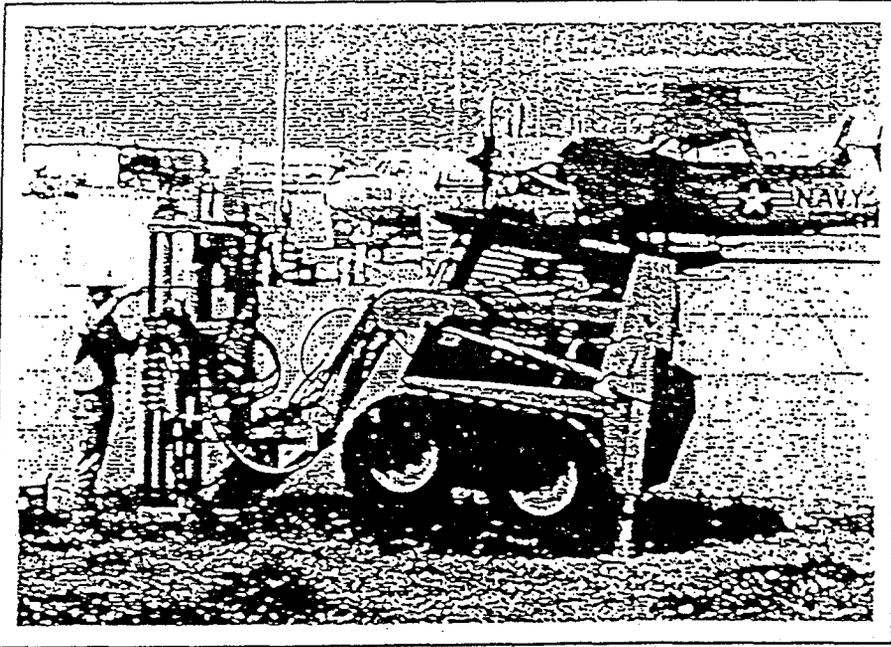


Figure 2. Precision's vibratory sampling rigs quickly advance the Waterloo Profiler

concentrations of contaminants can flow for great distances without being diluted. A recent investigation at an industrial facility – where detailed vertical monitoring was performed – identified a high-strength core of contamination that extends for over 7 kilometers².

At any contaminated site, inaccurate delineation of groundwater contamination can have tremendous consequences. Without an accurate understanding of the true magnitude and distribution of contamination, it is not possible to make intelligent corrective action decisions: underestimating the maximum contaminant concentrations invalidates any risk assessment; not identifying free product or localized contaminant hot spots may expose nearby receptors to unacceptable risks; and, without knowing the true

distribution of subsurface contamination, it is impossible to design effective active or passive remediation systems.

Regulators and site investigators across North America are discovering that collecting multiple, closely-spaced, depth-discrete groundwater samples – i.e., vertical groundwater profiling – is necessary to define the true extent and distribution of dissolved contaminants in the subsurface.

Description and Operation of the Waterloo Profiler

The Waterloo Profiler collects discrete groundwater samples from numerous depths during a single push. Figure 1 shows the tip of the Waterloo Profiler, which has screened ports located at the tip of the tool. The Profiler tip is attached to 3-foot lengths of heavy-duty threaded steel pipe that extend to the ground surface. The Profiler is advanced by pushing, pounding, or vibrating the steel pipe into the ground using one of Precision's custom-made sampling rigs (Figure 2). Three-foot lengths of pipe are continually added as the tool is advanced deeper into the ground to the first sampling depth. Groundwater samples are conveyed to the surface via small-diameter tubing that is attached to a fitting inside of the Profiler tip and passes up through the

inside of the threaded steel pipes. The internal tube is made of either stainless steel or Teflon to minimize sorption of organic compounds.

At sites where groundwater is shallow (i.e., less than 25 feet below the ground surface), samples can be collected using a peristaltic suction-lift

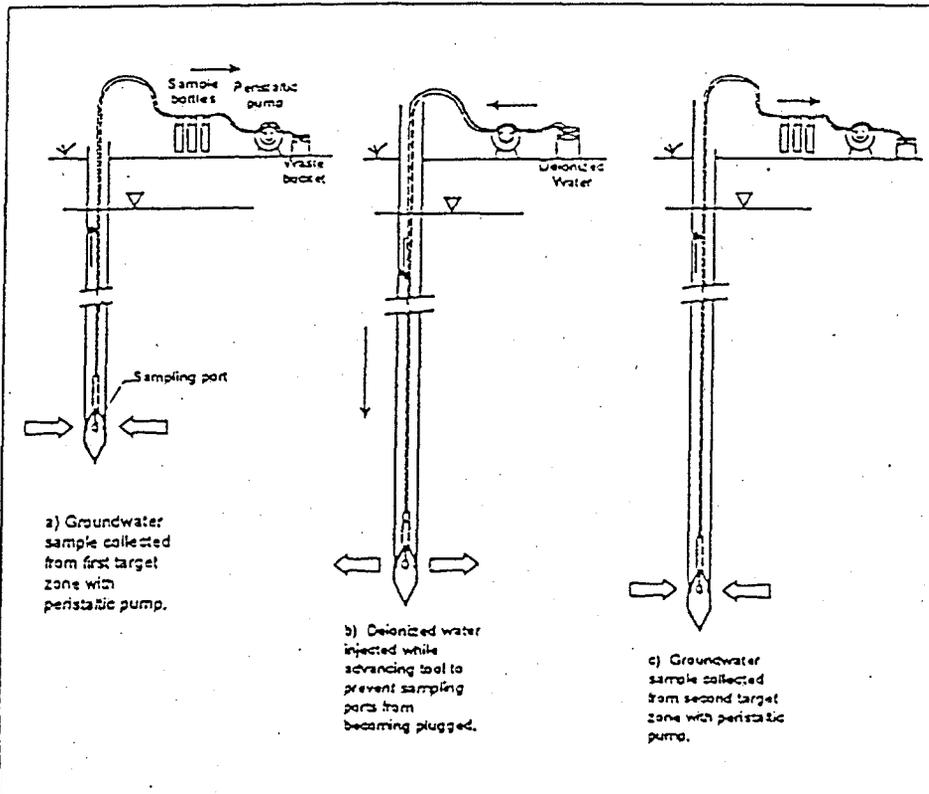


Figure 3. Collecting depth-discrete groundwater samples with the Waterloo Profiler

pump (Figure 3). Samples are collected in 40 ml glass vials placed in the sampling line, upstream from the peristaltic pump. Positioning the glass vials in the sampling line upstream from the peristaltic pump minimizes the loss of volatile organic compounds (VOCs) since the sample is never exposed to the atmosphere. However, at sites where groundwater has high concentrations of dissolved gases such as carbon dioxide or methane, pressure changes during sampling can cause bubbling in the sample line as the dissolved gases come out of solution.

