2/1/95-00719

Draft Final Report on the Phase II RCRA Facility Investigation of Sites 2D, 2E, 15, 24, and 25

Oceana Naval Air Station Virginia Beach, Virginia

Prepared for

ATLANTIC DIVISION NAVAL FACILITIES ENGINEERING COMMAND
Norfolk, Virginia

Contract N62470-93-D-4072

Prepared by

CH2M HILL

February 1995

Certification

I certify that the information contained in or accompanying the RCRA Facility Investigation Phase II addendum report is true, accurate, and complete.

As to those identified portion(s) of this RFI addendum report for which I cannot personally verify their accuracy, I certify under penalty of law that this RFI addendum report and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person of persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Date: _____

Signature: _____

Nina M. Johnson, P.E.
Head of Installation Restoration, North Section
Environmental Quality Division
LANTNAVFACENGCOM

CONTENTS

CONTENTS

Appendices **Page**

CONTENTS

Figures — **Follows Page**

CONTENTS

CONTENTS

Chapter 1
Introduction

In late 1992 and early 1993, a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of 17 RCRA solid waste management units (SWMUs) was conducted at the Oceana Naval Air Station. At the conclusion of this study (CH2M HILL, 1993), it was apparent that the various sites required different responses. Five sites did not require any additional work within the RCRA Corrective Action Program on the basis of the investigation results and site history.

Twelve sites remained active in the Corrective Action Program but were divided into different levels of priority for further study and remediation. These recommended action groups were (1) Sites 1, 2B, and 2C, (2) Sites 11, 18, 19, 20, and 24, and (3) Sites 2D, 2E, 15, 24, and 25. The locations of the 12 active sites within the station are shown in Figure 1-1. Each of these groups of sites will follow a separate track and their future progress in the RCRA corrective action process will be reported separately. At the time of this report, a draft CMS report on sites 1, 2B, and 2C has been completed (CH2M HILL, November 1994) and a groundwater remediation action is being designed. A final CMS (CH2M HILL, October 1994), and a soil remediation design (CH2M HILL, June 1994), have been completed for sites 11, 18, 19, 20, and 24 soils. The soil removal action was completed in January 1995. Sites 2D, 2E, 15, and groundwater at Site 24 are in the second phase of the RFI. These activities are reported in this document.

The contamination at Site 24 is being addressed by medium on two separate tracks. The soil was well characterized during the field investigation in February and March 1994, such that soil remediation can proceed at Site 24 in parallel with sites 11, 18, 19, and 20. The same investigation showed that groundwater contamination was more extensive than expected, so additional characterization work was completed in September and October 1994. The groundwater data for Site 24 are reported in this document.

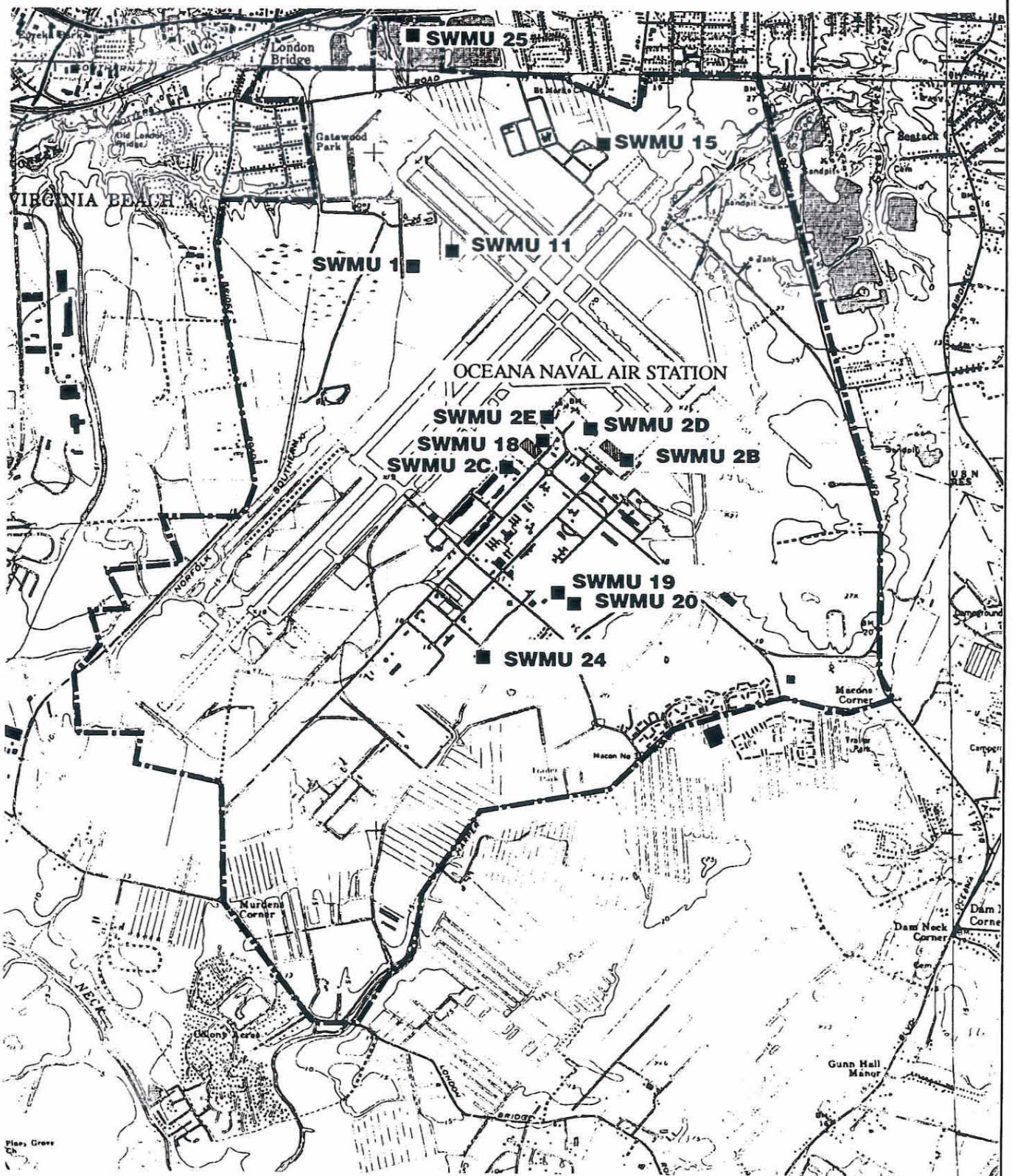


Figure 1-1
LOCATIONS OF ACTIVE RCRA SWMUs
RCRA RFI/CMS Investigations–Naval Air Station, Oceana

Although the sites were divided into three groups, the recommendations for additional characterization in the Phase I RFI report (CH2M HILL, 1993) and in the draft CMS report were implemented during a single field investigation. The field investigation associated with these CMS and RFI sites was conducted from February to October 1994.

This report serves two purposes. The first is to report the results of the investigation of the five Phase II RFI sites. The main body of the report is focused on the five sites, which are:

- Site 2D—Line Shack 125 Disposal Area
- Site 2E—Line Shack 109 Disposal Area
- Site 15—Abandoned Tank Farm
- Site 24—Bowser, Building 840 (groundwater only)
- Site 25—Inert Landfill

The second purpose is to report on elements of the field investigation that are common to the three groups of sites. This was done so there would be one reference for the general reporting of the investigations in the interest of consistency and clarity. The information common to all the sites is reported in the appendices and is summarized in this chapter. The second chapter addresses sites 2D, 2E, 15, 24, and 25 only.

This report is written as an addendum to the Phase I report. Certain information, such as the presentation of the extensive ecological study and substantial background information on the station and on each site, is not repeated. This report includes some background information but emphasizes changed conditions and interpretations. Familiarity with the details of the Phase I report is assumed. All tables of analytical data in this report show the results from all past investigations in addition to the results from this phase of sampling. This was done so that historical trends could be reviewed. For convenience, this additional RFI investigation will be referred to as the ''Phase II RFI'' in the remainder of this report.

The purpose of the Phase II RFI was to characterize the contamination at the five sites in enough detail that a sound determination of future action can be made, and if a CMS is appropriate, enough detail to support selection of a remedy.

CMS/POL/RFI Phase II Site Activities

The field investigation was completed as specified in the three work plan addenda (CH2M HILL, 1994), to the original work plan (CH2M HILL, 1992), with a few exceptions. Several wells, samples, and analyses were added during the investigation to enhance characterization, as dictated by field conditions. The field investigation at the twelve sites consisted of the following activities:

- Hydraulic probe sampling of soil and groundwater with onsite mobile lab analysis
- Drilling and monitoring well installation
- Environmental sampling of soil, groundwater, sediment, and surface water
- In situ hydraulic conductivity testing
- Containment, stockpiling, and disposal of investigation-derived waste (IDW) soil and groundwater
- Surveying of wells and surface water datum points and measurement of corresponding water levels

The activities at the individual sites are summarized in Table 1-1. Analytical sampling is summarized by medium in Tables 1-2, 1-3, and 1-4. The compounds included in each

Table 1-1
SUMMARY OF CMS/POL/PHASE II RFI FIELD ACTIVITIES[a]

	Site 1 West Woods	Site 2B Line Shack 130-31	Site 2C Line Shack 400	Site 2D Line Shack 125	Site 2E Line Shack 109	Site 11 Firefighting Rings	Site 15 Abandoned Tank Farm	Site 18 Hazardous Waste Storage Areas	Site 19 Waste Oil Storage Area Bldg. 541	Site 20 Waste Oil Storage Area Bldg. 543	Site 24 Bowser Bldg. 840	Site 25 Inert Landfill
Monitoring Points:												
Shallow Well (~20')	1	4	7	2	10	--	11	--	--	--	6	--
6-inch Extraction Well (~25')	1	1	--	--	--	--	--	--	--	--	--	--
3/4-inch piezometer (~9')	--	--	--	--	8	--	--	1	--	--	4	--
2-inch piezometer	5	9	--	--	--	--	6	--	--	--	--	--
2-inch Observation Well	--	1	--	--	--	--	--	--	--	--	--	--
(~25')	--	1	--	--	--	--	--	--	--	--	--	--
Test Pits (~8-10')	--	--	--	--	--	--	10	--	--	--	--	--
In situ Hydraulic Conductivity Test	--	--	--	3	3	--	3	--	--	--	--	--
Sample Collection:												
Hydraulic Probe												
Soil	--	11	9	3	1	3	15	--	--	--	--	--
Groundwater	--	4	14	5	21	4	16	1	1	1	24	--
Soil Borings (drilling)	17	--	--	4	3	--	2	--	--	--	--	--
Groundwater	6	6	13	5	10	--	11	--	--	--	6	--
Surface Water	--	4	--	1	--	--	--	--	--	--	--	--
Sediment	5	3	--	--	--	--	--	--	--	--	--	3
Soil												
Hand Auger	--	--	--	--	3	10*	--	6	6	10	12	--
Power Auger	--	--	--	--	16	--	--	--	--	--	--	--

*Includes sampling in north and south firefighting training rings.
[a]Phase II includes investigations in the Spring and Fall of 1994.

Table 1-2
SUMMARY OF PHASE II GROUNDWATER SAMPLING AND ANALYSIS PROGRAM[f]
NAVAL AIR STATION, OCEANA

Parameters	Analytical Method[a]	Number of Samples Collected									
		Site 1 (6)	Site 2B (6)	Site 2C (13)	Site 2D (5)	Site 2E (5)	Site 15 (6)	Site 18 (1)	Site 19 (1)	Site 20 (1)	Site 24 (4)
Volatiles[b]	SW-8240	6	8	13	5	10	11		1	1	10
Total Metals	SW-6010/7000					5		1		1	10
Dissolved Metals	SW-6010/7000					5		1		1	10
Total Petroleum Hydrocarbons	SW-418.1					10	11	1	1	1	10
Polynuclear Aromatics	SW-8100	6				10	11	1	1	1	10
Total Lead	SW-7421						11				
Dissolved Lead	SW-7421						11				
Total Lead/ Mercury/Zinc	SW-6010/7000					5					
Dissolved Lead/ Mercury/Zinc	SW-6010/7000					5					
Product Fingerprint	SW-8015B					1					

Notes:
This table includes standard laboratory analyses only, not mobile lab analyses.
( )The number of monitoring wells or hydraulic probe samples collected for offsite analysis. Quality control samples are not included.
[a]Analytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.
[b]A detection limit of 2 μg/l or less was required for vinyl chloride.
[f]Phase II includes investigations in the Spring and Fall of 1994.
Constituents for each method are listed in Chapter 3 of the Phase I RFI report.

Table 1-3
SUMMARY OF PHASE II SOIL SAMPLING AND ANALYSIS PROGRAM[a]
NAVAL AIR STATION, OCEANA

Parameters	Analytical Method[a]	Number of Samples Collected										
		Site 1	Site 2B	Site 2C	Site 2D	Site 2E	Site 11[e]	Site 15	Site 18	Site 19	Site 20	Site 24
Volatiles	SW-8240	13	2	2	5	3	7	1				
TPH	SM-418.1[c]	16				3	13	1	4	6	10	12
Lead	SW-7421											
Metals	SW-6010/7000	2[b]					1					3
Agricultural Parameters[f]	Several Methods	13										
Appendix IX	See Phase I report, Chapter 3								2			
Polynuclear Aromatics	SW-8100	13				3	7	1	4			6
TCLP Metals[d]	SW-8080	3					6					
TCLP Volatiles[d]	SW-8010	3										
TCLP Semivolatiles[d]	SW-7060	3										

Notes:
This table does not include drum samples, samples analyzed in the mobile lab, or quality control samples.
[a]Analytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.
[b]These two soils were background soil samples collected near the Oceana main gate, not at Site 1. They are listed under Site 1 for convenience.
[c]Analytical method as per *Standard Method for Analysis of Water and Wastewater*.
[d]Includes only in situ soil samples.
[e]Includes three samples for TCLP metals, PAHs, VOCs, and TPH from each of the firefighting training rings in April, 1994.
[f]Agricultural parameters include total Kjeldahl nitrogen, total phosphorus, ammonia-N, and nitrate/nitrite-N.
[g]Phase II includes investigations in the Spring and Fall of 1994.

Table 1-4
SUMMARY OF PHASE II SURFACE WATER AND SEDIMENT SAMPLING AND ANALYSIS PROGRAM[#]
NAVAL AIR STATION, OCEANA

Parameters	Analytical Method[a]	Number of Samples Collected				
		Site 1	Site 2B		Site 2D	Site 25
		Sediment	Sediment	Surface Water	Surface Water	Sediment
Volatiles[b]	SW-8240	2	4		1	
Total Organic Carbon	415.2	5		3		3
Total Metals	SW-6010/7000					3
TCL Pesticides	SW-8080	1				3
Polynuclear Aromatics	SW-8100	4				

Notes:
Constituents for each method are listed in Chapter 3 of the Phase I RFI report.
Table does not include quality control samples.
[a]Analytical methods as per *Test Methods for Evaluating Solid Waste*, 3rd Edition, Dec. 1986.
[b]A detection limit of 2 μg/l or less was required for vinyl chloride in water.
[#]Phase II includes investigations in the Spring and Fall of 1994.

analytical method are listed in Chapter 3 of the Phase I RFI report (CH2M HILL, December 1993).

The analytical data collected during this investigation was validated using EPA protocols for Level C data packages. Data validation remarks are included in the analytical tables in this report and in the corresponding POL and CMS reports. The data validation procedures are described in Appendix G of the Phase I report. Appendix E of this report summarizes some of the findings of the data validation for this round of data collection.

Report Organization

This report is divided into three parts. This introductory chapter describes the context for the investigation as a whole. Chapter 2 is a detailed description of results for the five RFI sites. It includes the following sections:

- Site Conditions
- Investigation Activities
- Site Contamination
- Health and Environmental Assessment
- Recommendations

The appendices include investigation data for the entire investigation. Appendix A describes drilling and test pit excavation activities and includes test pit logs and all soil boring logs for the new wells as well as three Site 15 wells installed by R.E. Wright Associates in 1982. Appendix B summarizes quality control sampling and field sampling data, particularly parameters such as pH, temperature, and conductivity recorded during groundwater sampling. Appendix C presents the time-series graphs of the *in situ* hydraulic conductivity tests. Appendix D presents surveying data and a summary of all wells installed at the active RCRA sites. Appendix E is a summary of data validation.

Appendix F contains a memorandum to the EPA describing the results of background soil sampling for metals. The background data presented in Appendix F apply to soil data collected at the CMS, RFI Phase II, and POL sites but are presented only in this report. Appendix G is a memorandum describing the results of a records search for Site 2E historical use data.

WDCR832/001.WP5

Chapter 2

Results of RFI Phase II Site Investigation

Introduction

This chapter presents the results for the five sites investigated during the Phase II RFI. Changes in conditions and understanding are emphasized in the individual site sections, particularly those arising from new data collected during the Phase II investigation. Some details about site history and location, ecology, and past investigations are repeated from the Phase I report as needed (CH2M HILL, 1993). However, the reader is referred to the Phase I report for additional detail.

The individual topics discussed at each site are:

- Site Conditions
- Investigation Activities
- Data Interpretation
- Health and Environmental Assessment
- Recommendations

The discussion of site conditions encompasses the site location, history, and ecology. Few details of the ecological setting have been modified since the ecological study conducted as part of the Phase I investigation. Aspects of the site history that are new or have been reinterpreted since the Phase I report was finalized are highlighted in this section. Geologic cross sections of Sites 2E, 15, and 24 are included in this section.

Investigation Activities is a description of the individual tasks at each site. This section is primarily a summary of the activities described in the work plan but includes some important adjustments in response to field conditions encountered during the field

investigation. The Data Interpretation section presents groundwater flow data and analytical results. The distribution of contamination is described in this section. A discussion of the fate and transport of site contamination also is presented. Tables include results from all samples collected at the site since these sites were first investigated in 1990 or 1993. The complete data record is provided so that historical trends can be reviewed. As before, only detected constituents are included in the tables. Detection limits are indicated either by individual sample or by constituent. The complete list of constituents within each analytical method was presented in Chapter 3 of the Phase I report. The analytical data are compared to potential criteria, guideline values, and standards in the section Health and Environmental Assessment. The discussion is tailored to determining whether future action is advisable. A more detailed discussion of the approach to assessing contaminant concentrations is included in the introduction to Chapter 4 of the Phase I RFI Report (CH2M HILL, 1993).

Site 2D—Line Shack 125 Disposal Area

Site Conditions

Site 2D includes the area near Line Shack 125 and the southeast corner of Building 111. The area near Line Shack 125 is used for aircraft maintenance and storage of equipment and materials. The line shack was constructed in 1963. Building 111 was constructed more recently, in the late-1980s or early-1990s. The Initial Assessment Study (IAS) identified Site 2D as an area where aircraft cleaning and maintenance chemicals were disposed (RGH, 1984). The period of potential release started with construction in 1963 and ended with the implementation of a rigorous hazardous waste pickup system in the early 1980s. During this period, oil, hydraulic fluid, PD 680, aromatic hydrocarbons, and halogenated solvents may have been disposed. The area of potential disposal indicated in the IAS is illustrated in Figure 2-1-1.

One area of clarification is the wetland depression at the southeast corner of the parking lot outside the fenceline. In the work plan, this depression was said to have no outlet; however, adjacent to the depression is a stormwater culvert that crosses the access road to the southeast. On the other side of the road is a grate that traps debris from stormwater originating from flightline areas east and northeast of the depression. The elevation of the grate appears higher than the culvert so water appears to drain to the depression rather than away from it. If this is true, this depression receives runoff from the paved parking lot to the north and the paved flightline area to the southeast, east, and possibly northeast, depending on runoff patterns.

The depression was dry during an April 22, 1994, site visit. This suggests that the depression is fed primarily by stormwater and receives groundwater only when the water table is high. The presence of cattails and other wetland features indicates that the water table is within inches of the bottom of the depression most of the year.

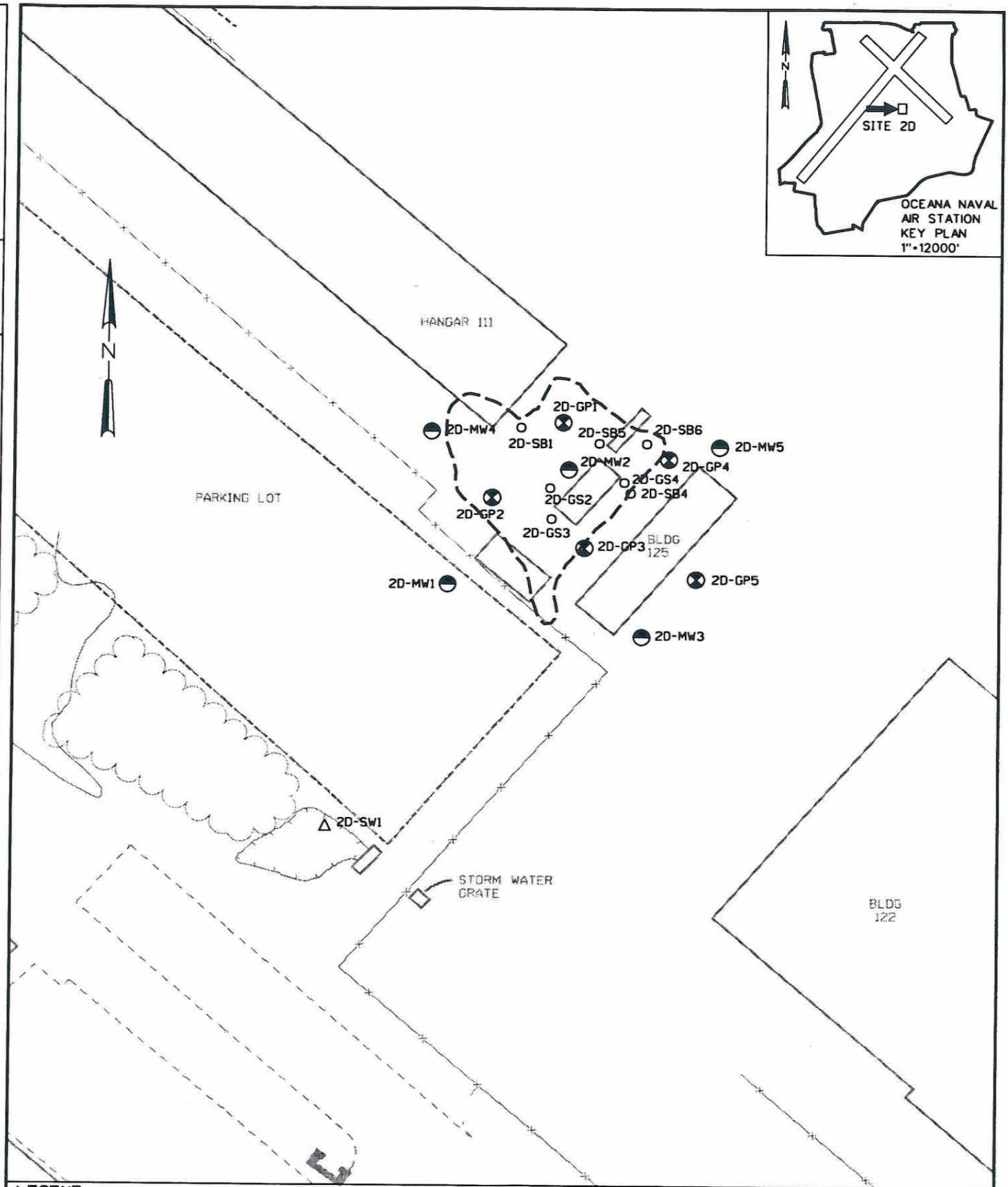


Figure 2-1-1

RFI PHASE II
SAMPLING LOCATIONS
AT SITE 2D

CH2MHILL

ONAS0368bdr.dgn 2-63
ONASPC21183.DGN -59
ONAS721183.dgn -63
ONASTC24183.DGN -63
ONASPC24183.DGN 1-39, 41-44, 46-59
ONAS0368W12D.DGN 1-63
ONAS0368BTXT.DGN 1-63

0368m2d2.dgn
14-DEC-1994

Investigation Activities

Investigation activities included in-situ soil and groundwater sampling, well installation, slug testing, and surveying. Figure 2-1-1 shows the locations sampled during the Phase II RFI. Two purposes of the Phase II work at Site 2D were to attempt to find a soil source for the 1,1-dichloroethylene (1,1-DCE) in well 2D-MW2 and to determine the extent of 1,1-DCE contamination in groundwater.