In such environments, VOCs in the groundwater can partition into the bubbles, reducing the concentration in the water. A recent study by Baerg et al. indicates that the small negative bias in samples collected using a peristaltic pump is on the order of 12% for tetrachloroethene (PCE) and 7% for trichloroethane (TCA). While this error is not insignificant, the advantage of being

able to delineate the plumes in detail outweighs the sampling bias caused by the sample collection method, especially when the natural variation in the samples is in the order of three to four orders of magnitude. Nevertheless, the investigator is cautioned to be aware that negative biases exist when using peristaltic pumps, and to consider not only the partial pressures of dissolved gases, but also the volatility of the target analyte. Additional discussion of sample bias associated with the Waterloo Profiler is presented by Pitkin, et al.³

When groundwater occurs at a depth greater than 25 feet, suction-lift pumps do not work and other sample collection methods are necessary. Currently, a triple-tube displacement pump is used for collecting samples at these depths. Also, Precision Sampling and the University of Waterloo are finalizing the design of a down-hole bladder pump that will be used to pump groundwater samples to the surface. Both of these pumping methods reduce the negative sampling bias associated with suction-lift methods.

Once a sample is collected in the 40 ml vials, new glass vials are placed in the sample holder and the Profiler is pushed to the next sampling depth. A picture of the sample holder is shown in

Figure 4. The next sampling depth can be any distance below the previous depth, but usually ranges between 2 and 5 feet deeper. To prevent the ports from clogging as the tool is pushed through the soil, deionized water is slowly pumped through the inner tube and out of the sampling ports as the tool is being advanced. Note that only a very small amount of water is injected – typically less than 10 milliliters per minute – just enough to keep the ports from becoming plugged. For injection pressures up to approximately 50 pounds per square inch (psi), the water is injected by reversing the flow on the peristaltic pump.

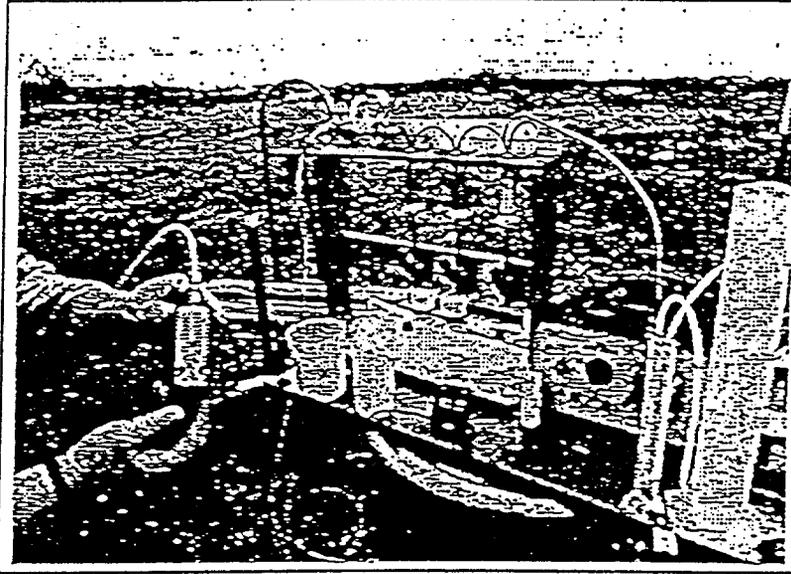


Figure 4. Bottle holder with three 40-ml glass sample vials. Peristaltic pump shown at right. Profiler tip with internal Teflon tubing shown at left.

When greater injection pressures are needed to keep the ports clear, an auxiliary high-pressure, low-flow pump is used. In addition to keeping the ports open, injecting DI water while advancing the tool purges the tubing of the water left over from the previous sampling event. This prevents cross contamination of the next groundwater sample.

Note that the pressure/flow relationship of the injection water can be monitored to provide an indication of the hydraulic conductivity of the formation. This way, geologic contacts (i.e., the

contact between a sand and an underlying clay confining unit) can be accurately identified as the profiler tool is advanced.

Once the tool has been advanced to the next sampling depth, the flow of the pump is reversed, and groundwater from the aquifer is again extracted. Purging of the system is required, since the tubing and ports now contain DI water that had been pumped down through the system. Purging is considered complete when the electrical conductivity of the extracted groundwater increases and then stabilizes. Several other chemical parameters such as salinity, temperature, pH, and dissolved oxygen (DO) can be monitored using in-line sensors mounted in flow-cells in the sampling line. Once the investigator is confident that formation water is being extracted, the 40 ml glass sample vials are removed and capped, ready to be analyzed by the on- or off-site laboratory.

The primary advantage of the Waterloo Profiler is that because the tubing is purged between samples, several depth-discrete ground-water samples can be collected in one push, without having to remove, clean, and re-insert the tool. Also, because the tool can be pushed through clay and silt beds without plugging, the Profiler is ideal for sampling multiple water-bearing zones at sites with stratified geology.