The program began with in-situ groundwater sampling at five locations (2D-GP1 to 2D-GP5). Samples 2D-GP2, 2D-GP3, and 2D-GP5 were collected from 13 to 15 feet, 2D-GP4 was collected from 10 to 15 feet, and 2D-GP1 was collected from 14 to 16 feet. The screen lengths and depths varied because different types of lead rods or screens were used to sample. All in-situ groundwater samples were collected from a depth even with the mid-depth of the monitoring wells so that in-situ results and monitoring well results would be comparable.

Seven soil samples were collected using the in-situ sampler (2D-GS2, 2D-GS3, 2D-GS4) and the drill rig with a split-spoon sampler (2D-SB1, 2D-SB4, 2D-SB5, and 2D-SB6). The three in-situ samples were analyzed in the on-site mobile lab, whereas the four samples collected with the drill rig were analyzed using full Level C QC in CH2M HILL's Montgomery, Alabama, laboratory. A split was taken of in-situ sample 2D-GS2 to confirm the on-site lab results. In-situ samples were collected from 3 to 5 feet and samples collected with the drill rig were from 4 to 6 feet.

Two shallow monitoring wells were installed after review of in-situ soil and groundwater results. Well 2D-MW4 was installed as indicated in the work plan but well 2D-MW5 was moved to the southeast to be more directly upgradient of soil locations with detected contamination (2D-SB4, 2D-SB5, 2D-GS2). The well construction of all Site 2D wells is summarized in Table 2-1-1. Groundwater samples were collected from all five wells during the Phase II RFI.

Table 2-1-1
SITE 2D MONITORING WELL SUMMARY

Well Number	Date Installed	Ground elevation (feet above MSL)	Total Depth (feet)	Screened Interval (feet below ground surface)
2D-MW1	06/28/90	21.52*	17	7-17
2D-MW2	07/02/90	22.3	19	9-19
2D-MW3	07/03/90	22.1	19	9-19
2D-MW4	02/21/94	22.4	20	8-20
2D-MW5	02/22/94	22.3	21	10-20

Note:
*Between surveying in 1990 and 1993, 2D-MW1 has been changed from a monitoring well with protective casing to a flush mount. 2D-MW1 is now located in a parking lot which has been graded. The former ground elevation was 18.9 feet. The ground elevation is now 21.52 feet.

WDCR820/009.WP5

The surveying of the low point in the wetlands depression and of the monitoring wells and the measurement of in-situ hydraulic conductivity of the surficial aquifer also were part of field activities at Site 2D. Slug tests were conducted in wells 2D-MW1, 2D-MW2, and 2D-MW3 to calculate hydraulic conductivity at these locations and infer the general conductivity for the site.

Data Interpretation

The water-level elevations for the five wells are listed in Table 2-1-2 and equipotential contours are illustrated in Figure 2-1-2. These data demonstrate that groundwater flowed to the west during the investigation. The groundwater flow direction was reported to be to the northwest during the Phase I RFI. The current determination is likely to be more representative because it is based on five wells instead of three. Both rounds of water-level measurements show that groundwater from Site 2D does not flow to the wetland depression.

The elevation of the bottom of the wetland depression is approximately 17.5 feet. This is considerably above the water levels of 14.3 to 14.9 feet measured in the wells during the investigation and higher than the water levels of 16.7 to 17.3 feet measured in January 1993. Even in high water table periods, the depression is not expected to be a groundwater discharge point. The elevation data suggest that surface water normally collects in this area and recharges to groundwater.

The average hydraulic conductivity from slug tests in wells 2D-MW1, 2D-MW2, and 2D-MW3 was $5x10^{-3}$ cm/sec or 14 ft/day. An aquifer test at Site 2B and a pump test at Site 1 showed that the hydraulic conductivity calculated from aquifer tests was approximately three times the average volume calculated from slug tests. If this ratio also holds at Site 2D, the area-wide hydraulic conductivity would be approximately 1.5×10^{-2} cm/sec, or 42 ft/day. The hydraulic gradient shown in Figure 2-1-2 is approximately 0.004 ft/ft from 2D-MW5 to 2D-MW2. If the porosity of the sand aquifer is 25 percent

Table 2-1-2
SITE 2D WATER-LEVEL DATA
May 23, 1994

Well	Elevation of Survey Datum (feet)	Water Level Distance Below Survey Datum (feet)	Water Level Elevation (feet)
2D-MW1	21.52	7.20	14.32
2D-MW2	22.26	7.86	14.40
2D-MW3	22.10	7.56	14.54
2D-MW4	22.40	8.03	14.37
2D-MW5	22.34	7.45	14.89

Elevations are in feet above mean sea level.

WDCR807/041.WP5

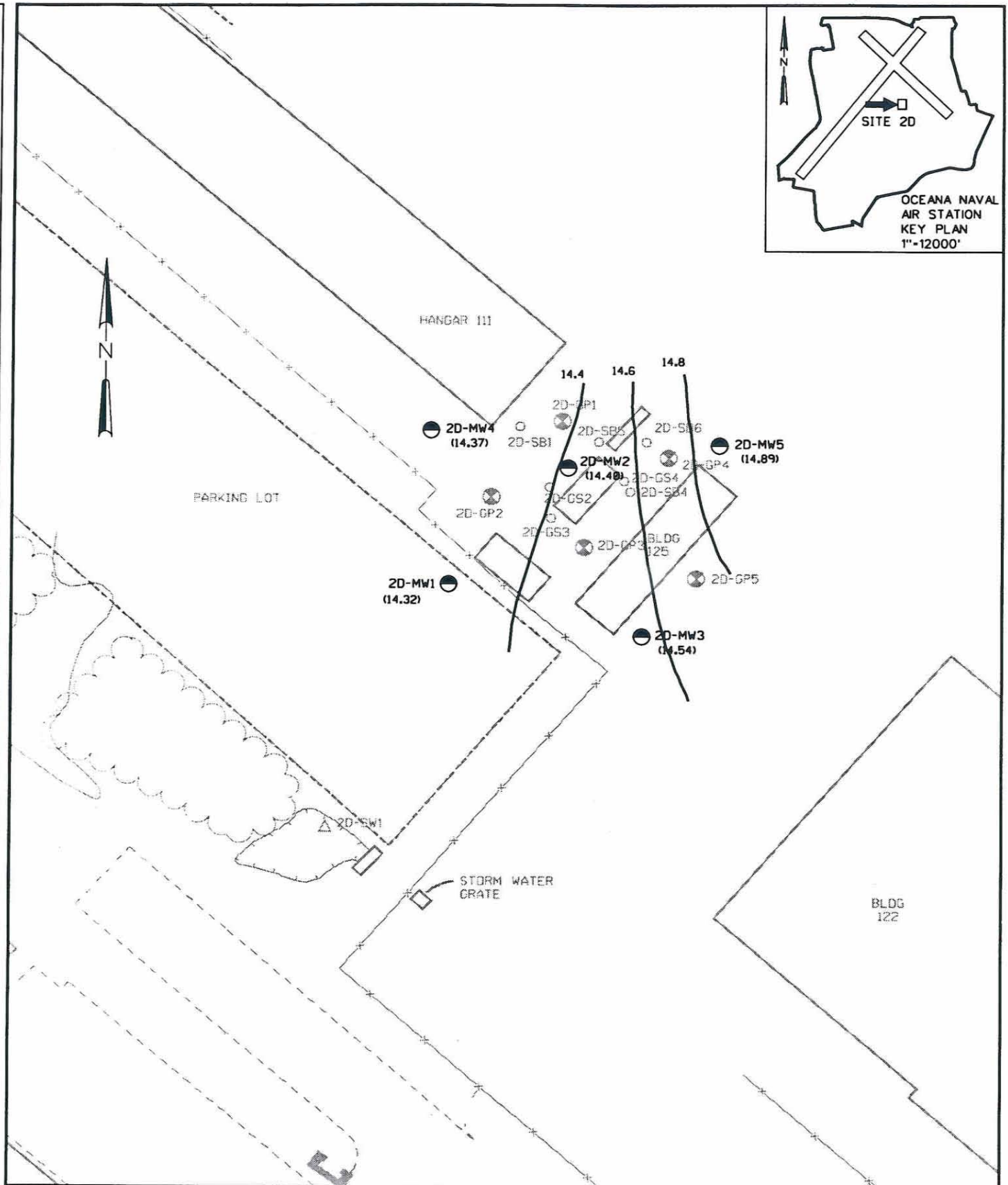


Figure 2-1-2
GROUNDWATER ELEVATIONS
AT SITE 2D
MAY 23, 1994

CH2MHILL

ONAS0368bdr.dgn 2-63
ONAS0PC21183.DGN -59
ONAST21183.dgn 53
ONAST0C24183.DGN
ONAS0PC24183.DGN 1-39, 41-44, 46-59
ONAS0368W12D.DGN 1-63
ONAS0368BT XT.DGN 1-63

0368m2d5.rdo
01-DEC-1994

and the hydraulic conductivity is 42 ft/day, the velocity of groundwater flow is approximately 240 ft/year to the west.

The concentrations of volatile organic constituents in in-situ groundwater samples are listed in Table 2-1-3 and illustrated in Figure 2-1-3. The concentrations of all constituents in in-situ groundwater samples were low. Only 2D-GP4 contained 1,1-DCE but its concentration was only 0.9 ppb, considerably less than the 9 ppb of 1,1-DCE in well 2D-MW2. Trace concentrations of fuel-related constituents below the Method 8240 detection limit were detected at each in-situ location except 2D-GP4.

The concentrations of VOCs in surface water samples and groundwater from monitoring wells are listed in Table 2-1-4 and illustrated in Figure 2-1-3. The VOC concentrations in monitoring wells and in the surface water from the wetland depression also were near the detection limit. No volatile constituents were detected in wells 2D-MW1, 2D-MW3, 2D-MW5 or in the surface water sample. Only trace concentrations were detected in well 2D-MW4. The VOC concentrations in well 2D-MW2 in 1993 were confirmed by the March 1994 sampling. The key constituent 1,1-DCE had a concentration of 9 ppb, the same as in 1990 and slightly lower than the 12 ppb detected in 1993. The total concentration of VOCs was 53 ppb in 1994 versus 78 ppb in 1993. The groundwater results suggest that groundwater contamination by VOCs is limited to a radius of approximately 50 feet from well 2D-MW2. The radius with 1,1-DCE above the maximum contaminant level (MCL) of 7 ppb is probably less.

The VOC data for soils are listed in Table 2-1-5 and illustrated in Figure 2-1-4. 1,1-DCE was not detected in the seven soil samples and the concentrations of other chlorinated VOCs also were near detection limits or undetected. Benzene, toluene, ethylbenzene, and xylene, known as BTEX compounds, were detected in all seven samples. This finding suggests that the soils in this area contain some petroleum products. Total BTEX concentrations were highest near the small building east of 2D-GS2. The total BTEX concentration in the mobile laboratory sample from 2D-GS2 was 1,960 ppb versus 6 ppb in the split sample sent to the offsite laboratory. The higher concentration in the soil sample

Table 2-1-3
ORGANIC COMPOUNDS IN IN-SITU GROUNDWATER AT SITE 2D
FEBRUARY 1994
(All data in µg/L)

Analyte	MCLs	Detection Limit Range	2D-GP1	2D-GP2	2D-GP3	2D-GP4	2D-GP5
TPV	—	5	*	*	*	*	*
Chlorinated Volatile Organic Compounds							
1,1-Dichloroethylene	7	2	*	*	*	0.9	*
Cis-1,2-Dichloroethylene	70	2	*	3.5	6.5	2.4	4.33
1,1-Dichloroethane	NS	2	1.8	*	0.54 j	3.3	0.36 j
Trichloroethylene	5	0.5	*	0.25 j	*	*	*
Aromatic Volatile Organic Compounds							
Benzene	5	5	4.7 j	*	2.5 j	*	3.9 j
Toluene	1,000	5	*	*	1.7 j	*	*
Ethylbenzene	700	5	*	*	3.6 j	*	*
Xylenes (total)	10,000	5	*	3 j	*	*	*

Notes:

TPV - Total Petroleum Volatiles. There is no MCL for TPV.
* - Compound analyzed but not detected above the instrument detection limit.
j - Indicates an estimated value below the instrument quantitation limit.
NS - No MCL.
The in-situ groundwater samples were mini-piezometers screened from the following depths:
10 to 15 feet—2D-GP4
13 to 15 feet—2D-GP2, 2D-GP3, and 2D-GP5
14 to 16 feet—2D-GP1

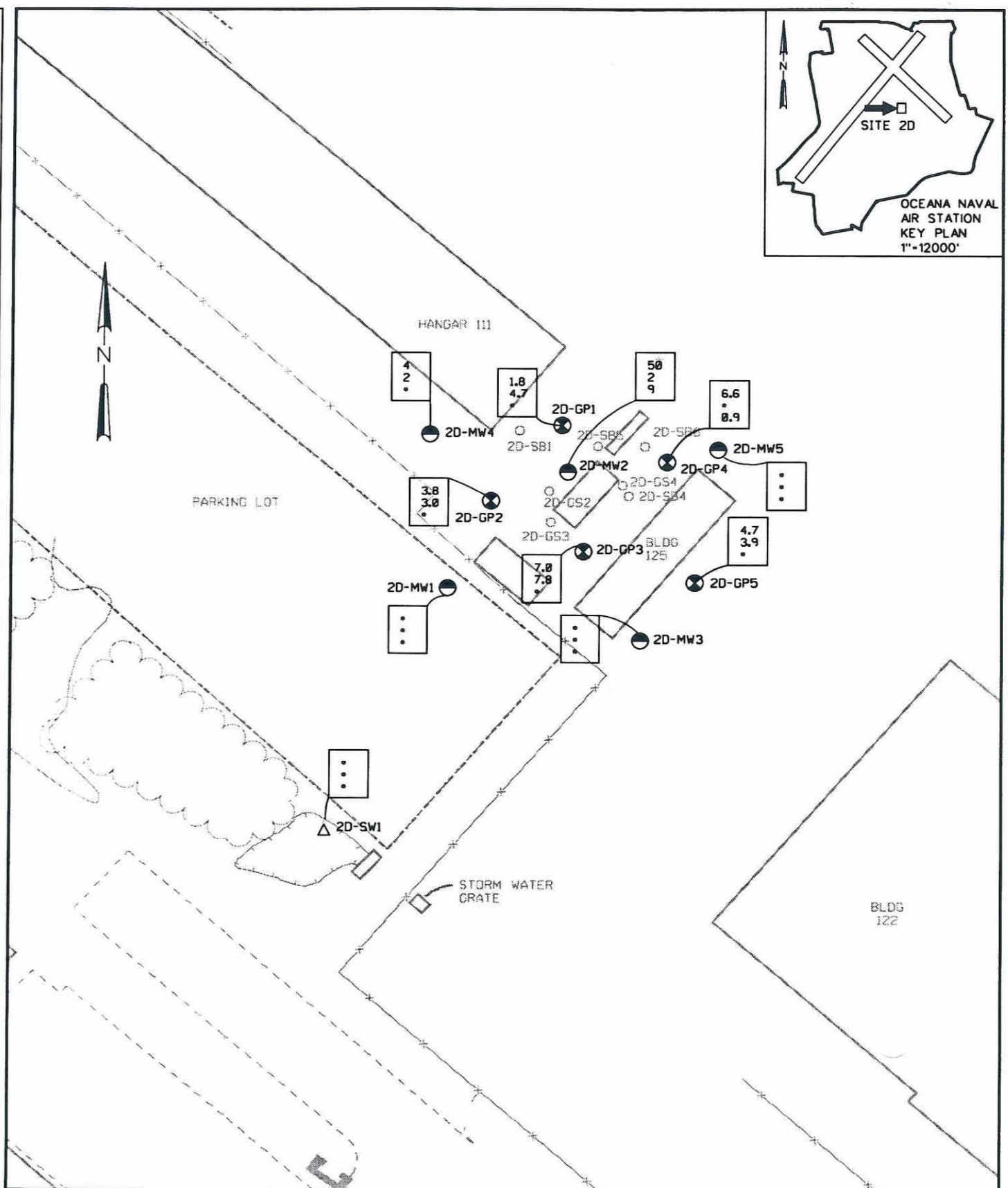


Figure 2-1-3
TARGET VOLATILES IN GROUNDWATER AND SURFACE WATER AT SITE 2D
FEBRUARY AND MARCH 1994

CH2MHILL

ONAS0368dr.dgn 2-43
ONASPC21183.DGN 59
ONASS721183.dgn 13
ONASIT21183.DGN
ONASPC21183.DGN 1-30, 41-44, 46-59
ONAS0368W12D.DGN 1-63
ONAS0368BT.XT.DGN 1-63

0368m2d3.rdo
01-DEC-1994

2-1-4

ORGANIC COMPOUNDS IN GROUNDWATER AND SURFACE WATER AT SITE 2D
AUGUST 1990 THROUGH MARCH 1994
(All data in ppb)

Analyte	Detection Limit	2D-MW1			2D-MW2			2D-MW3				2D-MW4	2D-MW5	2D-SW1#
		Aug. 90	Jan. 93	Mar. 94	Aug. 90	Jan. 93	Mar. 94	Aug. 90	Jan. 93		Mar. 94	Mar. 94	Mar. 94	Mar. 94
									Initial	Duplicate				
EDB	0.02	*	NA	NA	*	NA	NA	*	NA	NA	NA	NA	NA	NA
TPH	60	360	NA	NA	220	NA	NA	*	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds														
Acetone	10	5 bj	5 bj	*	5 bj	8 j	6 j	20 b	4 j	6 j	*	19 b	5 jb	10 b
Benzene	5	*	*	*	3 j	2 j	2 j	*	1 j	*	*	2 j	*	*
Carbon disulfide	5	*	*	*	*	*	*	1 j	*	*	*	1 j	3 j	*
1,1-Dichloroethane	5	*	*	*	64	56	36	*	*	*	*	*	*	*
1,1-Dichloroethylene	5	*	*	*	9	12	9	*	*	*	*	*	*	*
1,2-Dichloroethylene (total)	5	*	*	*	2 j	*	1 j	*	*	*	*	*	*	*
Ethylbenzene	5	*	*	*	2 j	*	*	*	*	*	*	*	*	*
Methylene chloride	5	4 bj	5 b	*	3 bj	3 bj	*	4 bj	2 bj	5 b	*	*	1 bj	2 bj
Styrene	5	*	*	*	*	*	*	*	*	*	*	3 j	*	*
Xylenes (total)	5	*	*	*	6	*	*	*	*	*	*	*	*	*
Chloroethane	10	*	*	*	*	5 j	4 j	*	*	*	*	*	*	*
Semivolatile Organic Compounds														
Di-n-Butylphthalate	10	NA	NA	NA	NA	2 j	NA	NA	NA	NA	NA	NA	NA	NA
Polynuclear Aromatics (PAHs)	2	NA	*	NA	NA	a	NA	NA	*	*	NA	NA	NA	NA

Notes:
EDB Ethylene Dibromide
TPH Total Petroleum Hydrocarbons
NA Not analyzed
(*) Concentration below detection limit
a PAH compounds were analyzed as part of the semivolatile analysis
b Compound found in laboratory blank as well as sample
j Estimated value; measured value is less than the accurately quantitative detection limit
#2D-SW1 is a surface water sample collected from the shallow wetlands depression near Site 2D.

WDCR807/029.WP5

Table 2-1-5
ORGANIC COMPOUNDS IN SOIL AT SITE 2D
February 1994
(All data in ppb)

Analyte	2D-SB1	2D-GS2		2D-GS3	2D-GS4	2D-SB4	2D-SB5	2D-SB6
	4.0-6.0 ft.	3.0-5.0 ft.		3.0-5.0 ft.	3.0-5.0 ft.	4.0-6.0 ft.	4.0-6.0 ft.	4.0-6.0 ft.
		Mobile Lab	Standard Lab					
Total Petroleum Volatiles	NA	2,800	NA	678.7	645.5	NA	NA	NA
Volatile Organic Compounds								
Methylene Chloride	8 b	NA	6	NA	NA	26 b	4 jb	7 b
Acetone	99 bj	NA	20 b	NA	NA	390 dj	28 b	140 bj
Carbon Disulfide	2 j	NA	<6	NA	NA	7 j	<6	<6
2-Butanone	21 j	NA	<12	NA	NA	150 j	5 j	28 j
Benzene	<6	74.9	<6	<25	6.8 j	7 uj	<6	<6
Toluene	27	31.5	<6	<25	10.7	330 d	5 j	<6
Ethylbenzene	7	727.8	2 j	128	29.5	14 j	68	<6
Xylene (total)	36	1,126.2	4 j	83.2	25.6	66 j	200	4 j
4-Methyl-2-Pentanone	<12	NA	<12	NA	NA	22 j	<11	3 j
2-Hexanone	<12	NA	<12	NA	NA	35 j	<11	4 j

Notes:
2D-GS2, GS3, and GS4 were geoprobe samples which were analyzed in the mobile laboratory for field VOCs. The other soil samples (2D-SB1, 2D-SB4, 2D-SB5, 2D-SB6) were collected with a drill rig and submitted to the analytical laboratory for Method 8240 analysis.
QC Sampling: 2D-GS2 was split and analyzed in the mobile lab for field VOCs. The duplicate was submitted to the analytical laboratory.
The analytical laboratory performed a dilution run on 2D-SB4.
b The analyte is found in the associated blank as well as the sample.
d Identifies compounds which have been run at a dilution to bring the concentration of that compound within the linear range of the instrument.
j Indicates an estimated value. Measured value is less than the quantitative detection limit.
* Compound analyzed but not detected in any samples.
The (—) for 2-butanone in 2D-GS2 indicates the value was rejected because the instrument calibration was out of the specified range.
NA - Not analyzed.
All volatile organic compounds not listed above were analyzed but not detected. In the case of 2D-SB4, the quantitation limits for all unlisted compounds were qualified as estimated during the data validation process.
uj = Reported quantitation limit was qualified as estimated during the data validation process. Constituent was not detected as the estimated quantitation limit.
< The compound was not detected above the stated instrument detection limit.

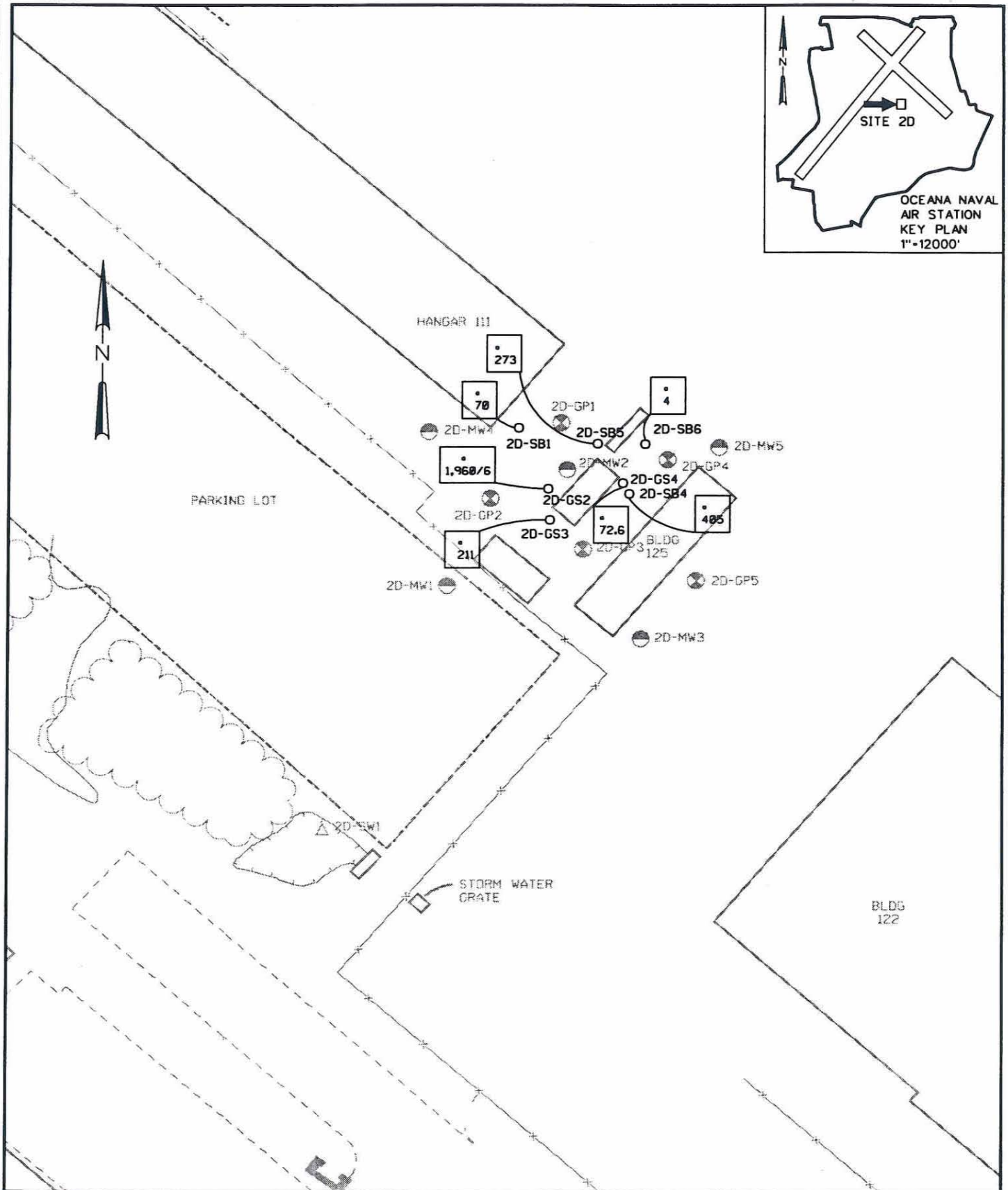


Figure 2-1-4
VOCs IN SOIL SAMPLES AT SITE 2D FEBRUARY, 1994

CH2MHILL

0368m2d4.dgn
14-DEC-1994

sent to the onsite laboratory may be due to the reduced handling and analytical time for the onsite analysis.

Health and Environmental Assessment

As in 1990 and 1993, the only constituent that exceeds health-based criteria is the 1,1-DCE in well 2D-MW2. The concentration was 9 ppb, slightly above the MCL of 7 ppb. The threat to human health or the environment from Site 2D is minimal because:

- The area of groundwater contamination is small and does not appear to be migrating.
- The concentration of 1,1-DCE is only slightly above the MCL at one location.
- The contaminated area is paved with asphalt or concrete and therefore is not accessible.
- There is no contact with groundwater at the site.

The nearby wetland depression does not appear to receive groundwater from the site, so no effect to the biota in the depression is expected.

Conclusions and Recommendations

The Phase II investigation demonstrated that the extent of groundwater contamination at Site 2D is limited to the vicinity of well 2D-MW2 and that nearby surface water is unaffected. No source of the chlorinated VOCs was located by the Phase II soil sampling. The presence of BTEX compounds in soils suggests that some petroleum products have been disposed or spilled in the area; however, the groundwater has not been affected.

Because the concentrations in groundwater are low and do not appear to be migrating, no aggressive remediation or monitoring program is recommended.

Site 2E—Line Shack 109 Disposal Area

Site Conditions

Site 2E is the area bounded by Building 23, Line Shack 109, Building 110, and a steam line along First Street. Line Shack 109 has been used since 1963 for cleaning and maintaining aircraft and storing equipment and material. The Phase I RFI report includes historical details about Site 2E; however, other observations have been made and additional data has been collected about the site characteristics, conditions and activities since the Phase I RFI report was prepared. Important new data and observations are:

- The free product recovery program implemented in September 1993 has allowed the free-phase fuel thickness to be tracked over time.
- A study of the historical uses and construction records of the area near Building 23 and Building 109 was conducted in August 1994.
- The effect of runoff from active areas was observed during the investigation in March 1994.

After the discovery of free product in 2E-MW1 during the Phase I RFI groundwater sampling event in January 1993, the NAS Oceana Public Works Department instituted a product recovery program. Since January 1993, free product has been removed from the monitoring well every month using a bailer. Free product has been removed twice a month since June 1994. The free phase, which is black and more viscous than fresh fuel, typically has been approximately 1 foot thick during most bailing events.

As part of the drilling phase of the field work in February 1994, all underground utilities were marked by the NAS Oceana Public Works Department. The utility markings revealed a 25-foot-wide utilities corridor that runs parallel and adjacent to the flightline fence.

According to Fred Tipton of the Oceana Public Works Department, Electrical Branch, high-voltage electrical conduit typically rests in concrete banks for added reinforcement and protection. In some cases, the area around and beneath the bank is backfilled with sand or gravel during construction. The utility bank is believed to be primarily above the water table.

During a utility clearance meeting in February 1994 with personnel from the Public Works Department, the two adjacent manholes located approximately 25 feet south of the southern corner of Building 23 were identified as utility access points. Both compartments were filled with liquid to 1 to 2 feet below grade. One compartment had floating oil of unknown thickness at the surface and the other contained water only. During a 1993 site inspection, field personnel noted that the surfaces of the compartment seemed to be smeared with oil and the fluid levels were approximately 4 feet below grade. These structures may have been the manholes into which waste oil was reportedly discharged through a funnel as discussed in the Phase I report.

CH2M HILL personnel observed the influence of the localized topography upon stormwater run-off while conducting field activities during February 1994. After a rainstorm, field personnel observed runoff flowing from the main aircraft parking area west of Building 23 and subsequently ponding in the low grassy areas between the southeastern-side of Building 23 and the flightline fence. A fuel-like sheen was observed on the runoff. The extent to which this type of discharge is one of the sources of the PAHs detected in soils near and outside the flightline fence is not known.

A detailed review of historical utility and construction records and a series of interviews with current and long-term Oceana personnel were conducted in August 1994. The purpose of this records search was to identify possible sources of the contamination at Site 2E. Seven potential sources were identified and are discussed in detail in a memorandum included as Appendix G with this report. The search for a definitive source of the fuel problem at Site 2E was inconclusive despite a detailed search involving several people familiar with the site and fuel operations at the station. The records search did

provide important site context and was used to guide the September 1994, sampling program.

Investigation Activities

The groundwater sampling results from the Interim RFI in 1990 indicated that the parameters analyzed were either detected at low levels or were not detected. However, in January 1993 during the RFI field investigation, a free-phase petroleum product that smelled like diesel was discovered in well 2E-MW1. This discovery lead to additional site characterization.

The primary focus of the Site 2E investigation was to characterize the extent of free-product contamination and continue characterization of groundwater contamination. The Phase II study was completed in two phases – one in February and March 1994 and the second in September and October 1994. During the Phase II study, field personnel:

- Probed the sub-surface with a power auger and drilled to determine the extent of free-phase contamination qualitatively.

- Collected three soil samples (2E-SS11, 2E-SS12, and 2E-SS13) from the outer fringe of the free-product contaminant plume as determined by the qualitative power auger results.

- Collected 21 in-situ groundwater samples (15-GP1 through 15-GP21) using a hydraulic-probe sampler, and analyzed the samples in a mobile laboratory for field VOCs.

- Installed eight small-diameter PVC piezometers screened across the water-table to facilitate long-term monitoring of the free-product contamination. The piezometers were installed using the direct-push sampler. The

piezometers were screened from 3 to 9 feet, installed using sand and bentonite, and completed at the surface with concrete.

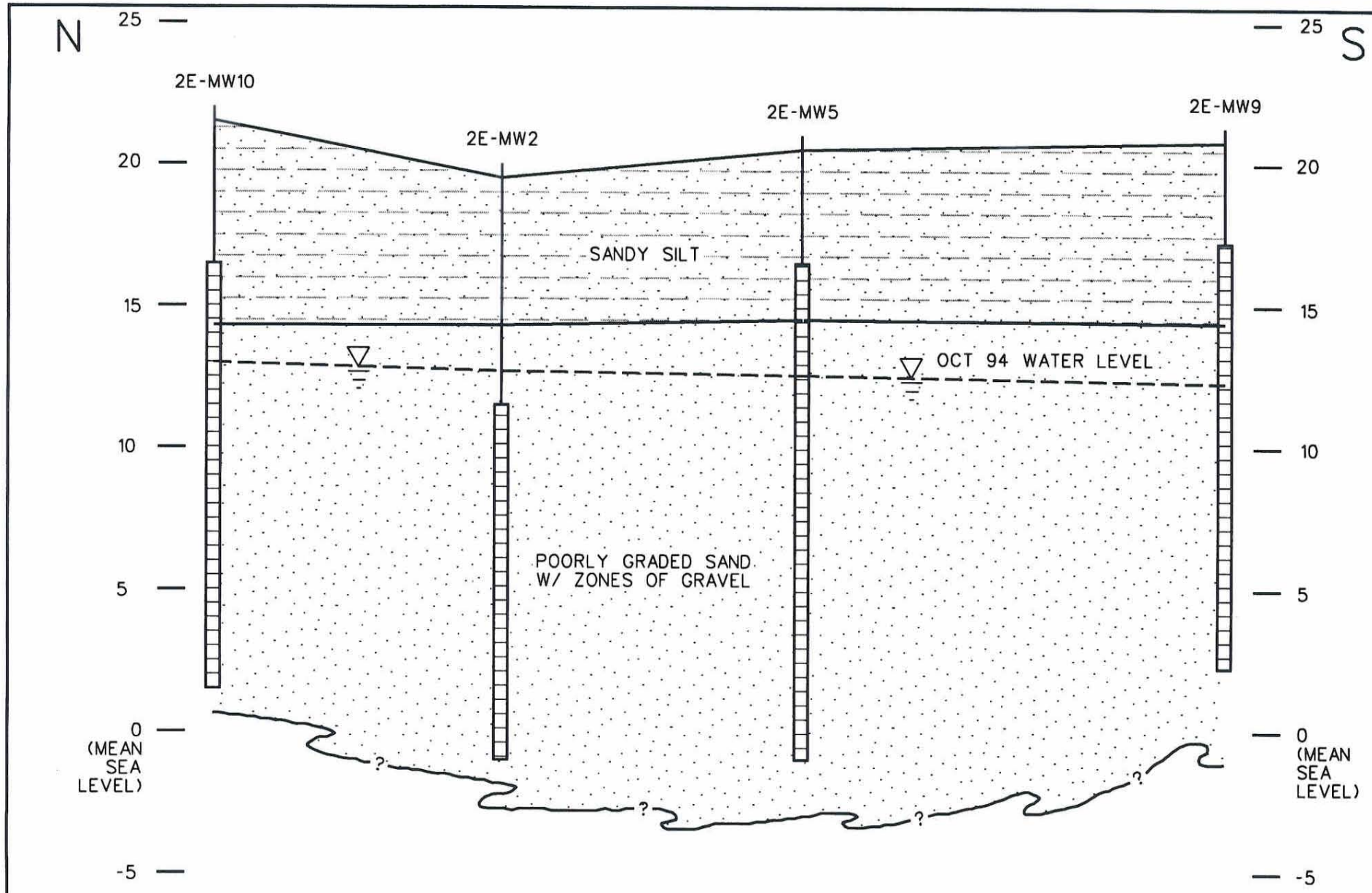
- Installed 10 monitoring wells (2E-MW4 through 2E-MW13) to assist with groundwater characterization and delineate the downgradient extent of the contaminant plume.

Figure 2-2-1 is a geologic cross section of Site 2E. The RFI Phase II soil sampling locations are shown in Figure 2-2-2. Groundwater sampling locations and the alignment of the geologic cross section are shown in Figure 2-2-3.

The boreholes were advanced to the water table, which was at approximately 4.5 to 5 feet. A total of 23 borings were drilled with the power auger or drill rig. The number exceeded the 15 borings called for in the work plan in an effort to broaden the characterization of soils. CH2M HILL field personnel recorded health-and-safety instrument readings and general observations related to contamination. These data are presented in Appendix A.

The three soil samples (2E-SS11, 2E-SS12, and 2E-SS13) were collected from 3.0 to 4.0 feet using a hand auger or hydraulic-probe sampler. The soils were sampled for VOCs, total petroleum hydrocarbons (TPH), and polynuclear aromatic hydrocarbons (PAHs).

Groundwater samples were collected from 20 of 21 locations using the hydraulic-probe sampler and were analyzed by an onsite mobile laboratory. The 20 samples were collected iteratively over three days, allowing early results to be used to select later sampling locations. The hydraulic-probe sampler was used to develop a better understanding of the extent of contamination and allow field personnel to select monitoring well locations more effectively. The screened section of the sampling probe was placed across the water table to determine if free-product contamination was present. Eight 3/4-inch inner diameter (ID) piezometers were installed during the hydraulic probe investigation. The piezometers were installed to help determine the extent of free-phase petroleum.



SCALE:
1"=100' HORIZ.
1"=5' VERT.

Figure 2-2-1

GEOLOGIC CROSS SECTION
OF SITE 2E
(SECTION TRENDS NORTH - SOUTH)

CH2MHILL

14-NOV-1994 03681116.dgn

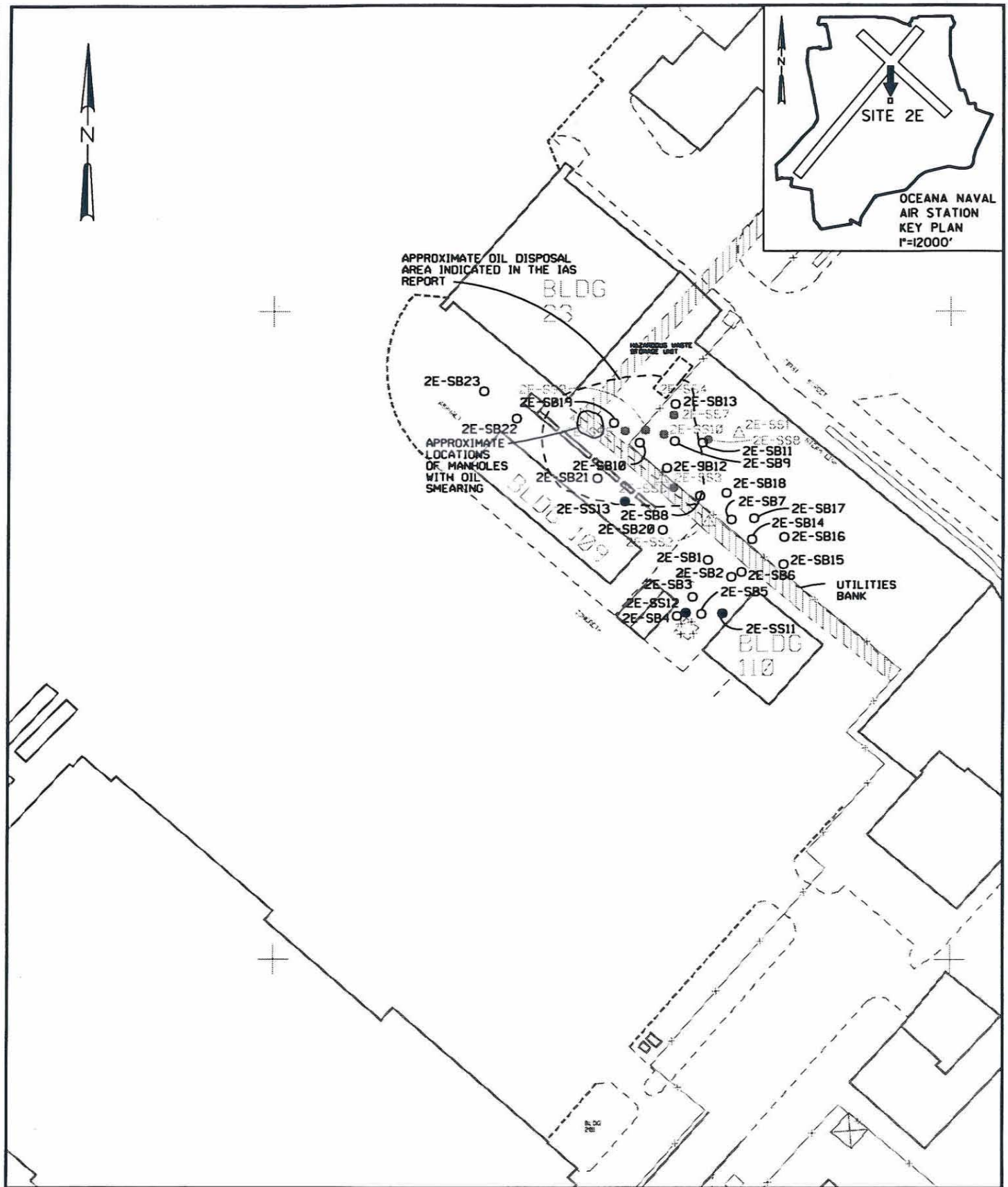


Figure 2-2-2
RFI PHASE II
SOIL SAMPLING LOCATIONS
AT SITE 2E

CH2MHILL

ONAS0368bdr.dgn 2-13
ONAS9C2118J.DGN 13
ONAS0368W12E.DGN
ONAS0368BTXT.DGN 1-00
ONAS1721R3.DGN 48

0368m2e7.dgn
23-FEB-1995

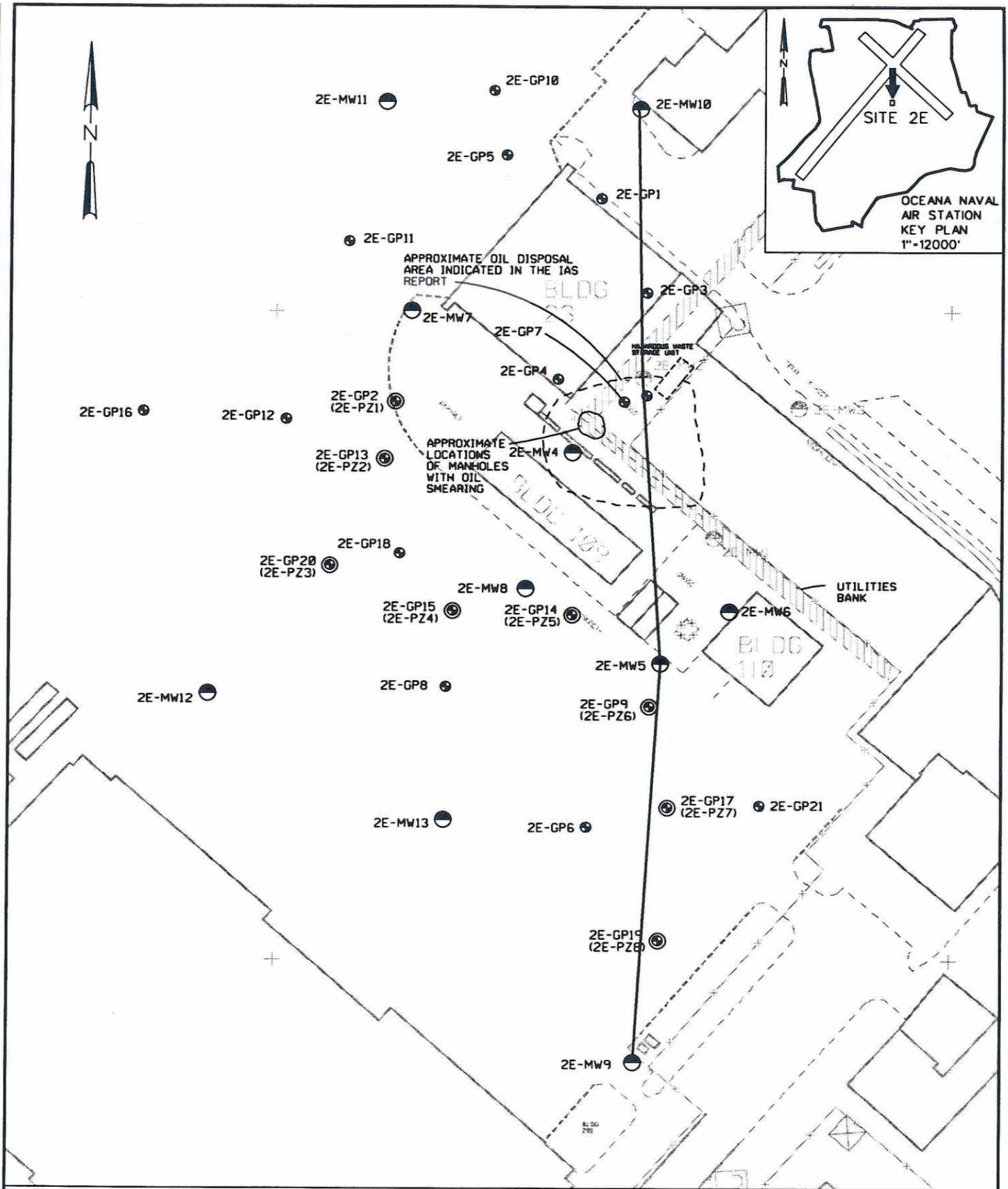


Figure 2-2-3
RFI PHASE II
GROUNDWATER
SAMPLING LOCATIONS
AT SITE 2E

368m2e12.dgn
14-DEC-1994

The locations of the ten monitoring wells installed during the RFI Phase II field investigation (2E-MW4 to 2E-MW13) were determined from information gathered during screening activities. Five of the 10 wells were installed in February 1994 and the remaining five wells were installed in September 1994. The well locations were based upon field observations recorded during in-situ groundwater sampling, power augering, and soil sampling. The intention was to place the wells at the outer edge of dissolved-phase areas. Drilling locations were moved outward if product was encountered so that the wells would be outside the free-phase area. For example, borings 2E-SB22 and 2E-SB23 were initial locations for well 2E-MW7 but both borings contained free-phase petroleum. Monitoring well specifications such as total depth and screen length for the Site 2E wells are presented in Table 2-2-1. The groundwater samples from the 10 Phase II monitoring wells were analyzed for VOCs, PAHs, and TPH.