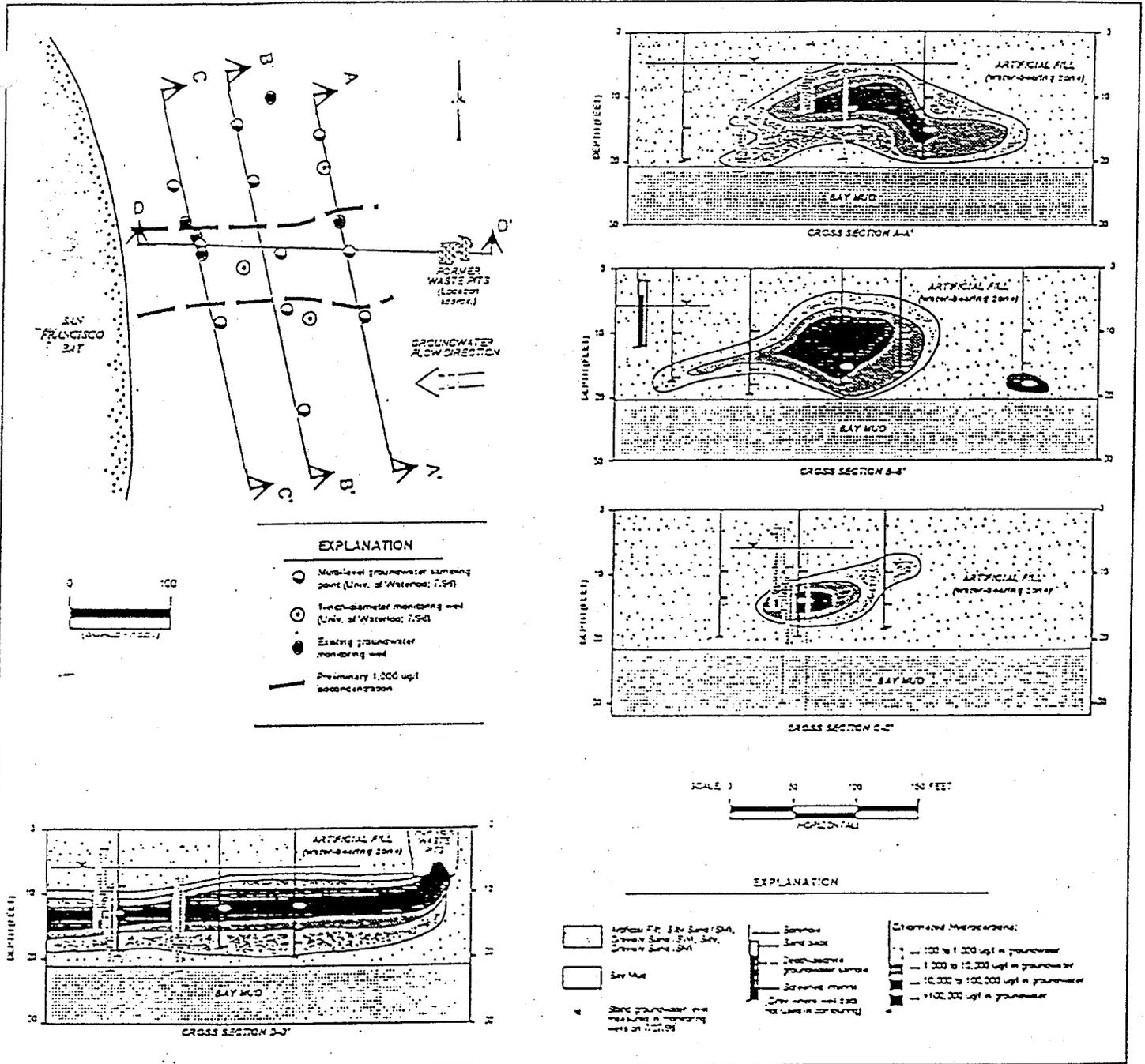


Figure 5. Map and transects from a recent site characterization at Alameda Naval Air Station in California. Note the great vertical variation in the concentration of dissolved contaminants, even in this homogeneous sand.

Sealing the Hole Created with the Waterloo Profiler

Probe holes should be sealed to prevent the holes from becoming conduits for contaminant migration. This is especially important at sites where DNAPL is present that could flow down the open probe holes and contaminate deeper aquifers. In most homogeneous sands, the sand will collapse as soon as the profiler is withdrawn, restoring the original permeability of the formation. However, in other geologic formations, the soil may not collapse, and other methods of sealing the probe hole are necessary. The Waterloo Profiler is equipped with a knock-out disposable tip that facilitates reliable retraction grouting (Figure

1). Once the last groundwater sample has been collected, cement or bentonite grout is pumped down the steel pipe using a high-pressure grout pump. Once a critical pressure is reached, the disposable tip separates from the rest of the tool, and grout flows out of the pipe into the probe hole. The grout is continuously pumped, filling the probe hole as the pipe is removed. This ensures that the probe hole is effectively sealed. Retraction grouting using the Waterloo Profiler is much more reliable than re-entry methods used with other sealed-screen groundwater sampling systems³.

Case Study

The Waterloo Profiler was recently used to delineate the areal and vertical extent of a plume of chlorinated organics and petroleum hydrocarbons at a portion of Alameda Naval Air Station in California. The investigation was performed to define the optimum location and depth of an innovative in-situ reactive-wall funnel and gate remediation system¹⁰. Continuous soil cores were first collected with Precision's Enviro-Core system to define the site geology (the Enviro-Core soil coring system is described in Technical Note # 2). Next, depth-discrete groundwater samples were collected with the Waterloo Profiler at 14 locations (Figure 5). The locations were along three transects drawn perpendicular to the presumed plume orientation. Groundwater samples were analyzed on-site for chlorinated organic compounds and petroleum hydrocarbons by GC/MS methods.