Data Interpretation

The water-level elevations are listed in Table 2-2-2. The water levels and equipotential contours on October 11, 1994, are depicted in Figure 2-2-4. These data show that groundwater flows in an area from south-southwest to south-southeast and that the gradient is approximately 0.0005 ft/ft from 2E-MW7 to 2E-MW13 and from 2E-MW2 to 2E-MW9. The presence of free phase makes it difficult to determine the water levels in wells 2E-MW4 and 2E-MW8 because the weight of the petroleum product depresses the water level. The water levels in these wells were not used in contouring water levels in Figure 2-2-4. The average hydraulic conductivity determined from slug tests in wells 2E-MW3, 2E-MW7, and 2E-MW8 was $6x10^{-3}$ cm/sec, or 17 ft/day. A comparison of aquifer test data to slug test data at Sites 1 and 2B showed that hydraulic conductivity values from aquifer tests were approximately three times the values determined from slug tests. If this were representative of Site 2E also, then a representative conductivity of 1.8×10^{-2} cm/sec would be predicted at Site 2E. If porosity is assumed to be 25 percent, hydraulic conductivity is assumed to be 1.8×10^{-2} cm/sec, and the prevailing gradient is 0.0005 ft/ft,

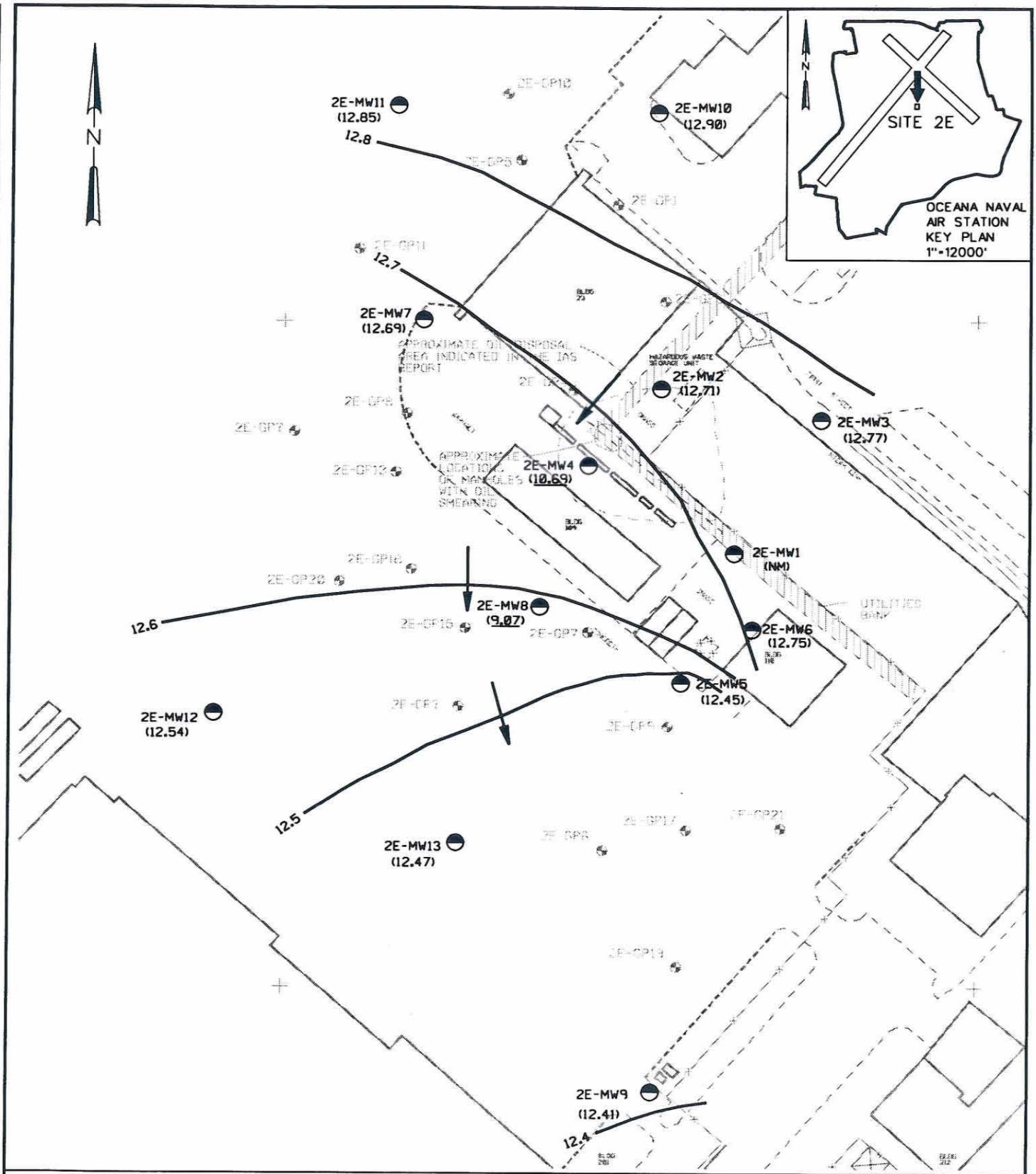
Table 2-2-1
SITE 2E MONITORING WELL SUMMARY

Well Number	Date Installed	Ground Elevation (feet above MSL)	Total Depth (feet)	Screened Interval (feet below ground surface)
2E-MW1	06/28/90	20.3	19	9-19
2E-MW2	07/06/90	19.4	18	8-18
2E-MW3	07/02/90	18.9	18	8-18
2E-MW4	02/22/94	20.7	22	4.5-19.5
2E-MW5	02/23/94	20.4	23	4-19
2E-MW6	02/24/94	20.5	23	4-19
2E-MW7	03/12/94	20.9	18	3-18
2E-MW8	03/07/94	20.4	20	3-18
2E-MW9	09/21/94	20.7	20	3.5-18.5
2E-MW10	09/22/94	21.4	20	5-20
2E-MW11	09/26/94	20.3	20	5-20
2E-MW12	09/23/94	20.6	20	5-20
2E-MW13	09/26/94	20.4	20	5-20

Table 2-2-2
SITE 2E WATER-LEVEL DATA
October 11, 1994

Well	Elevation of Survey Datum (feet)	Water-Level Distance Below Survey Datum (feet)	Water-Level Elevation (feet)
2E-MW1	22.52	NM	—
2E-MW2	19.43	6.72	12.71
2E-MW3	20.83	8.06	12.77
2E-MW4	20.69	10.0-12.0	8.69-10.69[a,b]
2E-MW5	20.37	7.92	12.45
2E-MW6	20.51	7.76	12.75
2E-MW7	20.94	8.25	12.69
2E-MW8	20.43	11.36	9.07
2E-MW9	20.74	8.33	12.41
2E-MW10	21.64	8.74	12.90
2E-MW11	20.32	7.47	12.85
2E-MW12	20.60	8.06	12.54
2E-MW13	20.35	7.88	12.47

Notes:
All elevations are in feet above mean sea level.
[a]The water levels in the wells with free-product are lower than expected because of the weight of the free-phase petroleum.
[b]Experienced technical difficulties with oil-interface probe. Unable to obtain exact measurements so a range was provided.
NM - Not measured because unable to open well.



LEGEND

- SHALLOW MONITORING WELL
- HYDRAULIC PROBE GROUNDWATER SAMPLING LOCATION
- EQUIPOTENTIAL CONTOUR
- FLOW DIRECTION
- NM NOT MEASURED
- ( ) WATER-LEVEL ELEVATION
- (—) WATER-LEVEL ELEVATION, WELL WITH FUEL
- UTILITIES BANK (DASHED WHERE INFERRED)

0 50 100 150
SCALE IN FEET

Figure 2-2-4
GROUNDWATER ELEVATIONS AT SITE 2E
OCTOBER 11, 1994

CH2MHILL

0368m2e8.dgn
14-DEC-1994

ONAS0368bdr.dgn 2-19 31-63
ONASSPC2118X3.DGN 63
ONAS0368W12E.DGN
ONAS0368BTXT.DGN
ONAST72118X3.DGN 48

the average velocity of groundwater flow in the surficial aquifer is approximately 40 ft/year.

The Phase II investigation showed that free-phase petroleum contamination is limited to areas near Building 109. Due to extensive soil sampling and in-situ groundwater sampling, the approximate limit of free-phase petroleum contamination has been identified.

The thickness of free-phase petroleum in the wells and piezometers during various measurement events is shown in Table 2-2-3. The thickness of free-phase petroleum observed in 2E-MW4 was 3.25 feet in March, 6.47 feet in August, and 2.7 to 4.7 feet in October 1994. The measurements in well 2E-MW8 were 0.25 feet in March, 3.25 feet in August, and 4.06 feet in October 1994. The thickness of free-phase petroleum in 2E-MW1 was 0.47 feet in March 1994 and 0.4 feet in August 1994; however, the water table at 2E-MW1 was above the top of the well screen in March 1994, so active free-phase flow into the screen was not possible. The program of free-phase recovery also may have reduced the thickness of free phase in the well, especially during periods when the water table is above the screened zone. Approximately 7 feet of free-phase petroleum were measured in well 2E-MW1 in January 1993. In 2E-MW7, samplers noted a moderately strong fuel odor. An explosimeter reading of more than 300 percent of the lower explosive limit (LEL) was measured after opening the well cap to begin well development; however, the oil-water interface probe indicated no measurable thickness of free product in 2E-MW7 during sampling.

No free product was measured in any of the eight mini-piezometers shown as 2E-PZ1 to 2E-PZ8 in Figure 2-2-2. The piezometers are too narrow to accommodate commercial oil-water interface probes, so the measurements were qualitative. A slight odor was noted in piezometer 2E-PZ5.

Qualitative observations during drilling and power augering to 5 or 6 feet were an important element in determining the extent of petroleum contamination. The observations from this program were the following:

Table 2-2-3
THICKNESS OF FREE-PHASE HYDROCARBONS AT SITE 2E
(in feet)

Well	March 1994	August 1994	October 1994
2E-MW1	0.47	0.4	—
2E-MW2	0	0	0
2E-MW3	0	0	0
2E-MW4	3.25	6.47	2.7-4.7*
2E-MW5	0.01	0	0
2E-MW6	0	0	0
2E-MW7	odor	0	0
2E-MW8	0.25	3.25	4.06
2E-MW9	0	0	0
2E-MW10	0	0	0
2E-MW11	0	0	0
2E-MW12	0	0	0
2E-MW13	0	0	0
PZ-1	—	—	0
PZ-2	—	—	0
PZ-3	—	—	0
PZ-4	—	—	0
PZ-5	—	—	fuel odor
PZ-6	—	—	0
PZ-7	—	—	0
PZ-8	—	—	0

Notes:
*Experienced technical difficulties with oil-interface probe. Unable to obtain exact measurements so a range was provided.
— = Not measured
The piezometers were installed in September 1994.

- Samples 2E-SB9, 2E-SB12, 2E-SB8 northeast of the fence were contaminated with free product but a second tier several feet to the east (2E-SB13, 2E-SB11, 2E-SB18, 2E-SB7, 2E-SB14, 2E-SB17, 2E-SB16, 2E-SB15) was not contaminated.

- Sampling along the utilities bank was not possible below 2 feet (2E-SB10, 2E-SB19, and 1993 soil sampling).

- Contamination was low or absent at 2E-SB4, 2E-SB5, 2E-SS12, and 2E-SS11 but present at 2E-SB3 and 2E-SB2.

- Fuel contamination was high in a line along Building 109 from 2E-SB20 to 2E-SB23 but was not reported when drilling well 2E-MW7.

- The fuel contamination was at the water table at a depth of 4.5 to 5.0 feet. Accumulated free phase hydrocarbons did not appear to be thick except at 2E-SB20, 2E-SB21, 2E-SB22 and 2E-SB23 where the presence of free product at 3 feet or shallower suggests that it was over 1-foot thick.

The results of the three Phase II soil analyses (2E-SS11, 2E-SS12, and 2E-SS13) are listed along with past soil results in Table 2-2-4. Sample 2E-SS13 was from an area with obvious free-phase contamination. The TPH concentration of 7,700,000 ppb, the ethylbenzene concentration of 960 ppb, and the xylene concentration of 80 ppb confirm this observation. Soil samples 2E-SS11 and 2E-SS12 were believed to be at the fringe of free product contamination but TPH results (717,000 and 944,000) show that these points contained petroleum constituents. The presence of numerous polynuclear aromatic hydrocarbon (PAH) constituents in 2E-SS11 and of elevated 1-methylnaphthalene and 2-methylnaphthalene in 2E-SS12 and 2E-SS13 also indicate petroleum contamination.

A sample of the black fuel product in well 2E-MW4 was submitted to the analytical laboratory for POL fingerprinting analysis. This analysis is used to identify the type of

Table 2-2-4
ORGANIC COMPOUNDS IN SOILS AT SITE 2E
August 1990 through February 1994
(All data in ppb)

Analyte	2E-SS1	2E-SS2	2E-SS3	2E-SS4	2E-SS5		2E-SS6		2E-SS7	2E-SS8	2E-SS9	2E-SS11		2E-SS12	2E-SS13
	Aug. 90	Aug. 90	Aug. 90	Aug. 90	Jan. 93		Feb. 93		Jan. 93	Jan. 93	Feb. 93	Feb. 94		Feb. 94	Feb. 94
	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 -1.0 ft.	2.0 -3.0 ft.	0.5 - 1.0 ft.		0.5 - 1.0 ft.	0.5 - 1.0 ft.	2.0 - 3.0 ft.	3.0 - 4.0 ft.		3.0 - 4.0 ft.	3.0 - 4.0 ft.
							Initial	Duplicate				Initial	Duplicate		
TPH	99,400	513,000	242,000	NA	607,000	64,500	189,000	77,400	26,500	286,000	10,800	717,000	463,000	944,000	7,700,000
EDB	*	*	*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds															
Acetone	11 bj	21 b	13 b	14 b	56 b	20 b	10 j	5 j	17 b	12 b	86 b	43 b	16 b	11 bj	110 b
Methylene chloride	24 b	13 b	61 b	120 e	9 b	7 b	4 bj	4 bj	8 b	10 b	9 b	7 b	4 jb	3 bj	28
Toluene	*	*	*	2 j	*	*	*	*	*	*	*	*	*	*	*
2-Butanone	*	*	*	*	13	*	*	*	*	*	14	*	*	*	*
Xylene (total)	*	*	*	*	*	21	*	*	*	3 j	6 j	5 j	2 j	54	80
Carbon Disulfide	*	*	*	*	*	*	*	*	*	*	*	5 j	2 j	*	*
Ethylbenzene	*	*	*	*	*	*	*	*	*	*	*	*	*	54	960 d
Semivolatile Organic Compounds															
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	170 bj	57 bj	NA	NA	NA	NA	NA	NA	NA
bis (2-ethylhexyl) phthalate	NA	NA	NA	NA	NA	NA	43 j	*	NA	NA	NA	NA	NA	NA	NA

Table 2-2-4
ORGANIC COMPOUNDS IN SOILS AT SITE 2E
August 1990 through February 1994
(All data in ppb)

Analyte	2E-SS1	2E-SS2	2E-SS3	2E-SS4	2E-SS5		2E-SS6		2E-SS7	2E-SS8	2E-SS9	2E-SS11		2E-SS12	2E-SS13
	Aug. 90	Aug. 90	Aug. 90	Aug. 90	Jan. 93		Feb. 93		Jan. 93	Jan. 93	Feb. 93	Feb. 94		Feb. 94	Feb. 94
	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 -1.0 ft.	2.0 -3.0 ft.	0.5 - 1.0 ft.		0.5 - 1.0 ft.	0.5 - 1.0 ft.	2.0 - 3.0 ft.	3.0 - 4.0 ft.		3.0 - 4.0 ft.	3.0 - 4.0 ft.
							Initial	Duplicate				Initial	Duplicate		
Polynuclear Aromatics (PAHs)															
Acenaphthene	NA	NA	NA	NA	*	35 j	*	*	*	*	*	59 j	57 j	* uj	*
Fluorene	NA	NA	NA	NA	*	30 j	*	*	*	*	*	64 j	49 j	* uj	*
Phenanthrene	NA	NA	NA	NA	*	96	*	*	110	*	*	350 j	310 j	* uj	*
Fluoranthene	NA	NA	NA	NA	*	64	*	*	100	43 j	*	370 j	220 j	* uj	*
2-Methylnaphthalene	NA	NA	NA	NA	*	*	*	*	*	*	*	* uj	* uj	9,800 j	53,000
1-Methylnaphthalene	NA	NA	NA	NA	*	*	*	*	*	*	*	* uj	* uj	6,300 j	31,000
Pyrene	NA	NA	NA	NA	*	43 j	*	*	120	*	*	340 j	190 j	* uj	*
Benzo(a)anthracene	NA	NA	NA	NA	*	*	*	*	54 j	*	*	220 j	96 j	* uj	*
Chrysene	NA	NA	NA	NA	*	*	*	*	75	*	*	240 j	100 j	* uj	*
Benzo(b)fluoranthene	NA	NA	NA	NA	*	*	*	*	110	*	*	220 j	81 j	* uj	*
Benzo(k)fluoranthene	NA	NA	NA	NA	*	*	*	*	110	*	*	190 j	62 j	* uj	*
Benzo(a)pyrene	NA	NA	NA	NA	*	*	*	*	98	*	*	230 j	54 j	* uj	*
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	*	*	*	*	110	*	*	170 j	* uj	1,600 uj	*
Benzo(g,h,i)perylene	NA	NA	NA	NA	*	*	*	*	73	*	*	111 j	* uj	* uj	*
Naphthalene	NA	NA	NA	NA	*	*	*	*	*	*	*	* uj	* uj	* uj	

Table 2-2-4
ORGANIC COMPOUNDS IN SOILS AT SITE 2E
August 1990 through February 1994
(All data in ppb)

Analyte	2E-SS1	2E-SS2	2E-SS3	2E-SS4	2E-SS5		2E-SS6		2E-SS7	2E-SS8	2E-SS9	2E-SS11		2E-SS12	2E-SS13
	Aug. 90	Aug. 90	Aug. 90	Aug. 90	Jan. 93		Feb. 93		Jan. 93	Jan. 93	Feb. 93	Feb. 94		Feb. 94	Feb. 94
	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 - 1.0 ft.	0.5 -1.0 ft.	2.0 -3.0 ft.	0.5 - 1.0 ft.		0.5 - 1.0 ft.	0.5 - 1.0 ft.	2.0 - 3.0 ft.	3.0 - 4.0 ft.		3.0 - 4.0 ft.	3.0 - 4.0 ft.
							Initial	Duplicate				Initial	Duplicate		
Acenaphthylene	NA	NA	NA	NA	*	*	*	*	*	*	*	* uj	* uj	* uj	*
Dibenzo (a,h) Anthracene	NA	NA	NA	NA	*	*	*	*	*	*	*	* uj	* uj	* uj	*
Anthracene	NA	NA	NA	NA	*	*	*	*	*	*	*	87 j	86 j	* uj	*

Notes:
QC sampling: 2E-SS30 is a duplicate of 2E-SS6; 2E-SS40 is a duplicate of 2E-SS11.
NA Not analyzed
EDB Ethylene Dibromide
TPH Total Petroleum Hydrocarbons
(*) Concentration analyzed but not detected. All volatile organic, semivolatile organic and polynuclear aromatic compounds not listed above were analyzed but not detected.
b Compound found in laboratory blank as well as sample.
d Result quantified from sample dilution run.
e Compound found in laboratory blank as well as sample. Sample concentration is greater than 10 times blank concentration.
j Estimated value. Measured value is less than the quantitative detection limit, or analyzed outside holding time or the instrument calibration was outside specifications.
uj Reported quantitation limit was qualified as estimated during the data validation process. Constituent was not detected at the estimated quantitation limit.

fuel by comparing the chromatograph of the sample to chromatographs of laboratory spikes of JP-4, JP-5, diesel, gasoline, and other fuels. The fuel at Site 2E was identified as diesel. This result was confirmed by the organic chemist, who expressed a high degree of confidence in the identification. The fuel in well 2E-MW4 appeared to be of uniform color over its entire thickness during the October 1994 measurements and sampling.

The analytical results from the in-situ groundwater sampling event are listed in Table 2-2-5 and presented graphically in Figure 2-2-5. The results indicate two broad areas of BTEX and total petroleum volatiles (TPV) contamination at Site 2E. The largest contaminant plume extends southwest from Building 23 to 2E-GP20, and southeast to 2E-GP14. The dissolved-phase contamination detected in this area can be attributed to the free-product contamination northeast of Building 109.

A second, BTEX contaminant plume with lower concentrations appears to exist south of Building 109. 2E-GP17 and 2E-GP19 contained TPV and BTEX compounds. This plume may be caused by spills from small aircraft service vehicles parked near these locations; however, because this area is immediately downgradient of the worst areas of contamination, the main source of this second plume also may be the releases near Building 109.

The in-situ groundwater sampling results also suggest scattered areas with chlorinated volatile contamination. One plume extends downgradient from 2E-GP9, where cis-1,2-DCE was detected at 160 ppb, to 2E-GP19, where cis-1,2-DCE was detected at 6.7 ppb. This contamination may be a result of the maintenance activities being performed in Building 110. Cis-1,2-DCE also was detected in the vicinity of Building 23 at 2E-GP5 (120 ppb), 2E-GP1 (5 ppb) and 2E-GP4 (15 ppb). In addition to these areas, an isolated detection of cis-1,2-DCE at 2 ppb was detected in 2E-GP16.