As shown in Figure 5, Precision's investigation accurately delineated the dissolved plume in three dimensions. The plume does indeed have a very concentrated core, with concentrations of vinyl chloride as high as 130,000 mg/l, that had been missed by the existing conventional monitoring wells. Projection of concentration contours to the ground surface shows that the plume emanates from a former waste disposal pit, and flows to the west where it discharges into San Francisco Bay. Note that groundwater samples collected from the base of the aquifer had much lower concentrations of all compounds than samples collected higher up in the aquifer. This is conclusive evidence that a pool of DNAPL does not occur atop the Bay Mud aquitard in that part of the site.

The site characterization was comprehensive and yielded accurate data that the investigators needed to install the passive remediation system. Yet, the investigation was neither lengthy nor costly. Precision performed the entire investigation in 4 days at a cost slightly under \$10,000.

Maximum Depth, Productivity, and Limitations

Like other direct-push groundwater sampling tools, the Waterloo Profiler is intended for use in unconsolidated sand and gravel formations. The maximum sampling depth depends on the site-specific soil conditions. In the San Francisco Bay Area, the Profiler is routinely advanced to depths greater than 50 feet. It has been advanced to depths greater than 80 feet near Cape Canaveral in Florida. In soft clays near Cape Cod, the tool has been advanced to depths greater than 100 feet.

Sample collection is the most time-consuming part of the operation. Advancing the sampling tool usually takes very little time. In coarse-grained sands and gravels, sample collection takes less than 10 minutes per sample. In fine- to medium-

grained sand, 20 to 30 minutes is typically required to purge and collect a sample. In sediment finer than a fine-grained sand, collecting groundwater samples with the Waterloo Drive-Point Profiler is very time consuming and may not be economically feasible.

References

- ¹ Pitkin, S.E., Ingleton, R.A., and Cherry, J.A. Use of a Drive Point Sampling Device for Detailed Characterization of a PCE Plume in a Sand Aquifer at a Dry Cleaning Facility. In Proceedings of 8th Annual Outdoor Action Conference: NGWA., 1994.
- ² Mackay, D.M., Freyberg, D.L., and Roberts, P.V. A Natural Gradient Experiment on Solute Transport in a Sand Aquifer 1. Approach and Overview of Plume Movement. *Water Resources Research* 22(13):2017-2029, 1986.
- ³ Frind, E.O. and Hokkanen, G.E. Simulation of the Borden Plume Using the Alternating Direction Galerkin Technique. *Water Resources Research* 23 (5):918-930, 1987.
- ⁴ LeBlanc, D.R., Garabedian, S.P., Hess, K.M., Gelhar, L.W., Quadri, R.D., Stollenwerk, K.G., and Wood, W.W. Large-Scale Natural Gradient Tracer Test in Sand and Gravel, Cape Cod, Massachusetts. 1. Experimental Design and Observed Tracer Movement. *Water Resources Research* 27(3):893-910, 1994.
- ⁵ Rivett, M. Soil-gas signatures from volatile chlorinated solvents: Borden field experiments. *Ground Water* 33(1):84-98, 1995.
- ⁶ van der Kamp, G., Luba, L.D., Cherry, J.A., and Maathuis, H. Field Study of a Long and Very Narrow Contaminant Plume. *Ground Water* 32(5):1003-1016, 1994.
- ⁷ Baerg, D.F., Starr, J.A., Cherry, J.A., and Smyth, D.A. Performance Testing of Conventional and Innovative Downhole Samplers and Pumps for VOCs in a Laboratory Monitoring Well, 1992.
- ⁸ Pitkin, S.E., Cherry, J.A., Ingleton, R.A., and Broholm, M. Assessment of cross contamination associated with the Waterloo Profiler for direct-push groundwater sampling. *Ground Water Monitoring and Remediation* 1997. (in press).
- ⁹ USEPA, 1997, Tools for Expedited Site Characterization. Washington, D.C. in press.
- ¹⁰ University of Waterloo, 1995. Workplan for Semi-Passive Groundwater Remediation Demonstration Project at Site 1, Alameda Naval Air Station, California. September 1995.

APPENDIX C

STANDARD OPERATING PROCEDURES

SOP APPROVAL FORM

PRC ENVIRONMENTAL MANAGEMENT, INC.

STANDARD OPERATING PROCEDURE

WELL INSTALLATION

SOP NO. 020

REVISION NO. 2

Date of Original Issue: 03/31/91

Title: Well Installation

1.0 BACKGROUND

Well type, well construction, and well installation methods will vary with drilling method, well utility, subsurface characteristics, or other site-specific criteria. Specifications for well installation will be identified within a site work plan, sampling plan, or Quality Assurance Project Plan (QAPJP). A Monitoring Well Installation Record (see Attachment A) will be completed for each well installed by PRC. This standard operating procedure (SOP) discusses general types of wells and minimum standards for well installation for PRC Environmental Management, Inc. (PRC) projects.

Specific boring protocols are detailed in individual SOPs. Well installation methods will depend somewhat on the boring method. In turn, the boring method will depend on site-specific geology and hydrogeology. Boring methods include:

- hollow-stem auger
- cable tool
- rotary (mud, reverse, or air)
- rock coring
- jetting

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and the depth of the boring will be generally less than 100 feet.

This maximum depth is dependent on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because it is quick and inexpensive, addition of water into the subsurface is limited, and continuous samples can easily be collected.

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Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. This method, however, is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids, or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative samples limit this method's utility. However, this method can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications of this method such as dual-tube drilling, drill through casing hammers, or eccentric type drill system can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

1.3 DEFINITIONS

None.

1.4 REFERENCES

Driscoll, Fletcher G., 1986. Ground-Water and Wells, 2nd. Edition. Johnson Division, St. Paul, Minnesota, p. 438-442.

National Well Water Association (NWWA), 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. NWWA, p. 145-246.

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1.5 REQUIREMENTS AND RESOURCES

- Monitoring Well

2.0 PROCEDURES

This section details the minimum general monitoring well installation criteria and procedures. Site-specific geologic regimes may result in departures from this procedure. Specific procedures should be detailed in a sampling plan, work plan, or QAPjP. Figure 1 shows the typical completed general monitoring well.