The in-situ sampling results assisted field personnel in choosing locations for the additional wells. The locations of the Phase II monitoring wells (2E-MW4 through 2E-MW13) are shown in Figure 2-2-3. The organic laboratory results for groundwater samples collected

Table 2-2-5
ORGANIC COMPOUNDS IN *IN SITU* GROUNDWATER FROM SITE 2E
(All data in ppb)

Compound	Detection Limit	2E-GP1	2E-GP2	2E-GP3	2E-GP4	2E-GP5	2E-GP6	2E-GP7		2E-GP8	2E-GP9	2E-GP10
		8 - 10 ft	8 - 10 ft	8 - 10 ft	8 - 10 ft	8 - 10 ft	8 - 10 ft	8 - 10 ft		8 - 10 ft	7 - 9 ft	8 - 10 ft
								Initial	Duplicate			
cis-1,2-Dichloroethylene	2	4.6	< 2.0	< 2.0	15	120	< 2.0	< 2.0	< 2.0	< 2.0	160	< 2.0
Trichloroethylene	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Benzene	2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Toluene	2	< 2.0	3.4	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	2	5.2	45	< 2.0	3.6	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Xylenes (total)	2	30	30	< 2.0	< 2.0	< 2.0	< 2.0	11	12	< 2.0	< 2.0	< 2.0
Total Petroleum Volatiles	15	28	1,400	20	120	< 15	< 15	120	95	< 15	< 15	< 15

Compound	Detection Limit	2E-GP11	2E-GP12	2E-GP13	2E-GP14	2E-GP15	2E-GP16	2E-GP17		2E-GP19	2E-GP20	2E-GP21
		8 - 10 ft	5 - 7 ft	6 - 8 ft	6 - 8 ft	6 - 8 ft	6 - 8 ft	6 - 8 ft		6 - 8 ft	6 - 8 ft	6 - 8 ft
								Initial	Duplicate			
cis-1,2-Dichloroethylene	2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	2.4	19	11	6.7	< 2.0	< 2.0
Trichloroethylene	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Benzene	2	< 2.0	< 2.0	46	47	< 2.0	< 2.0	< 2.0	< 2.0	2.9	5.8	< 2.0
Toluene	2	< 2.0	< 2.0	14	12	< 2.0	< 2.0	2.6	< 2.0	< 2.0	3.2	< 2.0
Ethylbenzene	2	< 2.0	3.6	23	64	< 2.0	< 2.0	< 2.0	< 2.0	6.9	24	< 2.0
Xylenes (total)	2	< 2.0	< 2.0	200	267	< 2.0	< 2.0	28	21	20	36	< 2.0
Total Petroleum Volatiles	15	< 15	18	5,100	4,100	89	< 15	510	710	290	1800	56

Notes:

All volatile compounds not reported were below detection limits in all samples.
MCL = Maximum contaminant levels
< = The value was less than the detection limit or was not detected.
NS = No standard or guideline concentration.
2E-GP18 was not sampled.

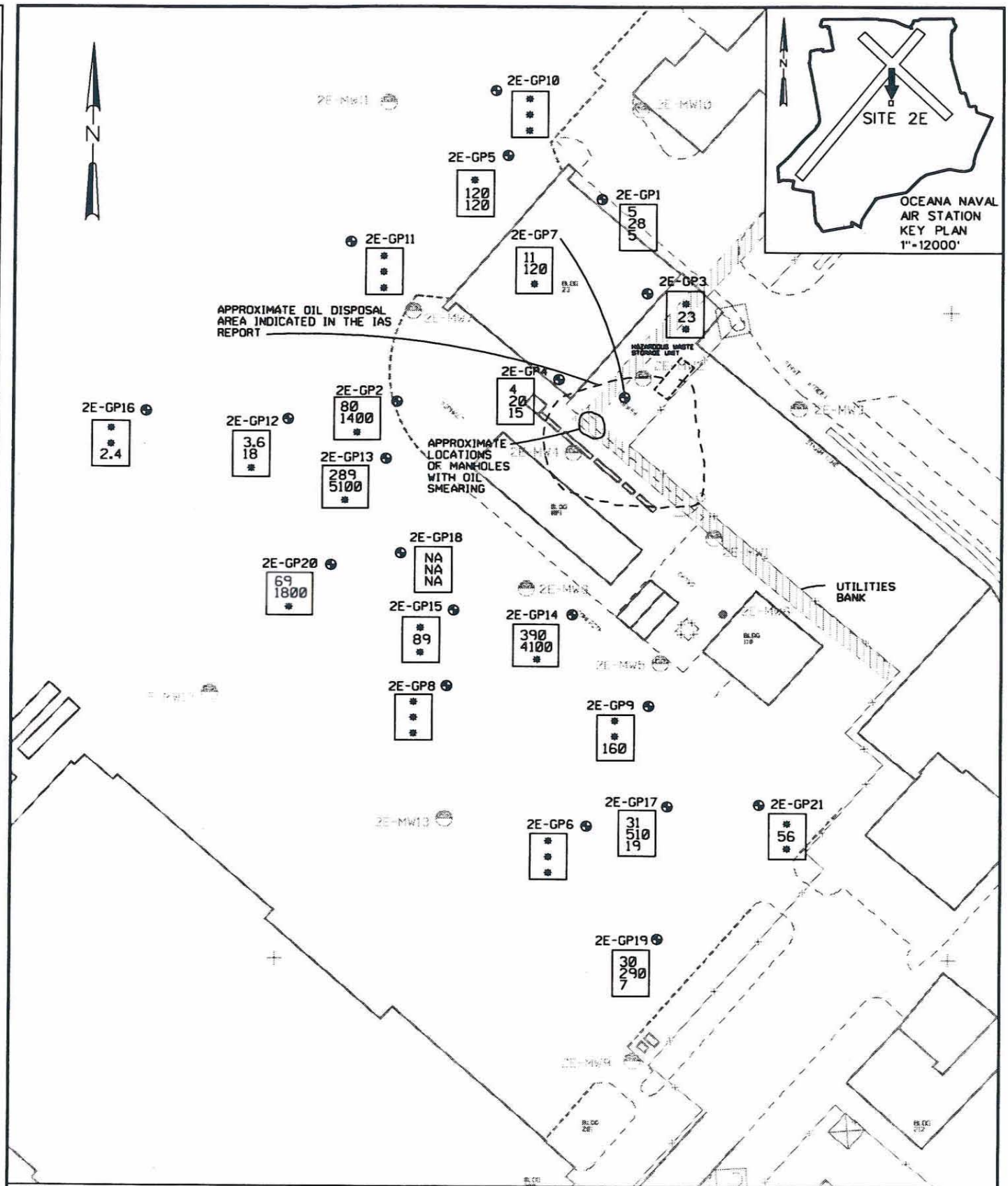


Figure 2-2-5
ORGANIC COMPOUNDS IN IN-SITU GROUNDWATER AT SITE 2E

CH2M HILL

368m2e10.dgn
14-DEC-1994

from the Phase II monitoring wells are presented in Figure 2-2-6 and listed in Table 2-2-6. Table 2-2-7 lists the inorganic results for groundwater. Only total and dissolved lead, zinc, and mercury were analyzed from the new well samples because these were the only potential metals of concern in previous sampling rounds. The concentrations of these three metals was low. The organic results suggest that organic groundwater contamination at Site 2E is well characterized. No TPH or BTEX compounds were detected in the downgradient wells except 6 ppb of BTEX compounds in 2E-MW13.

Figure 2-2-7 shows the extent of hydrocarbon contamination. It shows a central area where free product has been observed in wells and a more extensive area where hydrocarbon constituents were detected in groundwater. BTEX concentrations are shown for context; however, other evidence such as fuel odors also was considered in defining the extent of dissolved contamination.

The results of the duplicate TPH analysis at well 2E-MW7 was considerably lower (730 ppb) than the initial sample (3,790,000 ppb). Field samplers did not notice any difference between the initial and duplicate TPH sample volumes. One explanation for the difference in analytical results may be that a globule of free product was present in the initial sample but not the duplicate. Distinct spikes in concentration between sampling events or between splits are one of the characteristics of sites with free-phase contamination. However, the absence of PAHs and the minimal total BTEX concentration (6 ppb) is not consistent with the high TPH concentration in the initial sample.

Chlorinated volatile constituents were detected in monitoring wells 2E-MW9 and 2E-MW13. The vinyl chloride concentration was 13 ppb in 2E-MW9 at the southern limit of the site and 6 ppb in 2E-MW13. An estimated concentrations of 4 ppb of 1,2-DCE also was detected in 2E-MW13. No volatiles were detected in 2E-GP6.

Figure 2-2-8 shows the approximate extent of chlorinated VOCs in groundwater at Site 2E. The total concentration of chlorinated VOCs is shown next to each sampling location. The

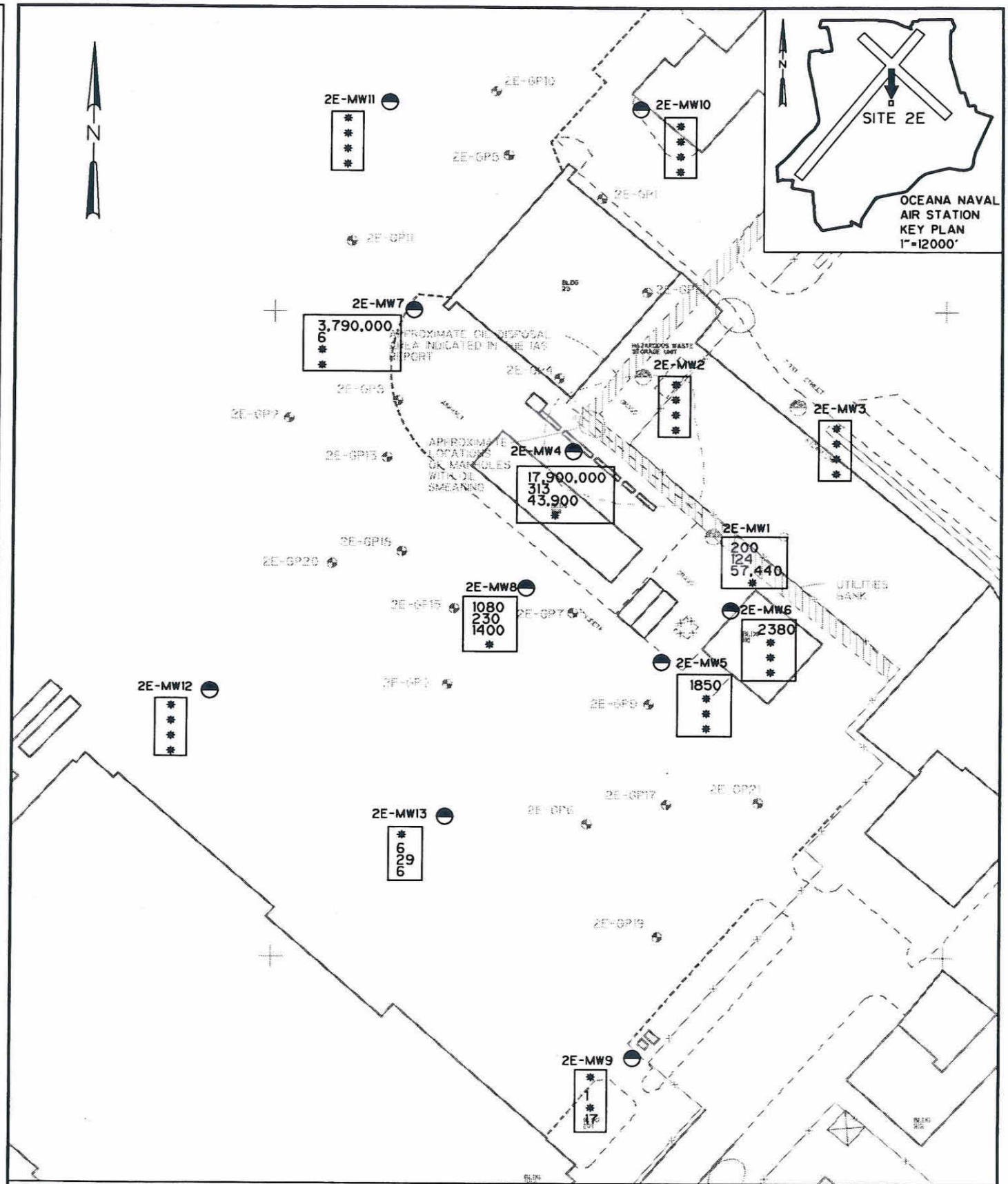


Figure 2-2-6
ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E DURING PHASE I AND PHASE II SAMPLING

CH2MHILL

368m2e11.dgn
15-DEC-1994

Table 2-2-6
ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E
August 1990 through October 1994
(Concentrations in ppb)

Analyte	Detection Limit	2E-MW1[a]			2E-MW2		2E-MW3		2E-MW4	2E-MW5	2E-MW6	2E-MW7		2E-MW8
		Aug. 90	Jan. 93		Aug. 90	Jan. 93	Aug. 90	Jan. 93	Mar. 94	Mar. 94	Mar. 94	Mar. 94		Mar. 94
			Initial	Duplicate								Initial	Duplicate	
TPH[b]	60/1,000	200	NA	NA	<60	NA	210	NA	17,900,000 j	1,850 j	2,380 j	3,790,000 j	730 j	1,080 j
EDB	0.02	*	NA	NA	*	NA	*	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds														
Acetone	10	6 bj	40 j	NA	6 bj	10 b	4 bj	*	24 b	*	6 bj	11 b	13 b	12 b
Benzene	5	2 j	8 j	NA	*	*	*	*	81	*	*	2 j	2 j	25
Carbon disulfide	5	*	*	NA	*	*	2 j	*	*	2 j	*	*	*	1 j
Ethylbenzene	5	2 j	54	NA	*	*	*	*	100	*	*	4 j	3 j	62
Methylene chloride	5	5 b	14 j	NA	7 b	3 bj	5 b	3 bj	*	*	1 bj	1 bj	1 bj	1 bj
2-Butanone	10	*	*	NA	*	*	*	*	*	4 j	*	*	2 j	*
Toluene	5	*	*	NA	*	*	*	*	2 j	*	*	*	*	3 j
Xylenes (total)	5	3 j	62	NA	*	*	*	*	130	*	*	*	*	140
Vinyl chloride	2	*	*	NA	*	*	*	*	*	*	*	*	*	*
2-Hexanone	10	*	*	NA	*	*	*	*	*	*	*	*	*	*
1,2-Dichloroethylene (total)	5	*	*	NA	*	*	*	*	*	*	*	*	*	*
Semivolatile Organic Compounds														
Naphthalene	10	NA	9,400 e	3,000	NA	NA	NA	NA	10,000	<2	<2	<2	<2	280
1-Methylnaphthalene	10	NA	*	*	NA	NA	NA	NA	5,900	<2	<2	<2	<2	390
2-Methylnaphthalene	10	NA	38,000 e	12,000 e	NA	NA	NA	NA	28,000	<2	<2	<2	<2	730
Fluorene	10	NA	3,400	1,200	NA	NA	NA	NA	<4,000	<2	<2	<2	<2	<50
Phenanthrene	10	NA	5,900	2,200	NA	NA	NA	NA	<4,000	<2	<2	<2	<2	<50
Anthracene	10	NA	410	120 j	NA	NA	NA	NA	<4,000	<2	<2	<2	<2	<50
Pyrene	10	NA	330	98 j	NA	NA	NA	NA	<4,000	<2	<2	<2	<2	<50
Acenaphthylene	10	NA	<250	500	NA	NA	NA	NA	<4,000	<2	<2	<2	<2	<50
Polynuclear Aromatics	2-4,000	NA	NA	NA	NA	<2	NA	<2	<4,000	<2	<2	<2	<2	<50

Table 2-2-6
ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E
August 1990 through October 1994
(Concentrations in ppb)

Analyte	Detection Limit	2E-MW9		2E-MW10	2E-MW11	2E-MW12	2E-MW13
		Oct 94		Oct 94	Oct 94	Oct 94	Oct 94
		Initial	Duplicate				
TPH	60/1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
EDB	0.02	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds							
Acetone	10	9 jbc	6 jba	11 jbc	* c	13 bc	16 bc
Benzene	5	1 j	*	*	*	*	2 j
Carbon disulfide	5	*	*	*	*	*	*
Ethylbenzene	5	*	*	*	*	*	3 j
Methylene chloride	5	3 bj	*	3 bj	2 bj	5 bj	4 bj
2-Butanone	10	3 jd	*	*	*	*	6 jd
Toluene	5	*	*	*	*	*	*
Xylenes (total)	5	*	*	*	*	*	1 j
Vinyl chloride	2	13	13	*	*	*	6 j
2-Hexanone	10	3 jc	*	* jc	31 c	* c	* c
1,2-Dichloroethylene (total)	5	*	4 j	*	*	*	*
Semivolatile Organic Compounds/Polynuclear Organic Compounds							
Naphthalene	10	<10	<10	<10	<10	<10	29
1-Methylnaphthalene	10	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	10	NA	NA	NA	NA	NA	NA
Fluorene	10	<10	<10	<10	<10	<10	<10
Phenanthrene	10	<10	<10	<10	<10	<10	<10
Anthracene	10	<10	<10	<10	<10	<10	<10
Pyrene	10	<10	<10	<10	<10	<10	<10
Acenaphthylene	10	<10	<10	<10	<10	<10	<10

Table 2-2-6
ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E
August 1990 through October 1994
(Concentrations in ppb)

Notes: All volatile, semivolatile, and polynuclear aromatic compounds not listed above were analyzed, but not detected. At 2E-MW1, the semivolatiles analysis encompasses the polynuclear aromatic analysis.

EDB = Ethylene dibromide
TPH = Total petroleum hydrocarbons
PAH = Polynuclear aromatics
(*) = Concentration below detection limit

a = This detection is estimated because the continuing calibration contained percent calibration differences greater than 25% but less than 50%.
b = Compound found in laboratory blank as well as in sample.
c = This detect or non-detect result is estimated because the continuing calibration contained percent calibration differences greater than 50% but less than 90%.
d = This result is qualified as estimated due to rinseate blank contamination.
j = Estimated value
e = Compound concentration exceeds calibration range.
NA = Not analyzed

[a]In January 1993, the field duplicate SVOC results were in poor correlation with the initial sample SVOC results as determined by the data validation process. No qualification was performed.
[b]In October 1994, the method reporting limit for TPH was 1,000 µg/L. All samples were non-detect at that limit.
QC Sampling: 2E-MW70 is a duplicate of 2E-MW7; 2E-MW80 is a duplicate of 2E-MW9.
Well 25-MW1 was analyzed for base-neutral extractable organics in 1993 but all other 1993 and 1994 samples were for PAHs. The 1994 results are shown under semivolatile organics for convenience only.

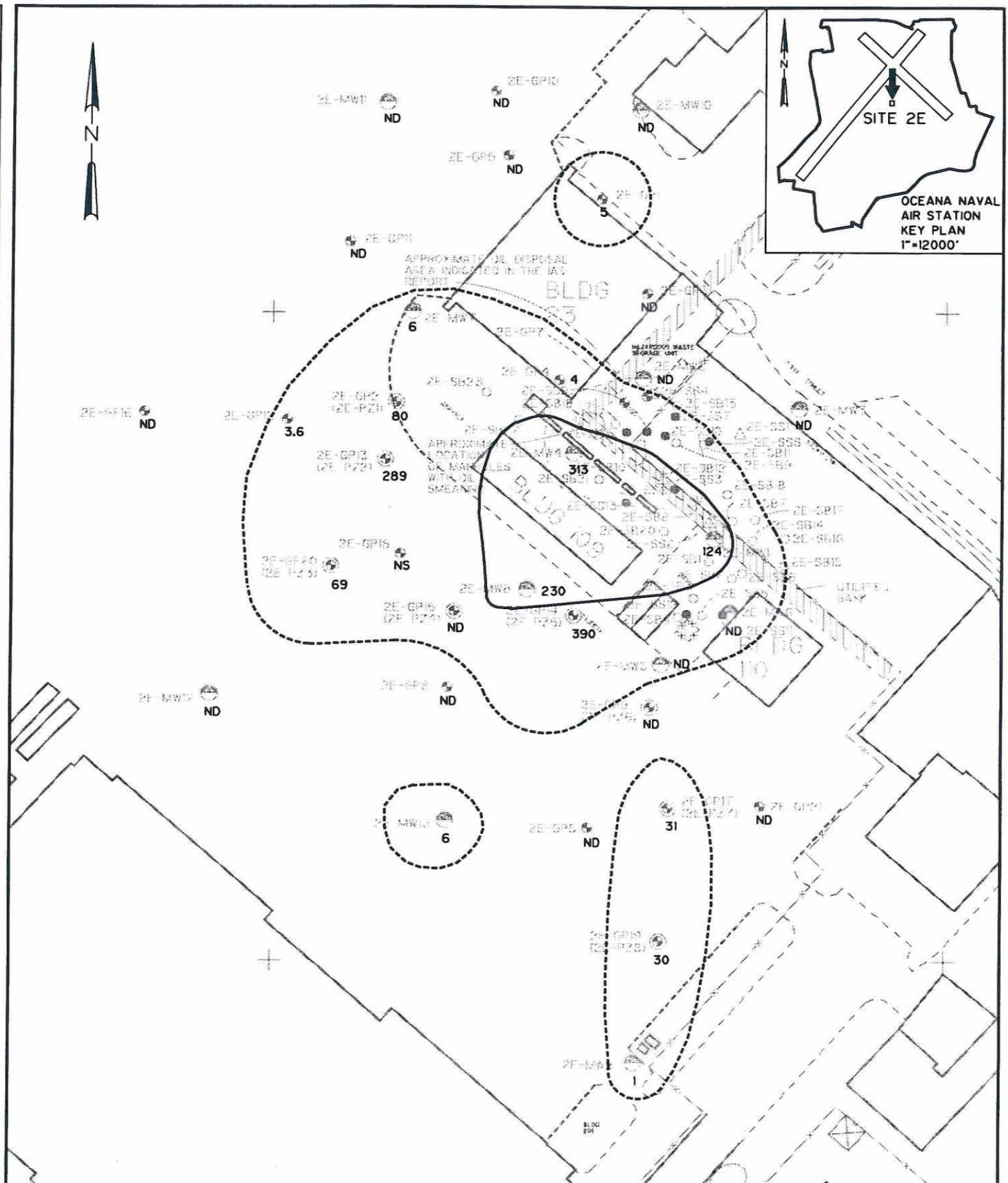
Table 2-2-7
INORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E
January 1993 to October 1994
(Concentrations in µg/L)

	January 1993 to February 1993							March 1994										
	2E-MW1			2E-MW2		2E-MW3		2E-MW4		2E-MW5		2E-MW6		2E-MW7			2E-MW8	
	Initial		Duplicate											Initial		Duplicate		
Analyte	Total	Dissolved	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Dissolved
Aluminum	1,830 +	53.4 b	1,290 +	435	41.6 b	230	212	13,600	261	23,300	88.1 b	11,900	53.8 b	52,400	78.2 b	59,000	68,800	58.4 b
Antimony	<16.4	<16.4	<16.4	<16.4	<16.4	<16.4	<16.4	<11.1 uj	<11.1	<11.1 uj	<11.1	<11.1 uj	<11.1	<11.1 uj	<11.1	<11.1 uj	16.8 bj	<11.1
Arsenic	7.3 n	2.0 b	6.2 b,n	2.9 b	2.0 b	3.3 b	1.5 b	10.6	3.9 b	13.5	1.8 b	13.8	2.4 b	20.3	<1.3	28.3	32.0	3.6 b
Barium	23 b	15.8 b	19.8 b	23.5 b	19.8 b	13.8 b	14.4 b	135 b	1,180	181 b	69.2 b	145 b	59.7 b	412	104 b	366	390	147 b
Beryllium	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	0.52 bj	<0.14 uj	1.0 bj	<0.14 uj	0.83 bj	<0.14 uj	2.9 b	<0.14 uj	2.9 b	3.3 b	<0.14 uj
Cadmium	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1
Calcium	14,200	16,100	14,300	12,200	11,700	7,430	7,120	37,100	34,900	43,700	41,800	45,300	42,200	76,400	52,100	57,200	57,100	67,600
Chromium	5.1 b	<2.8	4.4 b	<2.8	<2.8	3.1	<2.8	25.0	<2.3	45.1	<2.3	23.2	<2.3	113	<2.3	120	140	<2.3
Cobalt	<2.6	<2.6	<2.6	3.6 b	3.3 b	2.7 b	<2.6	15.1 bj	<1.6 uj	24.1 bj	<1.6 uj	16.3 bj	<1.6 uj	34.0 bj	<1.6 uj	47.4 b	50.4	<1.6 uj
Copper	7.7 b	4.3 b	6.7 b	<1.2	<1.2	<1.2	<1.2	13.5 b	6.6 b	21.6 b	<1.7	21.6 b	<1.7	62.6	<1.7	66.9	70.3	<1.7
Iron	19,100+	9,670	19,100 +	14,400	11,500	4,090	1,750	35,900	16,300	47,500	18,000	73,300	40,900	81,900	17,000	92,400	102,000	17,400
Lead	2.2 b,n	<1.7	2.8 b,w,n	21.7	<1.7	4.0	<1.7	10.2	2.0 b	17.3	<2.0	21.2	<2.0	26.6	<2.0	31.6	37.4	4.5
Magnesium	23,400	24,200	23,500	19,400	19,200	8,930	8,780	41,400	38,400	27,900	23,600	42,600	38,300	26,300	16,200	28,800	30,100	14,200
Manganese	1,560	1,590	1,570	622	612	298	294	926	821	839	686	1,410	1,220	970	1,880	2,350	2,390	586
Mercury	<0.07	<0.14	<0.07	0.12 b	0.10 b	0.15 b	0.08 b	0.12 b	<0.07	<0.07	<0.07	0.08 b	<0.07	<0.07	<0.07	0.07 b	0.10 b	<0.07
Nickel	13.0 b	<9.4	16.2 b	12.6 b	10 b	<9.4	<9.4	16.6 b	<7.3	29.8 b	<7.3	21.6 b	8.7 b	70.5	<7.3	76.2	89.2	<7.3
Potassium	1,200 b	982 b	1,070 b	<934	<934	<934	<934	5,420	14,500	5,920	2,670 b	4,000 b	1,890 b	17,000	6,260	14,700	16,000	8,720
Selenium	<1.8	<1.8	2.7 b,w,n	<1.8	<1.8	<1.8	<1.8	<15.0 R	<1.5 uj	<15.0 R	<1.5 uj	<15.0 R	<1.5 uj	<15.0 R	<1.5 uj	<15.0 R	<15.0 R	<1.5 uj
Silver	<2.0 n	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Sodium	14,600	15,000	14,000	11,700	11,800	14,900	15,500	33,100	38,100	24,900	25,100	31,500	31,600	39,400	32,200	32,300	32,600	40,400
Thallium	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<2.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Vanadium	5.0 b	<2.6	3.8 b	2.7 b	<2.6	<2.6	<2.6	35.2 b	<2.3	53.8	<2.3	36.7 b	<2.3	146	<2.3	149	169	<2.3
Zinc	30.4	33.3	34.1	61.7	101	31.8	28.5	35.4	414	62.7	20.1	60.0	18.0 b	139	42.9	171	194	113

Table 2-2-7
INORGANIC COMPOUNDS IN GROUNDWATER AT SITE 2E
January 1993 to October 1994
(Concentrations in µg/L)

Analyte	October 1994										
	2E-MW9			2E-MW10		2E-MW11		2E-MW12		2E-MW13	
	Initial		Duplicate								
	Total	Dissolved	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	1.4 b	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	24.6	<1.0	<1.0	<1.0
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	1.0 jc	0.89	1.1 jc	0.83 jc	0.61	1.3 jc	0.58	0.40 jc	0.89	1.3 jc	0.90
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	<12.0 a	<7.8 a	<18.0 a	<9.1 a	<6.1 a	<14.5 a	<17.9 a	81.2	<13.5 a	<8.0 a	<12.2 a

Notes:
< = Value less than IDL or was not detected.
a = The concentration is qualified as non-detect because the analyte was detected in the laboratory preparation blank. As required by EPA, all sample values less than 5 times the compounds level in the preparation blank are qualified non-detect.
b = Value less than the CRDL, but greater than or equal to the IDL.
w = Post digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50 percent of spike absorbance.
n = Spiked sample recovery not within control limits.
QC sampling: 2E-MW30 is a duplicate of 2E-MW1; however, no dissolved metals analysis was performed on 2E-MW30. 2E-MW70 is a duplicate of 2E-MW7 for total metals only; 2E-MW80 is a duplicate of 2E-MW9 for total metals only.
+ = Duplicate analysis not within control limits.
R = Quantitation limit qualified as rejected and unusable during data validation.
uj = The quantitation limit is qualified as estimated during data validation.
j = Value qualified as estimated.
jc = The value is qualified as estimated because the matrix-spike recovery values were outside the control limit.



LEGEND

- ------- APPROXIMATE EXTENT OF FUEL-RELATED DISSOLVED CONTAMINATION
- ——— APPROXIMATE EXTENT OF KNOWN ACCUMULATED FREE PRODUCT ON THE WATER TABLE
- 69 BTEX CONCENTRATION
- ND NOT DETECTED
- NS NOT SAMPLED

Figure 2-2-7

APPROXIMATE EXTENT OF FREE PHASE FUEL AND DISSOLVED-PHASE PETROLEUM CONTAMINATION AT SITE 2E

CH2MHILL

ONAS\0368dr.dgn 12-17-31-63
ONAS\PC2183.DGN
ONAS\0368W2E.DGN
ONAS\0368BTXT.DGN
ONAS\T2183.DGN 48

0368m2e9.dgn
15-DEC-1994

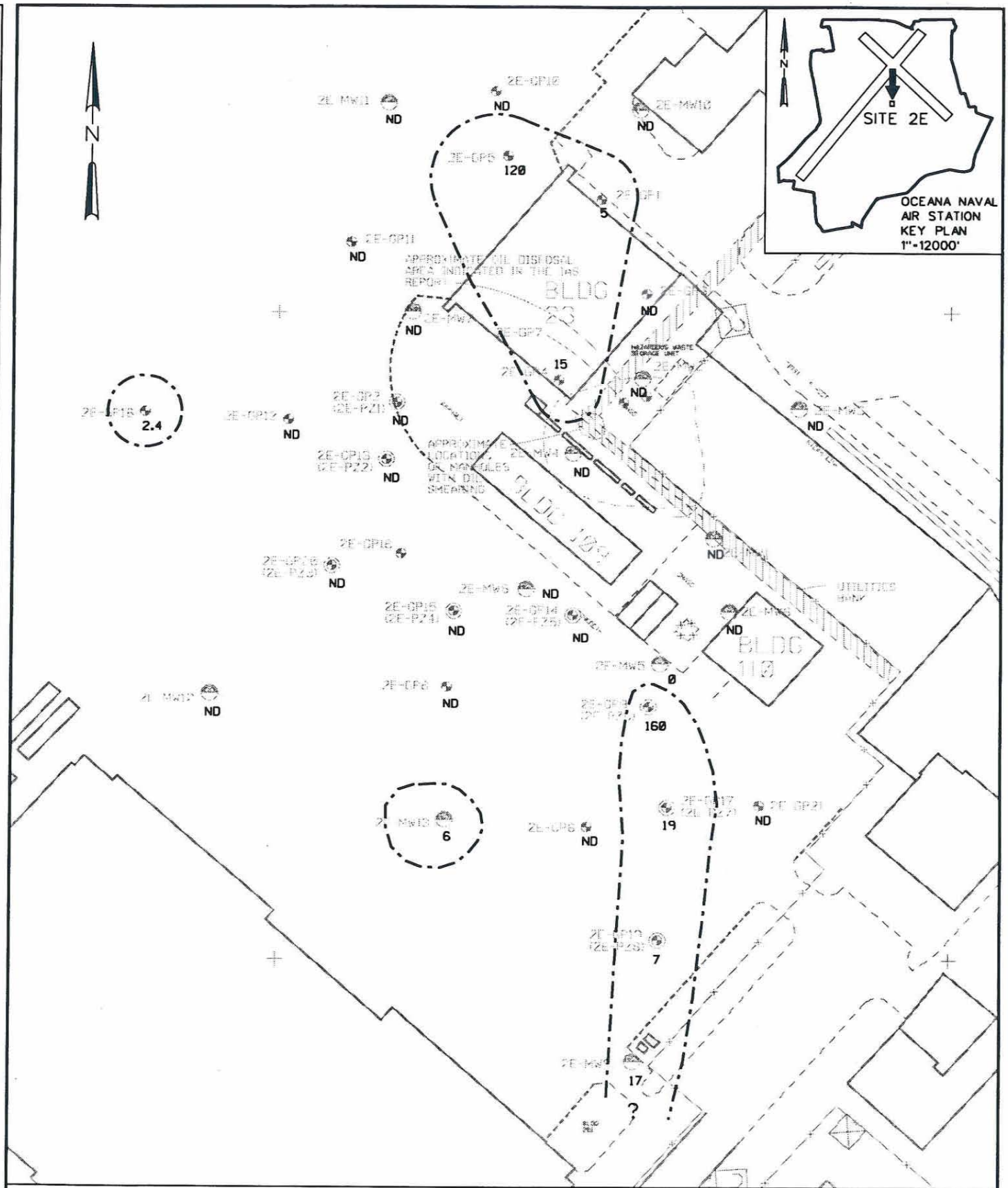


Figure 2-2-8

APPROXIMATE EXTENT OF CHLORINATED VOC CONTAMINATION AT SITE 2E

CH2MHILL

ONAS0368bdr.dgn
ONASPC2118J.DGN
ONAS0368W12E.DGN
ONAS0368BTXT.DGN
ONAS1721183.DGN

368m2e13.dgn
15-DEC-1994

values shown include estimated concentrations. The two main areas of chlorinated VOCs are near Building 23 and south of Building 110.

Health and Environmental Assessment

The data are compared to potentially applicable federal and Virginia standards and guidelines in Table 2-2-8. This table is based on the corresponding table in the Phase I report but includes reference to risk-based screening concentrations (RBCs) developed by EPA Region III. Benzene, mercury, and zinc were above Virginia groundwater standards or MCLs at several groundwater sampling locations. Benzene was above the MCL of 5 ppb in four wells that contain or are suspected of containing free product, that is, 2E-MW1, 2E-MW4, 2E-MW7, and 2E-MW8. Benzene also was above the MCL at three in-situ sampling locations. Two of these locations are underneath Building 23 (2E-GP3 and 2E-GP4), and the third is southeast of Building 109. Mercury concentrations exceeded the Virginia groundwater standard of 0.05 ppb in 10 of 13 wells, but were not above the MCL in any wells. The mercury concentration was above the Virginia standard both upgradient and downgradient of the site. The zinc concentrations exceeded Virginia standards in four wells (2E-MW2, 2E-MW4, 2E-MW7, and 2E-MW8). There is no primary MCL for zinc and the secondary MCL is 500 ppb, which is considerably greater than the detected concentrations.

The concentration of TPH was above the Virginia groundwater standard of 1,000 ppb in all five wells installed in February and March 1994, but in none of the five more distant wells installed in September 1994. Concentrations were considerably above standards in 2E-MW4 (17,900,000 ppb), a well with free-product fuel. The initial sample from well 2E-MW7 (3,790,000 ppb) was above the standard but the duplicate (730 ppb) was below the standard. Estimated concentrations in 2E-MW5 (1,850 ppb), 2E-MW6 (2,380 ppb), and 2E-MW8 (1,080 ppb) also exceeded the Virginia groundwater standard for TPH.

Table 2-2-8
CONSTITUENTS IN SITE 2E GROUNDWATER AND SOILS THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
(All data in ppb)

Groundwater

Compound	Location Detected	Concentration (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)
Mercury	2E-MW2		2	2	.05	11
	Total	0.12 b				
	Dissolved	0.10 b				
	2E-MW3					
	Total	0.15 b				
	Dissolved	0.08 b				
	2E-MW4					
	Total	0.12				
	Dissolved	<0.07				
	2E-MW6					
	Total	0.08				
	Dissolved	<0.07				
	2E-MW8					
	Total	0.10				
	Dissolved	<0.07				
	2E-MW9					
	Total	1.0				
	Dissolved	0.89				
	2E-MW10					
	Total	0.83				
	Dissolved	0.61				
	2E-MW11					
	Total	1.3				
	Dissolved	0.58				
	2E-MW12					
	Total	0.40				
	Dissolved	0.89				

Table 2-2-8
CONSTITUENTS IN SITE 2E GROUNDWATER AND SOILS THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
(All data in ppb)

Groundwater (continued)

Compound	Location Detected	Concentration (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)
Mercury (continued)	2E-MW13 Total Dissolved	 1.3 0.90				
Zinc	2E-MW2 Total Dissolved 2E-MW4 Total Dissolved 2E-MW7 Total Dissolved 2E-MW8 Total Dissolved	 61.7 101 35.4 414 139/171 42.9 194 113	NS NS	NS NS	50 50	NS NS
Benzene	2E-MW1 2E-MW4 2E-MW7 2E-MW8 2E-GP3 2E-GP4 2E-MW9 2E-MW13 2E-GP19 2E-GP20	8 81 2 25 46 47 1 j 2 j 2.9 5.8	5	0	NS	0.36
Vinyl Chloride	2E-MW9 2E-MW13	13 6 j	2	0	NS	0.019

Table 2-2-8
CONSTITUENTS IN SITE 2E GROUNDWATER AND SOILS THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
(All data in ppb)

Groundwater (continued)

Compound	Location Detected	Concentration (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)	
Total Petroleum Hydrocarbons (TPH)	2E-MW4 2E-MW5 2E-MW6 2E-MW7 2E-MW8	17,900,000 1,850 j 2,380 j 3,790,000/730 1,080 j	NS	NS	1,000	NS	

Soil

Compound	Location Detected	Concentration (ppb)	Health Based Criteria for Carcinogens	Health Based Criteria for Systemic Toxicants	Proposed RCRA Action Levels	Virginia Soil Guidance Limit	Eastern United States Soil Mean	RBC (Industrial/ Residential Soil)
Beryllium	2E-SS5 2E-SS6 2E-SS7 2E-SS8 2E-SS9	320, 340 a 150 430 520 570	143	400	200	NS	550	670/150
Total Petroleum Hydrocarbons (TPH)	2E-SS5 2E-SS6 2E-SS8 2E-SS11 2E-SS12 2E-SS13	607,000 189,000 286,000 717,000 944,000 7,700,000	NS	NS	NS	100,000	NA	NS
Benzo(a)pyrene	2E-SS7 2E-SS11	98 230 j	60.9	NS	NS	NS	NA	390/88
Benzo (a) anthracene	2E-SS7 2E-SS11	54 j 220 j	224	NS	NS	NS	NA	390/88
Chrysene	2E-SS11	240 j	NS	NS	NS	NS	NA	390/88

Table 2-2-8
CONSTITUENTS IN SITE 2E GROUNDWATER AND SOILS THAT EXCEEDED
POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
(All data in ppb)

Soil (continued)

Compound	Location Detected	Concentration (ppb)	Health Based Criteria for Carcinogens	Health Based Criteria for Systemic Toxicants	Proposed RCRA Action Levels	Virginia Soil Guidance Limit	Eastern United States Soil Mean	RBC (Industrial/ Residential Soil)
Benzo (b) fluoranthene	2E-SS7 2E-SS11	110 220 j	NS	NS	NS	NS	NA	390/88
Indeno (1,2,3-cd) pyrene	2E-SS7 2E-SS11	110 170 j	NS	NS	NS	NS	NA	390/88
Copper	2E-SS5 (0.5 ft.) 2E-SS7 2E-SS8	31,200 41,000 58,000	NS	NS	NS	NS	13,000	38,000,000/ 2,900,000
Lead	2E-SS5 (2 ft.) 2E-SS7 2E-SS8	25,200 53,900 26,200	NS	NS	NS	NS	14,000	NS for inorganic lead
Mercury	2E-SS9	110	NS	NS	20,000	NS	81	310,000/23,000
Nickel	2E-SS9	11,500	NS	2,000,000	NS	NS	11,000	NS
Zinc	2E-SS7 2E-SS8	105,000 74,000	NS	NS	NS	NS	40,000	NS

Notes:
The MCLs and MCLGs are listed in the Drinking Water Regulations and Health Advisories, dated December 1992.
Only those compounds which were detected and exceeded established standards are presented in the table above.
The health-based criteria for carcinogens and systemic toxicants were extracted from the RFI Guidance Document EPA 530/SW-89-031
The proposed RCRA action limits were listed in the *Federal Register* dated July 27, 1990.
The Virginia soil guidance limit is used for determining when to implement a corrective action.
a These two concentrations are from the 0.5 - 1.0 foot and 2.0 - 3.0 feet depths, respectively.
j Estimated value.

The soil concentrations exceeded carcinogenic criteria and residential soil RBCs for benzo (a) pyrene in soils 2E-SS11 and 2E-SS7 (2 out of 13 soil samples). RBCs for five PAHs for residential soil were exceeded in 2E-SS11; however, these concentrations were qualified as estimated. None of the PAH concentrations are above industrial soil RBCs. Because of the high dilutions and elevated TPH in 2E-SS12 and 2E-SS13, it is reasonable to assume that some of the same PAHs also are present in these two soil samples.

Conclusions and Recommendations

The primary problem at Site 2E is contamination by free-phase petroleum products. The free-phase generally is found at a depth of approximately 4 to 5 feet. In some areas, notably at locations 2E-SB20, 2E-SB21, and 2E-SS13, the free product is shallower than 3 feet, possibly because it is perched on a discontinuous clay layer found at 3 feet or is simply thick enough to be present closer to the surface. The origin of the fuel may be leaks and poor handling of fuels in the grassy area northeast of Building 109 but this is not known definitively. The activities in the immediate vicinity of Building 109 may not be the only source of the fuel because free product was observed in boring 2E-SB23 southwest of Building 23, a distance of 50 feet side-gradient from Building 109.

The origin of the free-phase petroleum product remains unknown despite a detailed study to identify the source. The identification of the fuel as diesel and not the jet fuels JP-4 and JP-5 appears to preclude most potential sources identified during the records search in August 1994 because JP-5 is the fuel used for all jets, the helicopters stationed in Building 23, and most of the support vehicles. The only potential source of diesel identified during the investigation were mobile generators, hydraulic test stands, and auxiliary power units used to service fighter engines. It is not known whether these vehicles used diesel fuel. These vehicles were reportedly parked in the area between Building 109 and the line of lockers to the northeast (Jones, November 30, 1994). This is also the center of the area contaminated with diesel fuel. The diesel contamination could have been caused by chronic leaks from such equipment but the substantial volume of diesel fuel suggests that a large-

volume release is more likely. These fighters were transferred from Oceana in late Summer 1994 so the support vehicles are no longer used in this area. The recent discovery of this potential source does not make it the most likely explanation of the diesel contamination; however, it is the only theory put forth that may be consistent with diesel contamination.

The utility bank may be facilitating migration of the fuel from its original release area, whether the release area is upgradient of Building 23 and Building 109 or adjacent to Building 109. Regardless of whether or not the utility bank acts as a conduit at Site 2E, it is clear that the free phase has migrated downgradient of the utilities bank. The direction of groundwater flow is primarily south-southwest, nearly perpendicular to the utility alignment. Free-phase petroleum has reached as far as well 2E-MW8 but does not appear to have migrated much farther downgradient judging from piezometer data.

The extent of the dissolved fuel-related plume and the free-phase hydrocarbon has been well characterized by the Phase II sampling program. The approximate extent of the area where the fuel thickness on the water table is greater than 0.01 feet is illustrated in Figure 2-2-7. The lateral extent of free-phase fuel was determined from drilling, in-situ sampling results, and free-phase measurements in the wells and piezometers in October 1994. A small area south of well 2E-MW9 may warrant additional characterization on the basis of the vinyl chloride detected in 2E-MW9.

This site has been characterized sufficiently to proceed with a corrective measures study (CMS) that addresses remediation options for the free-phase petroleum and dissolved-phase groundwater contamination. Future activities should include:

- Develop and implement a more aggressive interim measures program for recovering free phase from the broader free-phase area using pneumatic or electrical pumps. This should include the installation of 4-inch or 6-inch-diameter recovery wells.

- Develop a plan for storing and handling the recovered fuel.

- Collect in-situ groundwater samples at approximately six locations and analyzed them for field VOCs identified at Site 2E previously. Send one split sample to the laboratory for confirmation by 8240 VOC analysis.

- Installing two shallow monitoring wells south of wells 2E-MW13 and 2E-MW9 and a deep well in the Yorktown Formation south of Building 109. Sample these wells for PAHs, 8240 VOCs with a 2 ppb vinyl chloride detection limit, TPH, and total and dissolved lead, zinc, and mercury.

- Analyze wells 2E-MW7, 2E-MW9, 2E-MW10, 2E-MW11, 2E-MW12, and 2E-MW13 for 8240 VOCs, TPH, and PAHs.

- Preparing a full CMS of remediation options for free product recovery and remediation of soil and groundwater contamination.

- Surveying all wells and the lip of the manhole where oil was observed.

Site 15—Abandoned Tank Farm

Site Conditions

Site 15 is an abandoned tank farm that was part of the North Station area. The North Station was active from the mid-1950s to the mid-1970s. The tanks and associated piping have been removed and there is little evidence of the tank locations. Their position was inferred from historical maps and recent air photos.

The ecological setting of the site was described in detail in the RFI Phase I report (CH2M HILL, 1993). Two aspects of the ecological description that merit some clarification are the thickness of vegetation in the eastern half of the site and the prominence of the ditch shown transecting the site in Figure 4-7-3 of the Phase I report. The vegetation east of the ditch is shown to be discontinuous. In reality, the trees and bush are quite thick and the only clear paths are along horse trails and old roads oriented northeast-southwest. Four horse paths transect the area.

The ditch illustrated in the Phase I report is generally 10 to 30 feet wide and is quite shallow. In most areas the banks are not distinct. The ditch appears to be a broad elongated wet area that drains slowly to the southeast. It transects the entire site east of the former tank area.

There is no evidence of wells 15-MW1 to 15-MW4 installed in the early 1980s. They appear to have been abandoned. Their exact location is unknown.

Investigation Activities

The Phase II investigation at Site 15 consisted of two field events. After compiling the field data collected in February 1994, it was apparent that additional field activities were necessary to accomplish the objectives of the RFI, namely to complete contaminant

characterization of the site. During the first field event in February 1994, field personnel completed the following activities:

- Collected eight in-situ groundwater samples with the hydraulic probe sampler (15-GP13 to 15-GP20) in areas not covered by the Phase I in-situ sampling. The samples generally were in a line northeast of the known areas of contamination. The samples were collected from 7 to 9 feet, with the exception of 15-GP13 and 15-GP17, which were collected from 0 to 5 feet. An air photo of the area was used to determine sampling locations because the area is heavily wooded.