All wells will be equipped with factory slotted screen. Casings and screens should be threaded and flush coupled and watertight joints should be used. Casings and screens will be selected in accordance with criteria set forth in Section 2.1. Annular seals are described in Sections 2.2 and 2.3. General monitoring well installation should follow these steps:

- 1) Prior to the installation of any casing or screen into the borehole the material should be decontaminated. PRC SOP No. 002 explains decontamination rationale and procedures.
- 2) Well casing and screens should be anchored within the borehole using centralizers.
- 3) The filter pack and other annular sealing materials should be installed through the auger stem or borehole casing. A tremie pipe should be used to install this material and a weighted tape should be used to tamp material. The tremie pipe is slowly

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raised as material is added to the annular space. When wells are constructed in temporary casing such as hollow stem augers the augers should be lifted when 1 to 2 feet of construction material has accumulated in the annulus. The casing should be lifted enough so that the accumulated material settles to within 2 to 4 inches of the bottom of the temporary casing.

- 4) Screens will be placed within a filter pack. This filter pack will be constructed in the manner detailed in Section 2.2 and will extend a minimum of 2 feet above and 2 feet below the screened interval.
- 5) A fine sand collar should be installed to 2 feet above the top of the filter pack.
- 6) A minimum 2-foot thick bentonite slurry seal will be placed above the filter pack.
- 7) A bentonite cement slurry should be pumped through a tremie pipe into the annular space up to a point approximately 2-feet below the ground surface.
- 8) A protective outer casing and locking cap should then be placed in the borehole and a cement surface seal should be installed. The cement surface seal will form a pad around the monitoring well.

2.1 CASINGS AND SCREENS

The following procedure should be followed in selecting casings and screens.

The selection of well casing and screen materials must take into account environmental factors such as: 1) geologic environment, 2) natural geochemical environment, 3) anticipated well depth, and 4) types and concentrations of known or suspected contaminants. Other non-environmental factors that will impact on the material selection include: 1) anticipated life of the monitoring well, 2) drilling and installation methods, 3) cost, and 4) availability.

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Inner casings and well screens should be constructed of inert, durable materials. Two preferred types of casing are stainless steel and polytetrafluoride (Teflon). Epoxy-fiberglass and polyvinyl chloride (PVC) casing and screen are sound well construction materials in many sampling environments. Epoxy-fiberglass well construction materials are relatively new to the environmental monitoring field, however, preliminary data suggests they are comparable to stainless steel but approximately half the cost. Due to the recent introduction of this material into the groundwater monitoring field local regulatory authorities should be consulted prior to the use of this material. Several states, EPA regions, and Army Corps of Engineers Districts are using this material as an alternative to stainless steel. PVC may be used if the contaminants of interest do not react with PVC or the well life is expected to be short.

Casing and screen joints should be threaded, and Teflon tape should be used to assure a tight seal with Teflon or stainless steel components. Epoxy-fiberglass and PVC joints typically are fitted with rubber O-rings to provide a tight seal. Teflon tape may also be applied to these joints to assure a prolonged tight seal. Under no circumstances should joints be glued or solvent sealed.

Screens will be factory-slotted. The screen slot size will be dependent on the required flow rates for the well and the texture of the formation. When sieve analysis information is available for well packing material, slot sizes should be capable of retaining 90 percent of the filter pack material (see Section 2.2). When no such information is available a default screen size of 0.01-inches (No. 10 slot) will be used.

Screen length and well diameter will depend on site-specific considerations. These include intended well use, contaminants of concern, and hydrogeology. Some considerations are as follows:

- Water table wells should have screens of sufficient length and thickness to monitor the water table and provide sufficient sample volume during high and

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low water table conditions.

- Wells with low recharge should have screens of sufficient length and width so that adequate sample volume can be collected.
- Wells should be screened over short enough distances to allow for monitoring of discrete migration pathways.
- Where light non-aqueous phase liquids (LNAPLs) or contamination in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.
- Where dense non-aqueous phase liquids (DNAPLs) are being monitored, the screen should be set within the lower portion of the water bearing zone, just above a relatively impermeable lithologic unit.
- The screened interval should not extend across an aquiclude or aquitard.
- If contamination is known to be present and concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross contamination within the aquifer.
- If downhole geophysical surveys are to be conducted the casing and screen material must be of sufficient diameter and constructed of the appropriate material to allow effective use of the geophysical survey tools.
- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and or monitoring equipment, and allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

In many instances it may be necessary to isolate stratigraphically higher portions of the subsurface, during drilling, from the zone being monitored. In these cases special types of drilling may be necessary. An example of this is the use of temporary or permanent borehole casing that is

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telescoped to smaller diameters with depth. With this approach, a large diameter casing is installed through the zone to be isolated and drilling is continued to depth through this casing. If necessary additional smaller diameter casing can be installed to stabilize the formation or isolate progressively deeper stratigraphic units. Another alternative involves the drilling of a large diameter borehole to the base of the zone to be isolated. This borehole is then sealed with a cement-bentonite grout. When the grout has cured the well installation borehole is drilled through the grout down to its final completion depth. Just as with the casing approach described above progressively deeper units can be isolated by the grouting of the portion of the borehole which penetrates then advancing the borehole through the hardened grout.

Prior to installing the casing and screen they should be fitted with centralizers to assure a uniform thickness of the annular seals. The annular seal is composed of the filter pack, sand collar, bentonite seal, and cement-bentonite grout. The annular seal should have a uniform thickness around the casing and screen of between two to four inches. Thinner seals increase the possibility that the well screen may be exposed to the formation, and thicker seals may interfere with the aquifer hydraulics around the screen. The selection of the centralizer material should be based on the same criteria used to select the casing and screen material. The centralizers should be spaced at closer intervals for smaller diameter casing and screen. Two-inch casing and screen should have centralizers installed every ten to fifteen feet.

2.2 FILTER PACK

The filter pack will be composed of chemically inert, uncontaminated material. The preferred filter pack material is pure silica sand.