- Collected 15 in-situ soil samples in the former tank farm area (15-GP13 to 15-GP20). The samples were collected from seven locations in the most contaminated area as determined from in-situ groundwater sampling. At six locations, samples were collected from two intervals, 1 to 3 feet and 4 to 6 feet. At 15-GP14, samples were collected from 0 to 2 feet, 2 to 4 feet and 4 to 6 feet. All in-situ samples were analyzed for field VOCs in the mobile lab.

- Installed and sampled six monitoring wells (15-MW5 through 15-MW10). The wells were installed in locations that were intended to be outward from the contamination identified during the in-situ sampling. Groundwater samples were collected from each well for VOCs, TPH, PAHs, and total and dissolved lead analyses.

- Performed slug tests in three wells (15-MW5, 15-MW6 and 15-MW8) to determine the hydraulic conductivity of the aquifer at these locations.

Analysis of the data collected during February and March 1994, demonstrated that additional field work was necessary to characterize the site completely. For this reason, field personnel conducted a second field event in September and October 1994 to

characterize the southwest, northeast, and northwest limits of dissolved contamination and the extent of recoverable free-product fuel. The following field tasks were completed during this second phase of site characterization.

- Nine in-situ groundwater samples were collected (15-GP21 through 15-GP29) and analyzed in a mobile laboratory for field VOCs. The samples were collected from the water-table, which was approximately 7 to 9 feet below grade.

- Five shallow monitoring-wells (15-MW11 through 15-MW15) were installed and sampled. The results of the in-situ sampling were used to determine the new monitoring-well locations so that the new locations would be outside the dissolved contaminant plume. The new monitoring wells were sampled for VOCs, PAHs, total and dissolved lead, and TPH.

- Six test-pits (15-TP1 through 15-TP6) were excavated in order to expose the water table and to assess the extent of free-product contamination. Field personnel recorded observations from each test-pit. See Appendix A for this information.

- Six piezometers (15-PZ1 through 15-PZ6) were installed in the suspected free-product area to confirm the presence of free-product and to facilitate long-term monitoring of product concentrations.

Well construction specifications are summarized in Table 2-3-1. A geologic cross section of Site 15 is illustrated in Figure 2-3-1. The horizontal and vertical position of each new well was surveyed to aid in locating the well locations accurately on a map. Figure 2-3-2 presents the Site 15 RFI sampling locations and the alignment of the cross section.

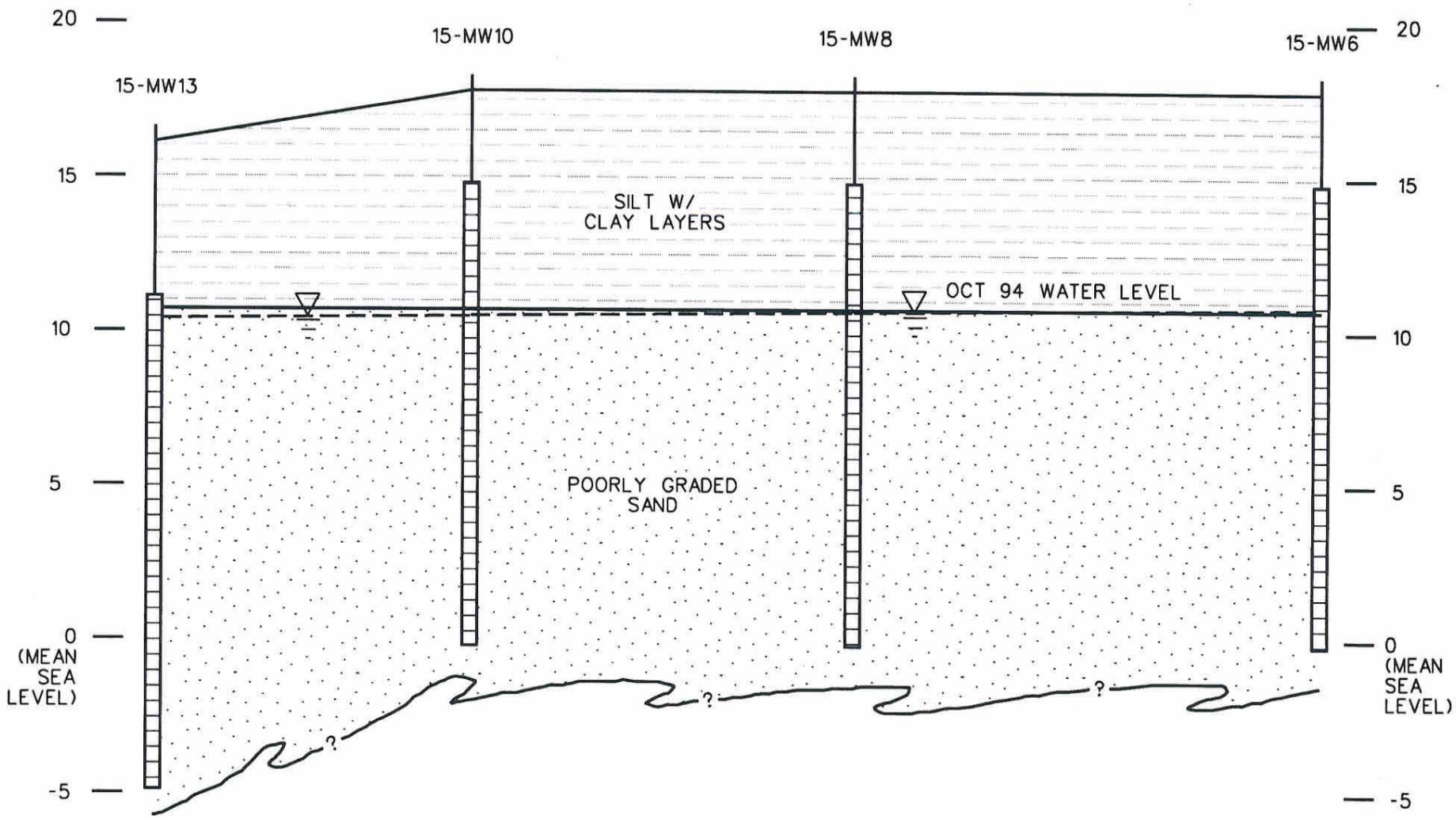
Table 2-3-1
SITE 15 MONITORING WELL SUMMARY

Well Number	Date Installed	Ground Elevation (feet above MSL)	Total Depth (feet)	Screened Interval (feet below ground surface)	Comments
15-MW1 (MW-1)	11/82	18.4	16	0.5-10.5	Abandoned
15-MW2 (MW-2)	11/82	17.6	20	0.5-10.5	Abandoned
15-MW3 (MW-3)	11/82	18.8	20	0.5-10.5	Abandoned
15-MW4 (MW-4)	11/82	ND	ND	ND	Abandoned
15-MW5	3/9/94	18.4	18	3-18	
15-MW6	4/13/94	17.9	20	3-18	
15-MW7	4/12/94	16.6	18	3-18	
15-MW8	4/12/94	17.8	18	3-18	
15-MW9	3/11/94	18.3	20	3-18	Drilled in Level C
15-MW10	4/13/94	17.8	20	3-18	
15-MW11	9/28/94	17.3	20	5-20	
15-MW12	9/27/94	17.6	20	5-20	
15-MW13	9/28/94	16.1	20	5-20	
15-MW14	9/27/94	17.7	20	5-20	
15-MW15	9/27/94	17.3	20	5-20	

Notes:

ND = No data available

Wells 15-MW1 through 15-MW4 were installed in November 1982 by a contractor under R.E. Wright Associates. The logs for the first three are in the drilling appendix under MW-1 to MW-3. The wells are no longer visible and appear to have been abandoned and removed.



SCALE:
1"=100' HORIZ.
1"=5' VERT.

Figure 2-3-1

GEOLOGIC CROSS SECTION
OF SITE 15
(SECTION TRENDS NORTHWEST - SOUTHEAST)

14-NOV-1994 0368I117.dgn

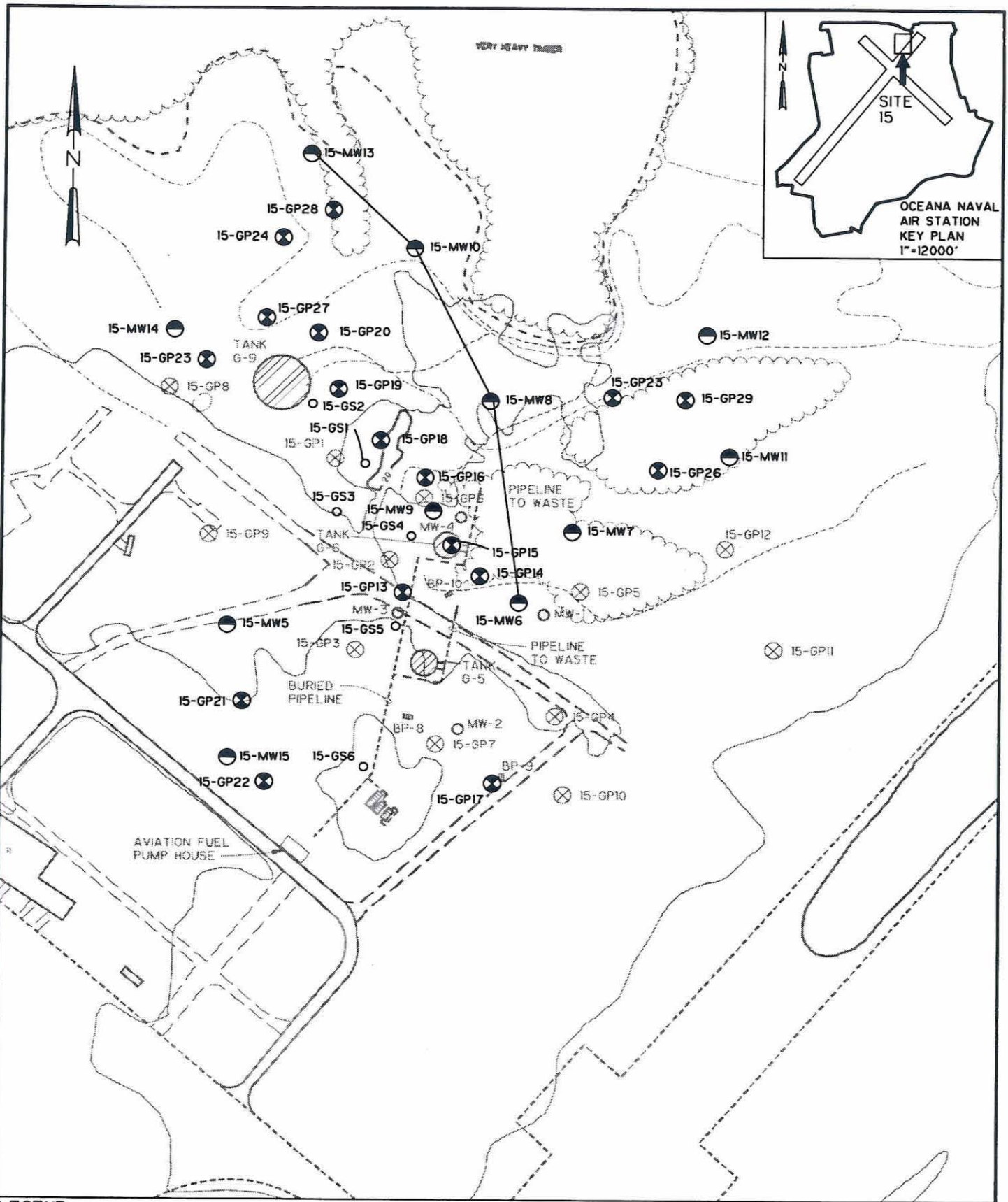


Figure 2-3-2
RFI PHASE II
SAMPLING LOCATIONS
AT SITE 15

CH2MHILL

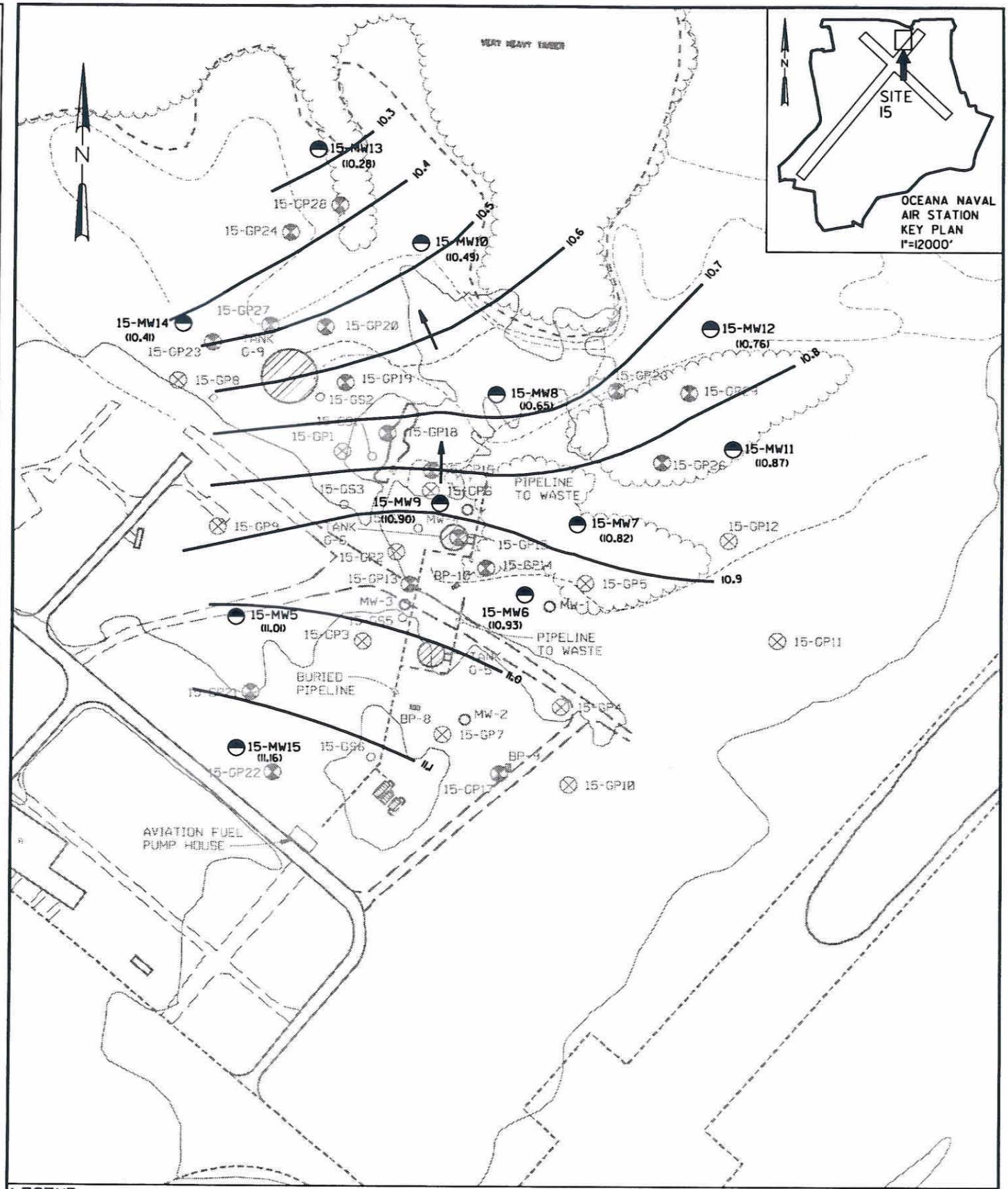
0368m158.dgn
15-DEC-1994

Data Interpretation

Water-level measurements were collected on three occasions during Phase II, with the most recent measurements on October 20, 1994. The groundwater-flow direction as evaluated from the October 1994 data, is illustrated in Figure 2-3-3, and the water-level elevations are listed in Table 2-3-2. As shown in the figure, the groundwater flow is north-northeast to north-northwest. The results of a May 1994 measuring event, demonstrated that flow was to the northeast. This second set appeared to be representative of flow at that time. This flow direction also is consistent with the flow direction recorded in the R.E. Wright report (1983). The October 1994 data set was used for analysis of groundwater flow directions because this set includes the new wells and is therefore more complete. The results from the first two water-level measurement events are mentioned as evidence that flow directions vary at the site.

The hydraulic gradient is low. On October 20, 1994, the gradient was approximately 0.001 ft/ft from 15-MW9 to 15-MW13, 0.001 ft/ft from 15-MW5 to 15-MW14, and 0.0007 ft/ft from 15-MW11 to 15-MW10. Slug tests were performed on wells 15-MW5, 15-MW6, and 15-MW8 during the investigation. The average hydraulic conductivity determined from these tests was $6x10^{-3}$ cm/sec, or 17 ft/day. The results of pump tests at Sites 1 and 2B at Oceana yielded hydraulic conductivity estimates approximately three times the average conductivity calculated from the slug tests. If the actual hydraulic conductivity is three times the slug test average at Site 15 also, then 1.8×10^{-2} cm/sec, or 50 feet/day would be representative of the site. If a porosity of 25 percent a hydraulic conductivity of 50 ft/day and an average gradient of 0.001 ft/ft are assumed to be representative, then the average velocity of groundwater movement in the surficial aquifer is approximately 70 ft/year. The depth to water was 6 to 9 feet during October 1994.

The in-situ soil data listed in Table 2-3-3 and illustrated in Figure 2-3-4 indicate that petroleum contamination of unsaturated soil is widespread in the center of the site. The samples collected from the 4 to 6 feet were generally more contaminated than the shallower



LEGEND

- PHASE I HYDRAULIC PROBE GROUNDWATER SAMPLING LOCATION
- PHASE II AND HYDRAULIC PROBE GROUNDWATER SAMPLING LOCATION
- SHALLOW MONITORING WELL
- PHASE II HYDRAULIC PROBE SOIL SAMPLING LOCATION

0 100 200 300

SCALE IN FEET

CONTOUR INTERVAL IS 0.1 FEET

- HORSE TRAILS
- EQUIPOTENTIAL CONTOUR
- (10.28) WATER-LEVEL ELEVATION
- DIRECTION OF GROUNDWATER FLOW

Figure 2-3-3

GROUNDWATER ELEVATIONS AT SITE 15 ON OCTOBER 20, 1994

CH2MHILL

0368m254.dgn
23-Nov-1994

ONAS0368grd.dgn 1-63
ONAS0368sil1.dgn 1-59
ONAS0368grd.dgn
ONAS0368Mgrd.dgn

ONAS0368bdr.dgn 3-4, 60-63
ONAS\721182.dgn 1-49, 51-63
ONASsp721182.dgn 1-59
ONAS\724182.dgn 1-49, 51-59

ONASsp724182.dgn 1-59
\Sspc24189.dgn 1-59
\St724189.dgn 1-49, 51-59
ONAS\721189.dgn 1-49, 51-59

ONASsp721189.dgn 1-59
ONAS0368wr15.dgn 1-63
ONAS0368K152.dgn 1-63

Table 2-3-2
SITE 15 WATER-LEVEL DATA
October 20, 1994

Well	Elevation of Survey Datum (feet)	Water-Level Distance Below Survey Datum (feet)	Water-Level Elevation (feet)
15-MW5	20.13	9.12	11.01
15-MW6	21.11	10.08	10.93
15-MW7	19.02	8.20	10.82
15-MW8	19.94	9.29	10.65
15-MW9	20.23	9.33	10.90
15-MW10	20.38	9.89	10.49
15-MW11	19.16	8.29	10.87
15-MW12	19.16	8.40	10.76
15-MW13	18.60	8.32	10.28
15-MW14	19.37	8.96	10.41
15-MW15	18.80	7.64	11.16

Note: All elevations are in feet above mean sea level.

Table 2-3-3
ORGANIC COMPOUNDS IN SOILS AT SITE 15
February 1994
(All data in ppb)

Analyte	Detection Limit[a]	15-GS1		15-GS2		15-GS3		15-GS4	
		1.0-3.0 ft.	4.0-6.0 ft.	1.0-3.0 ft.	4.0-6.0 ft.	1.0-3.0 ft.	4.0-6.0 ft.	1.0-3.0 ft.	4.0-6.0 ft.
Total Petroleum Hydrocarbons	1,000	NA	NA	NA	NA	NA	NA	NA	NA
Polynuclear Aromatic Compounds	6,700	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds									
1,1,1-Trichloroethane	0.5/6	*	*	*	*	*	*	*	*
Benzene	5/6	*	17,239 e	24 j	63	5,267	21,776 e	*	*
Toluene	5/6	6,368 e	6,816 e	19 j	32	3,448	4,936 e	5,935 j	12,329 e
Ethylbenzene	5/6	*	14,584 e	*	728	*	*	14,674 e	25,169 e
Xylene (total)	5/6	27,201 e	50,087 e	33	1,126	29,226	26,062 e	72,700 e	188,190 e
Methylene Chloride	6	NA	NA	NA	NA	NA	NA	NA	NA
Total Petroleum Volatiles	5	256,650	437,641	75	2,872	280,625	992,948	796,625	1,7060,222

Ta 3-3
ORGANIC COMPOUNDS IN SOILS AT SITE 15
February 1994
(All data in ppb)

Analyte	Detection Limit[a]	15-GS5		15-GS6		15-GS14			
		1.0-3.0 ft.	4.0-6.0 ft.	1.0-3.0 ft.	4.0-6.0 ft.	0-2.0 ft.	2.0-4.0 ft.		4.0-6.0 ft.
							Mobile Lab	Standard Lab	
Total Petroleum Hydrocarbons	1,000	NA	NA	NA	NA	NA	NA	259,000	NA
Polynuclear Aromatic Compounds	6,700	NA	NA	NA	NA	NA	NA	*	NA
Volatile Organic Compounds									
1,1,1-trichloroethane	0.5/6	*	*	*	*	*	4	*	*
Benzene	5/6	6,889 e	8,914 e	5 j	*	*	*	7	*
Toluene	5/6	3,123	*	5 j	*	*	28	4 j	950
Ethylbenzene	5/6	*	*	*	*	*	87	*	293
Xylene (total)	5/6	38,448 e	38,827 e	*	*	*	87	*	2,495
Methylene Chloride	6	NA	NA	NA	NA	NA	NA	9	NA
Total Petroleum Volatiles	5	142,300	159,035	273	*	*	1,853	NA	12,160

Notes:

15-GS1-1, 15-GS2-1, 15-GS3-1, 15-GS4-1, 15-GS5-1, and 15-GS6-1 were collected from 1.0-3.0 feet below grade.
15-GS1-2, 15-GS2-2, 15-GS3-2, 15-GS4-2, 15-GS5-2, and 15-GS6-2 were collected from 4.0-6.0 feet below grade.
15-GS14-2, 15-GS14-4, and 15-GS14-6 were collected from the following depths respectively; 0-2.0 feet, 2.0-4.0 feet, and 4.0-6.0 feet below grade.
15-GS14-4 was split and submitted to the standard lab for TPH, PAH, and VOC analysis.

[a]In instances where two detection limits are provided, the first limit applies to the mobile laboratory, and the second limit listed is from the analytical laboratory. The detection limits for TPH and PAHs correspond
to the analytical laboratory.
* Compound was analyzed but not detected.
NA - Not analyzed.
j Indicates an estimated value that was below the quantitation limit.
e Indicates an estimated value that was outside the linear working range of the instrument.
The detection of 2-butanone in 15-GS14 was rejected because the instrument calibration was out of the specified range. 2-butanone was not detected in any other samples.