The methods for choosing the filter pack grain size should be clearly outlined in the work plan, sampling plan, or QAPJP. The filter pack material must be tailored to the formation material. One

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method for choosing the filter pack grain size is based on the method proposed by NWWA (1989). Using this method, at least one standard sieve analysis of formation material is obtained. The grain size that retains 70 percent of the material is noted. This grain size is multiplied by a factor of 4 or 6. The factor of 4 is used for coarse poorly sorted formations, and the factor 6 is used for fine grained well sorted formations. The resultant grain size is used as the 70 percent retained point for the grain size of the filter pack. A second more conservative approach is described by Driscoll (1986). In this approach, the filter pack size is based on multiplying the 50 percent retained formation grain size by 2. If formation particle size distribution information is not available, an Ottawa grade sand, ASTM C-778 sand, or equivalent can be considered for use. The use of a default size filter pack becomes more tenuous in increasingly finer grained formations. The uniformity coefficient of the filter pack should not exceed 2.5. The filter pack should have a finished uniform thickness of 2 to 4-inches.

The filter pack should extend 2 feet above the top of the well screen. A sand collar should be installed on top of the filter pack. The sand collar should be constructed from a fine silica sand (.0021 to .0041 inch-diameter) and is should extend 2 feet above the filter pack. This sand collar is intended to prevent intrusion of bentonite and grout into the filter pack.

2.3 GROUT AND CEMENT

A bentonite slurry should be placed in the annular pack for a minimum of 2 feet above the fine sand collar. This slurry should be mixed at a ratio of approximately 22-pounds of dry bentonite to 7-gallons of water. This should result in a 10 to 11-pound/gallon slurry. The bentonite slurry will act as a formation seal for the monitoring well borehole. A cement and bentonite grout slurry will be placed in the annular space above the bentonite slurry, generally to a point approximately 2 feet below ground surface. Sufficient time should be allowed for the bentonite slurry to gel to a strength able to support the cement and bentonite gout. When mixing the slurry with a low shear device such as the grout pump or a drill rig, 30 to 60 minutes of mixing should be conducted prior to placing the slurry into the

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well annulus. After 30 to 60 minutes of low shear mixing the slurry should be thick enough to support the cement-bentonite grout. The cement and bentonite grout will consist of mixture of 8-gallons of water, 5-pounds of bentonite powder, and a 94-pound sack of Portland cement. An alternative cement-bentonite grout would be a premixed commercially equivalent material. A cement surface seal will be placed at the surface. Specific construction criteria may vary. These should be detailed in the work plan or QAPjP.

The bentonite slurry used as a formation seal above the filter pack and sand collar can be replaced with a seal composed of bentonite pellets or chips. These materials should be added to the annulus slowly to prevent bridging. Lifts of 3 to 4 inches should be separated by sufficient time to allow settlement. Past experience has shown that natural bentonite chips have slower hydration characteristics and are not as prone to bridging as formed bentonite pellets.

Bentonite seals are not always appropriate. If they are installed in the vadose zone they may never fully hydrate or they can dry creating desiccation cracks. Both situations cause seal failure. Groundwater with high chloride concentrations or total dissolved solids > 500 ppm may inhibit the full hydration of the bentonite. This could limit the effectiveness of the annular seal. The case of bentonite in areas where the seal may be exposed to high concentrations of organic solvents, hydrocarbons, organic acids, basic and natural polar-organic compounds, and neutral non-polar organic compounds may result in a several order-of-magnitude increase in the permeability of the seal. Neat cement is an alternative to bentonite seals given any of the above environmental conditions. Neat cement is a mixture of Portland cement (ASTM C-150) and water in the ratio of 5 to 6 gallons of water to 94 lbs. of cement. Type I Portland cement is the most commonly used material for this application.

2.4 OTHER COMPONENTS

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The procedures below should be followed under specific circumstances.

Several other well components which may be necessary depending of project specifications are listed below:

- Locking well caps and outer protective casings. These will be placed on all completed wells. These can either be above ground or flush mount.
- Bumper posts or well head protection. Protective bumper posts or other types of protective barriers should be placed around each completed well.
- Grout baskets. Grout baskets may be necessary when drilling proceeds through voids or open spaces (such as underground mines).
- Telescoping or conductor casing. Telescoping or conductor casing is used when wells are drilled to fairly deep depths when drilling proceeds through several separate saturated intervals, or when drilling through grossly contaminated intervals.

3.0 OTHER TYPES OF WELLS

This section discusses other types of wells which may be installed in special cases. These include well points, wells installed through multiple saturated zones, and well nests.

3.1 WELL POINTS

Under certain conditions it may be necessary to install well points. These wells are driven directly into the subsurface. Applications include use as vadose zone monitoring or shallow piezometer wells. However, the geologic subsurface must be compatible with this method. The utility of this

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method is limited because the annular space is generally not sealed to the surface. These types of wells are not acceptable for permanent monitoring well installations and should only be used under special circumstances.

3.2 WELLS INSTALLED THROUGH MULTIPLE SATURATED ZONES

When wells are installed through multiple saturated zones, special well construction methods have to be used to assure well integrity and to limit the potential for cross-contamination. Generally, these types of wells are necessary if hydraulic units are separated by relatively impermeable layers. Two procedures which may be used are described below.

The borehole is advanced to the base of the first saturated zone. Casing is then anchored in the impermeable layer below and grouted to the surface. After the grouting has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After this zone is reached, a conventional well screen and riser casing is set. A typical well constructed in this manner is shown on Figure 2.

Another acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. This method, however, is not acceptable when a competent aquitard or aquiclude may be structurally damaged by the driven casing, because this method may result in cross contamination of two saturated layers.

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3.3 WELL NESTS

Well nest are installed when several distinct intervals in aquifer are to be sampled at each groundwater sampling location. These wells can be completed similarly to those described in Section 2.0. These wells can be installed in a single borehole or in close proximity to each other. When installing multiple wells in a single borehole, extreme care should be exercised when placing bentonite slurry seals above the filter packs. These seals must prevent flow between the wells in the single borehole.

APPENDIX D

RESPONSE TO COMMENTS

**RESPONSE TO AGENCY COMMENTS ON THE DRAFT FIELD SAMPLING PLAN,
ALAMEDA POINT
ALAMEDA, CALIFORNIA**

This document has been prepared in response to the comments on the draft field sampling plan, Alameda Point provided by Ms. Anna-Marie Cook, Remedial Project Manager, U.S. Environmental Protection Agency (U.S. EPA), dated November 20, 1997.

U.S. EPA's comments are presented (verbatim) in bold type, the U.S. Navy's responses are presented in regular type.

GENERAL COMMENTS

RESPONSE TO COMMENTS

1. **Comment:** **The rationale for the investigations is not made clear in the document. The purpose of selecting these three sites for further investigation over other sites at the facility is not identified. There is reference to a workplan addendum dated March 1997 that may have provided some background into why investigations are being performed at Sites 4 and 5, and this information should be summarized in the workplan. An explanation for further investigations at Site 14 should be provided.**

Response: The text has been modified to include a clarification of the purpose of these investigations. The groundwater at Sites 4 and 5 have been investigated during several investigations, which are detailed in the following reports:

- PRC Environmental Management, Inc. (PRC) and James M. Montgomery (JMM). 1992. "Data Summary Report RI/FS Phases 2B and 3."
- PRC and Montgomery Watson (MW). 1993b. Phases 1 and 2A Data Summary Report."
- PRC and MW. 1995a. "Data Summary Report Background and Tidal Influence Studies and Additional Work at Sites 4 and 5."
- PRC and MW. 1995b. "CTO 260 Remedial Investigation/Feasibility Study Data Transmittal Memorandum."
- PRC and MW. 1995c. "CTO 280 Remedial Investigation/Feasibility Study Data Transmittal Memorandum."
- OGISO Environmental. 1997. "Geochemical Profiling for Definition of Chlorinated Solvent Plumes, Sites 4 and 5."

The results of these investigations indicate that additional investigations must be performed to assess the lateral and vertical extent of chlorinated solvents prior to completing the RI/FS for OU-2 (draft RI due February 1999).

The soil and groundwater at Site 14 have been investigated during several investigations, which are detailed in the following reports:

- PRC and JMM. 1992. "Data Summary Report RI/FS Phases 2B and 3."
- PRC and MW. 1995b. "CTO 260 Remedial Investigation/Feasibility Study Data Transmittal Memorandum."

Based on the results of these investigations, additional information is needed around and beneath the sump prior to completing the RI/FS for OU-1 (draft RI due February 1998).

2. **Comment:** **The workplan also discusses investigations performed under an Environmental Baseline Study for parcels not currently under the IR program. Since organic contaminants have been identified at some of these parcels, it would be appropriate to consider placing these parcels under the IR program.**

Response: All parcels under investigation through the Environmental Baseline Survey (EBS) are being considered for reclassification. A human health risk assessment is being performed on the data collected during the EBS investigation to aid in the reclassification of each parcel. Based on the results of the EBS investigation and the human health risk assessment, it is likely that some parcels may be placed under the Installation Restoration program.

SPECIFIC COMMENTS

RESPONSE TO COMMENTS

Introduction

1. **Comment:** **As stated above, no rationale is given for the limited investigations on the subject sites. In addition, no reference is made to the previous investigations that precipitated the investigation at Site 14. It would be helpful to state which OU's these sites are in and when the RI's are due that will present the results of these investigations.**

Response: The text has been revised to include the following:

"The focused investigations at Sites 4 and 5 are being conducted based on the findings from work completed under Contract Task Order (CTO) 260 (1995) and CTO 107, Mod 21 (1997). The results of the investigations completed under CTO 260 (1994-1995) and CTO 107, Mod. 21 (1996-1997), indicated that data gaps were still present in the chlorinated solvent plumes detected at Sites 4 and 5." This information must be evaluated prior to the completion of the RI/FS for OU-2 (draft RI due February 1999).

"The sump investigation at Site 14 is being conducted based on the findings from work completed under CTO 260 (1994-1995) and CTO 121 (1992-1993). The results of the investigations completed under CTO 260 (1994-1995) and

CTO 121 (1992-1993) indicated that additional information is needed regarding the area in the vicinity of the sump. This information must be evaluated prior to the completion of the RI/FS for OU-1 (draft RI due February 1998)."

2. **Comment:** The last paragraph of Section 1.0 states that information from these investigations will be used to determine remedial methods, namely bioremediation. Perhaps what is meant is that this information will be used in the RI/FS to evaluate which remedial actions are best suited to the site, and among those likely to be evaluated will be bioremediation. It would be beyond the scope of this document to decide on any remedial methods at this time.

Response: The text has been modified to read as follows:

"The Navy will use the data from these investigations to (1) evaluate the vertical and lateral extent of the chlorinated solvent plume in groundwater at Sites 4 and 5, (2) develop a conceptual model of contaminant distribution, and (3) gather subsurface information to incorporate into the RI/FS process."

Site 4 Investigation

3. **Comment:** It would be helpful to see on a figure where the plating, metal stripping, and blasting operations were located within the building to demonstrate proximity to the known plume.

Response: Figures 2-1, 2-2, and 2-7 have been modified to provide the approximate location of the former plating shop, solvent cleaning shop, weld shop, machine shop, blast shop, and NDI shop inside Building 360.

4. **Comment:** A brief explanation as to why the data indicate an increase in TCE concentrations from 1989 to 1997 and indicate no concentrations of TCE or vinyl chloride in 1991 and 1992 should be included.

Response: The text has been reworked to include more detail in the discussion of the Description and History section for Site 4. The plume maps in the report are based solely on the 1997 groundwater investigation (OGISO 1997). Groundwater samples containing trichloroethene (TCE) were collected from groundwater monitoring wells MW360-01 through MW360-04 during the 1989 investigation, from completely separate locations in 1991 and 1992 (groundwater grab samples from soil borings), from all on-site groundwater monitoring wells in 1994, and from discrete depths during the 1997 investigation. The only information that can be related is the analysis of the groundwater samples collected from groundwater monitoring wells MW360-01 through MW360-04. The concentration of TCE in these wells has generally decreased over this period. The concentration of TCE in MW360-04 has increased; however, TCE has not been detected in monitoring well M04-06 (located east of MW360-04). If this investigation indicates that the volatile organic compound (VOC) plume extends southeast toward MW360-04, this area will be investigated. The analytical results for the 1989 investigation are

provided in the Phases 1 and 2A Data Summary Report (PRC and MW 1993b) and the analytical results for the 1994 investigation is provided in the CTO 260 Remedial Investigation/Feasibility Study Data Transmittal Memorandum (PRC and MW 1995b) and the CTO 280 Remedial Investigation/Feasibility Study Data Transmittal Memorandum PRC and MW 1995c).

5. **Comment:** **Section 2.3 discusses the presence of elevated levels of solvents in an unidentified well on the eastern (upgradient) side of Building 360. Please identify the well and data in question and discuss if an additional upgradient source exists in the area.**

Response: The well in question is MW360-04. The response to Comment 3 provides details regarding the previous sampling results for this well. An upgradient source has not been identified; however, all data generated from the RI, including this investigation, will be discussed in the RI report for OU-2 (Draft RI due February 1999).

6. **Comment:** **An increase in TCE concentrations with depth indicate the potential for DNAPL. This possibility and the means of determining their presence should be discussed.**

Response: The text has been modified as follows to indicate that dense non aqueous-phase liquid (DNAPL) is present at Site 4.

“Based on the information collected during the March 1997 groundwater investigation, it appears that the chlorinated solvent plume is moving vertically as well as laterally. This indicates the possibility of the presence of dense nonaqueous phase liquid (DNAPL).”

7. **Comment:** **Section 2.4 discusses the “rules” for lateral sample collection during the sampling event. It is unclear whether additional sampling points outside of the grid would be installed if the analytical results indicated that the plume continued off the grid or if only the indicated sampling points would be used. Please clarify.**

Response: The text has been modified to include the following statement:

“If chlorinated solvents are detected in the samples collected from the borings located at the outer limits of the grid, north-south and east-west grid lines will be added in order to assess the extent of the chlorinated solvent plume.”

Site 5 Investigation

8. **Comment:** **A figure should be provided that indicates the location of operations (potential sources) inside the building.**

Response: Figures 3-1, 3-2, and 3-8 have been modified to provide the approximate location of the former plating shop, selective plating shop, wastewater treatment area, hazardous storage area, and battery storage area, all of which were located

in and around Building 5.

9. **Comment:** Section 3.2 discusses groundwater flowing “concentrically” from the southeastern corner of Building 5. Please give a brief summary of the conditions that may be contributing to apparent radial flow, i.e. the possibility of a broken water line to the south of the building, the presence of a potentially leaking sewer beneath the middle portion of the building and the existence of sheet piling at the north edge of the Seaplane Lagoon.

Response: The text has been modified to include the following hydrogeologic discussion:

“Based on the June 1997 groundwater monitoring event, the depth to groundwater in the Site 5 monitoring wells ranged between 4.21 and 6.11 feet below mean low low water level (MLLW). The shallow groundwater appears to flow northerly, away from Building 5; however, the hydraulics beneath Building 5 are difficult to understand. The difficulty is due to several factors that appear to influence groundwater flow in the vicinity of Site 5. These factors include (1) the presence of sheet pilings located on the northern side of the Seaplane Lagoon (located south of Building 5); (2) the presence of water bodies north, south, and west of the site; (3) potentially leaking water supply, sanitary, and storm sewer lines creating local areas of elevated water table; and (4) the utility trenches beneath and adjacent to Building 5 intercept the shallow groundwater, providing a path of preferential flow. The groundwater in the second water-bearing zone (SWBZ) appears to converge along an axis coinciding with the approximate location of an east-to-west trending paleochannel. Additionally, groundwater in the first water-bearing zone (FWBZ) and SWBZ near the southern portion of Site 5 appears to be tidally influenced based on the fluctuations in static groundwater levels in the monitoring wells. The time for a rise in the static groundwater level of Site 5 wells is delayed, probably due to the presence of the sheet pilings.”

This information differs substantially from the draft work plan. Due to the need for a detailed groundwater hydrology discussion, 1997 groundwater elevations and flow maps were used to describe groundwater flow conditions. The report containing this information has not, to this date, been submitted.

10. **Comment:** Figures 3.5 through 3.7 indicate the potential for contamination outside of the proposed sampling grid on the south side of the building. Will sampling continue to the south beyond the grid if contamination is indicated in this area?

Response: The text has been modified to include the following statement:

“If chlorinated solvents are detected in the samples collected from the borings at the outer limits of the grid, north-south and east-west grid lines will be added in order to assess the extent of the chlorinated solvent plume.”

Site 14 Investigation

11. Comment: The Navy proposes to plug any sump drain that may be discovered during cleanout of the sump. It would not be appropriate to plug any drain without first identifying the location and destination of any such drainpipe. Once identified, the soil surrounding the outlet from the drainpipe should be sampled appropriately to determine if it poses a continuing source of contamination.

Response: The text has been modified to include the following paragraph:
“In addition, the cleaning of the sump will reveal if a drain exists at the bottom of the sump. If a drain exists, the drain cover, if any, will be removed and a temporary plug will be inserted approximately 1 foot into the drain pipe. The drain outfall will be located, if possible, and investigated. If the outfall opens directly to the atmosphere, a sample will be collected from just below the outfall.”

12. Comment: The technical aspects of the Quality Assurance Project Plan (Appendix A) and the Standard Operating Procedures for well installation (Appendix B) appear adequate.

Response: Comment noted.