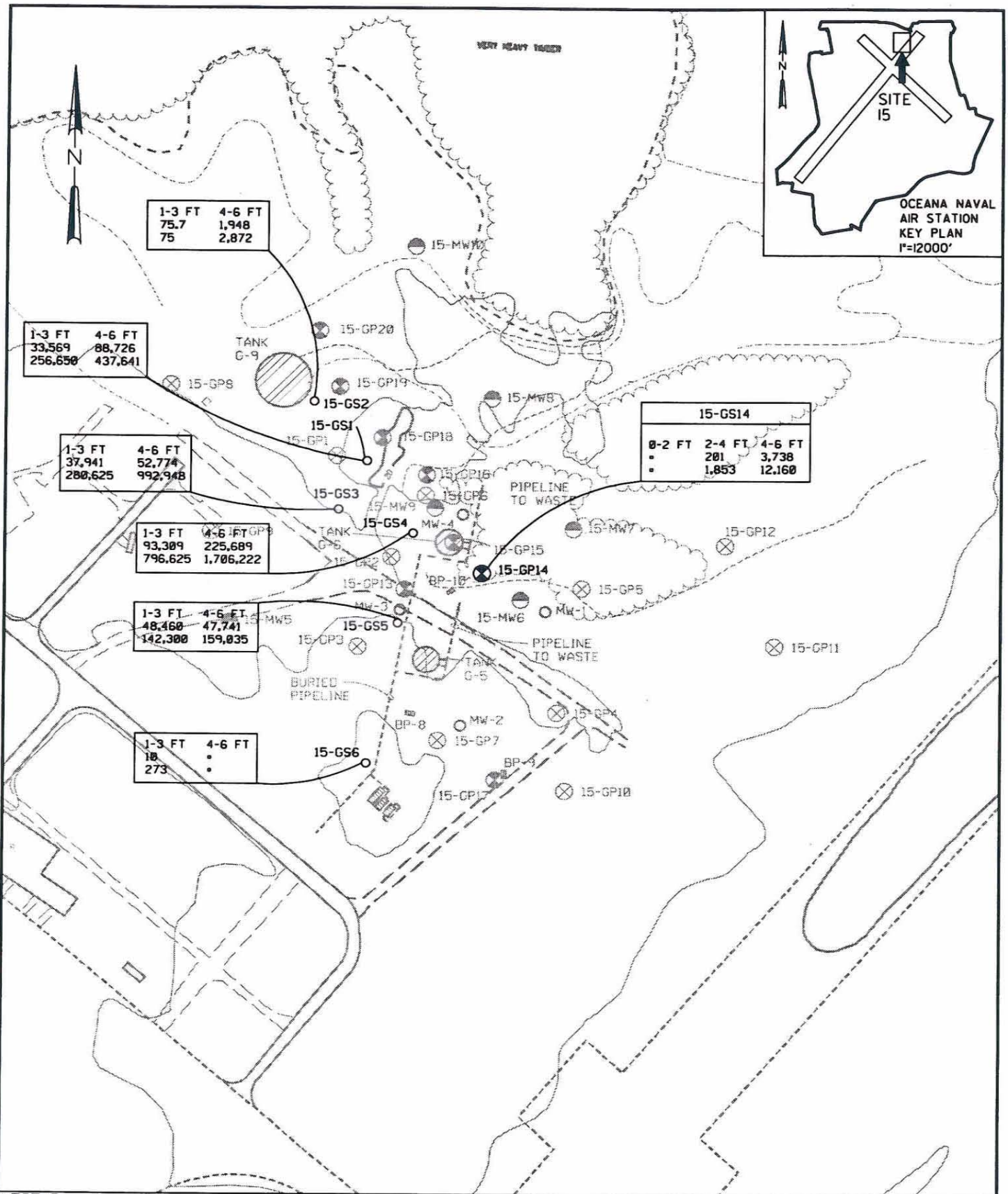


Figure 2-3-4

FUEL-RELATED CONSTITUENTS IN SOILS AT SITE 15

CH2MHILL

ONASpc21188.dgn | I-59 | I-63
ONASd368wr15.dgn
ONASpc24182.dgn | I-59 | I-40, 51-59
ONASpc24188.dgn | I-59 | I-40, 51-59
ONASd724189.dgn | I-40, 51-59
ONASd721189.dgn | I-40, 51-59
ONASd368bdr.dgn | 3-4, 60-63
ONASd721182.dgn | -63
ONASpc21182.dgn | -59
ONASd724182.dgn | -59

Ø368m154.dgn
19-Nov-1994

samples from 1 to 3 feet. All samples contained BTEX compounds. BTEX concentrations in samples 15-GS5, 15-GS4, 15-GS3 and 15-GS1 were all greater than 33,000 ppb. These concentrations and field observations of a hydrocarbon sheen on the rods confirm that these samples were collected from an area where soils are contaminated with hydrocarbons. 15-GS2 and 15-GS14 indicated moderate contamination by BTEX compounds. The results from these samples may indicate residual fuel contamination rather than free product per se. The soils from 15-GS6 contained negligible concentrations of fuel constituents. It is noteworthy that during installation of piezometer 15-PZ4, field personnel upgraded to Level C after drilling to 1 foot. This suggests there is high surficial soil contamination at that location.

The contaminant concentrations in groundwater samples collected with the hydraulic probe and analyzed in the on-site mobile laboratory are listed in Table 2-3-4 and illustrated in Figure 2-3-5. The concentrations of petroleum constituents were high in in-situ groundwater samples 15-GP13, 15-GP14, 15-GP15, 15-GP16, and 15-GP18. Concentrations of benzene, ethylbenzene, and xylenes generally were hundreds of parts per billion in these samples.

BTEX compounds were not detected in any of the outermost in-situ groundwater samples. Chlorinated volatiles also were non-detect in most samples, with the exception of 15-GP27 and 15-GP28 which contained cis-1,2-DCE at concentrations of 4.2 ppb and 2.4 ppb, respectively. The existence of cis-1,2-DCE in the two wells is consistent with the detection of 11 ppb of trans-1,2-DCE is 15-GP8 in November 1992.

The analytical laboratory results for total and dissolved lead, VOCs, TPH, and PAHs in the ten monitoring wells installed during Phase II are listed in Table 2-3-5 and the distribution of organic constituents in the monitoring wells is illustrated in Figure 2-3-6. The groundwater contains BTEX constituents at comparatively high concentrations in wells 15-MW7, 15-MW9, and 15-MW15 and at lower concentrations in well 15-MW5, but BTEX compounds were below quantitative detection limits in other wells. These results

Table 2-3-4
ORGANIC COMPOUNDS AND LEAD IN IN-SITU GROUNDWATER AT SITE 15
November 1992 through September 1994
(All concentrations in ppb)

Analyte[a]	Detection Limit	November 1992												
		15-GP1	15-GP2	15-GP3	15-GP4	15-GP5	15-GP6		15-GP7	15-GP8	15GP-9	15-GP10	15-GP11	15-GP12
							Field Lab	Standard Lab[b]						
Aromatic Volatile Organic Compounds														
Benzene	10	*	6.3	86	*	*	16,000	620	*	*	*	*	*	*
Toluene	10	*	4.3	32	*	*	6,900	960	*	*	*	*	*	*
Ethylbenzene	10	*	3.7	*	*	*	13,000	2,600	*	*	*	*	*	*
o-Xylene	100	NA	NA	NA	NA	NA	NA	3,200	NA	NA	NA	NA	NA	NA
m-and p-xylene	200	NA	NA	NA	NA	NA	NA	10,000	NA	NA	NA	NA	NA	NA
Total xylenes	10	*	15	3,300	*	*	22,000	13,200	*	*	*	*	*	*
Chlorinated Volatile Organic Compounds														
trans-1,2-Dichloroethylene	2	*	*	*	*	*	NA	NA	*	11	*	*	*	*
cis-1,2-Dichloroethylene	2	*	*	*	*	*	NA	NA	*	*	*	*	*	*
Total Petroleum Volatiles	10/15	11	1,100	13,000	29	270	1,600,000	NA	660	100	*	*	*	*
Lead - total	1.7	NA	NA	NA	NA	NA	NA	668	NA	NA	NA	NA	NA	NA
- dissolved		NA	NA	NA	NA	NA	NA	25.8	NA	NA	NA	NA	NA	NA
Polynuclear Aromatic Hydrocarbons														
Naphthalene	2	NA	NA	NA	NA	NA	NA	26	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	18	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	12	NA	NA	NA	NA	NA	NA

Table 2-3-4
ORGANIC COMPOUNDS AND LEAD IN IN-SITU GROUNDWATER AT SITE 15
November 1992 through September 1994
(All concentrations in µg/l)

Analyte*	Detection Limit	February 1994							
		15-GP13	15-GP14	15-GP15	15-GP16	15-GP17	15-GP18	15-GP19	15-GP20
Aromatic Volatile Organic Compounds									
Benzene	10	13,152 e	109	923.3	857	3 j	*	*	32
Toluene	10	11,527 e	*	*	*	*	*	*	*
Ethylbenzene	10	8,835 e	359	706	527	*	642	*	15 j
o-Xylene	100	NA	NA	NA	NA	NA	NA	NA	NA
m-and p-xylene	200	NA	NA	NA	NA	NA	NA	NA	NA
Total xylenes	10	60,434 e	1,226	1,470	1,032	*	1,038	*	20 j
Chlorinated Volatile Organic Compounds									
trans-1,2-Dichloroethylene	2	*	*	*	*	*	*	*	*
cis-1,2-Dichloroethylene	2	*	*	*	*	*	*	*	*
Total Petroleum Volatiles	10	565,898	5,145	9,036	7,607	*	5,704	*	750
Lead - total - dissolved	1.7	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA	NA NA
Polynuclear Aromatic Hydrocarbons									
Naphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA

T 3-4
ORGANIC COMPOUNDS AND LEAD IN IN-SITU GROUNDWATER AT SITE 15
November 1992 through September 1994
(All concentrations in µg/l)

Analyte[a]	Detection Limit	September 1994									
		15-GP21	15-GP22		15-GP23	15-GP24	15-GP25	15-GP26	15-GP27	15-GP28	15-GP29
			Initial	Duplicate							
Aromatic Volatile Organic Compounds											
Benzene	10	*	*	*	*	*	*	*	*	*	*
Toluene	10	*	*	*	*	*	*	*	*	*	*
Ethylbenzene	10	*	*	*	*	*	*	*	*	*	*
o-Xylene	100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m-and p-xylene	200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total xylenes	10	*	*	*	*	*	*	*	*	*	*
Chlorinated Volatile Organic Compounds											
trans-1,2-Dichloroethylene	2	*	*	*	*	*	*	*	*	*	*
cis-1,2-Dichloroethylene	2	*	*	*	*	*	*	*	4.2	2.4	*
Total Petroleum Volatiles	10	*	*	*	*	23	29	25	19	17	15
Lead - total	1.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
- dissolved		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polynuclear Aromatic Hydrocarbons											
Naphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

T -3-4

ORGANIC COMPOUNDS AND LEAD IN IN-SITU GROUNDWATER AT SITE 15
November 1992 through September 1994
(All concentrations in µg/l)

Notes:

Field GC detection limits were 10 ppb for aromatic VOCs and 2 ppb for chlorinated VOCs. Standard lab detection limits are listed above.
a Field analysis was for Mobile Lab chlorinated VOCs, total petroleum volatiles, and Mobile Lab aromatic VOCs; 15-GP6 was split and analyzed for 8020 aromatic volatiles, total and dissolved lead, and 8100.
b Positive VOC results were qualified as tentatively identified during validation process because the results were not confirmed by second column analyses.
NA - Not analyzed.
* Concentration below detection limit
e The value is estimated because it is outside the linear working range of the curve.
j Indicates an estimated value.
The total petroleum volatiles detection limit was 10 ppb during the November 1992 until the February 1994 investigations. In October 1994, the IDL was 15 ppb.

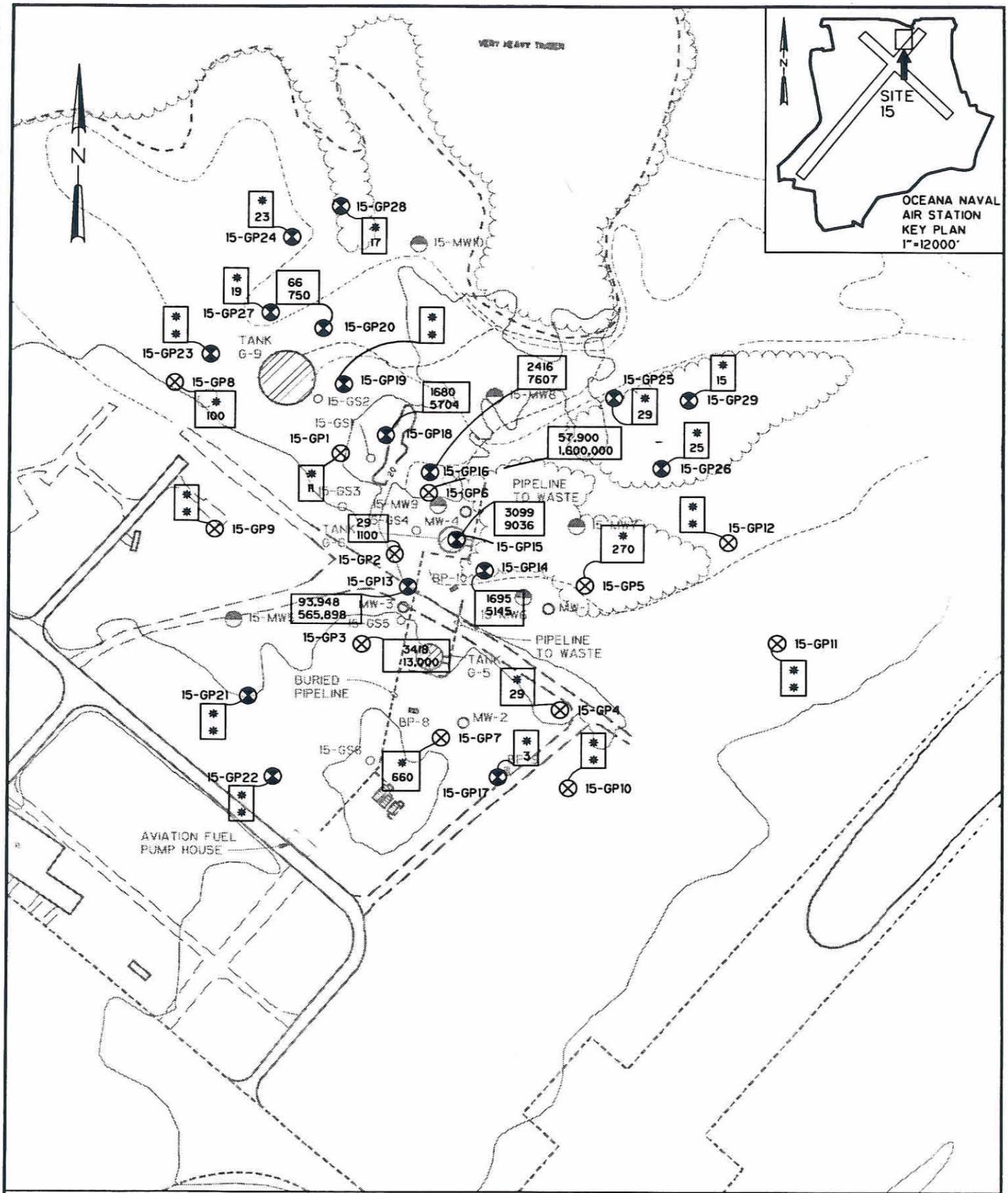


Figure 2-3-5

FUEL-RELATED CONSTITUENTS IN IN-SITU GROUNDWATER AT SITE 15

CH2MHILL

0368m258.dgn
15-DEC-1994

Table 2-3-5
ORGANIC COMPOUNDS AND LEAD IN GROUNDWATER AT SITE 15
(All data in µg/L)

Analyte	Detection Limit[a]	April 1994								October 1994					
		15-MW5	15-MW6		15-MW7	15-MW8	15-MW9		15-MW10	15-MW11	15-MW12		15-MW13	15-MW14	15-MW15
			Initial	Duplicate			Initial	Duplicate			Initial	Duplicate			
Total Petroleum Hydrocarbons	60/1,000	3,000	1,250	960	960	<60	790	NA	310	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Volatile Organic Compounds															
Methylene Chloride	10	2 jb	3 jb	*	*	2 jb	*	NA	2 jb	2 jb	2 jb	2 jb	*	2 jb	*
Acetone	10	9 j	*	5 j	24 d	6 j	*	NA	*	*	*	*	*	*	*
Benzene	5/10	22	*	*	300 d	*	740 d	NA	*	*	*	*	*	*	270 d
Toluene	5/10	*	*	*	2 jd	*	140 d	NA	*	*	*	*	*	*	1 j
Ethylbenzene	5/10	26	*	*	*	*	300 d	NA	*	*	*	*	*	*	3 j
Xylene	5/10	*	*	*	79 d	*	980 d	NA	1 j	*	*	*	*	*	270
Polynuclear Aromatic Compounds															
Naphthalene	2/10	*	*	*	*	*	8	NA	*	*	*	*	*	*	*
2-Methylnaphthalene	2	*	*	*	*	*	2	NA	*	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	2	*	*	*	*	*	3	NA	*	NA	NA	NA	NA	NA	NA
Lead															
Total	1.8/1.0	21.9	22.7	9.6	73.3	13.3	40.8	21.8	10.8	13.4	<1.0	<1.0	< 4.7 c	17.3	6.0
Dissolved	1.8/1.0	<1.8	4.3	NA	2.9 B	<1.8	4.8	NA	2.3 B	<1.0	<1.0	NA	<1.0	<1.0	<1.0

Notes:

All volatile organic compounds and polynuclear aromatic compounds not listed in the table above were analyzed for but not detected.
QC Sampling: 15-MW30 is a duplicate of 15-MW9 for total lead only; 15-MW31 is a duplicate of 15-MW6; 15-MW32 is a duplicate of 15-MW12.
b - This compound was found in the associated laboratory blank as well as the sample.
c - The EPA requires that all sample values below 5 times the preparation blank contaminant level of 1.02 µg/L be qualified as non-detect.
B - The reported value obtained was less than the contract required detection limit (CRDL), but greater than or equal to the IDL.
d - Identifies compounds which have been run at a dilution to bring the concentration of the compound within the linear range of the instrument.
j - This is an estimated value because it was detected below the accurately quantitative detection limit.
* - The compound was analyzed for, but not detected.
NA - Not analyzed
< - The constituent was not detected at this instrument detection limit.
[a]Where two detection limits are provided, the first limit applies to the April 1994 sampling event, and the second limit to the October 1994 Sampling Event.

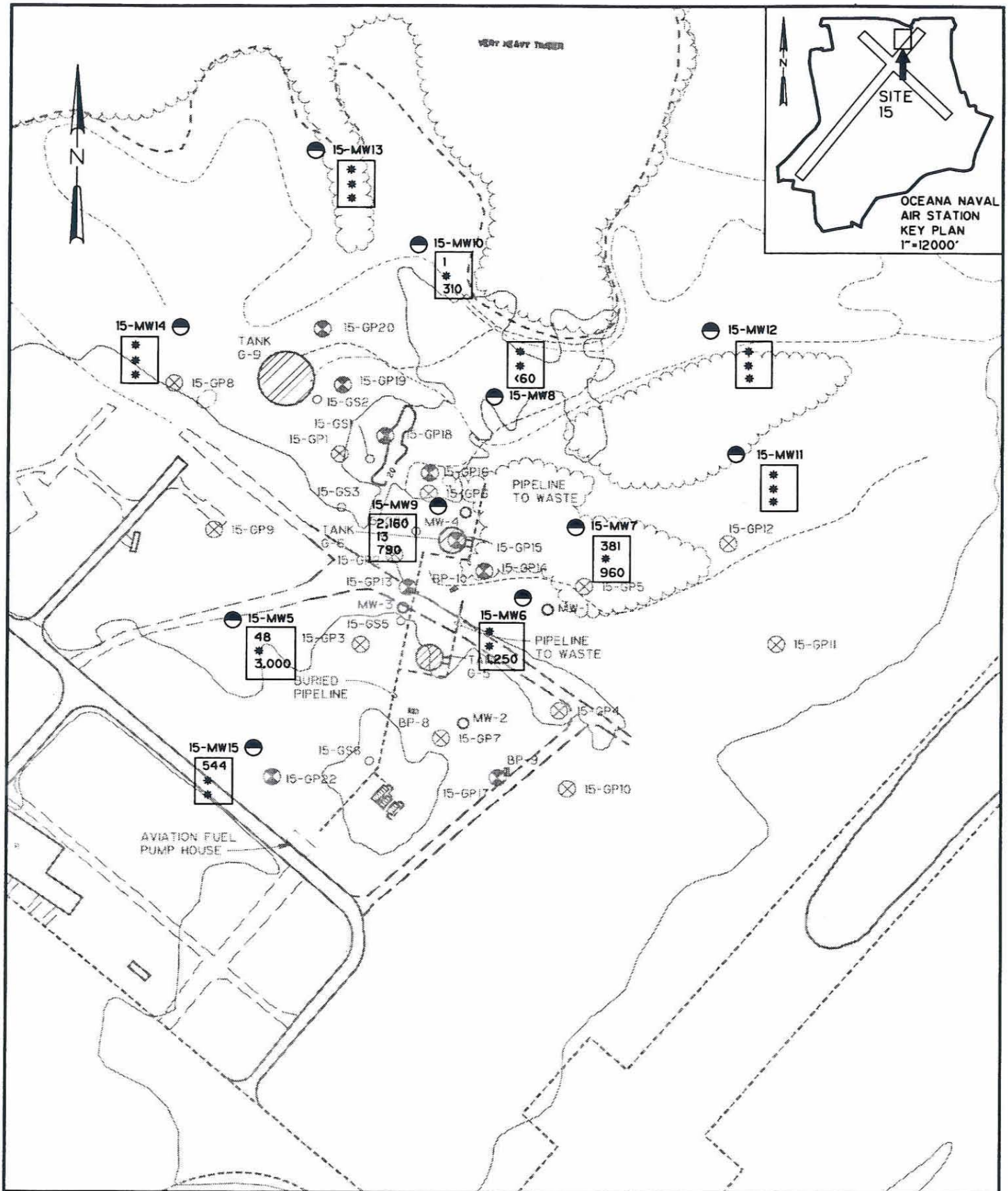


Figure 2-3-6

FUEL-RELATED CONSTITUENTS IN GROUNDWATER AT SITE 15

CH2MHILL

0368m259.dgn
15-DEC-1994

are consistent with the results of the hydraulic probe groundwater sampling, with the exception of 15-MW15.

Well 15-MW9 contains the highest concentrations of fuel-related compounds. Volatile concentrations were 740 ppb of benzene, 140 ppb of toluene, 300 ppb of ethylbenzene, and 980 ppb of total xylenes. Minor concentrations of PAHs also were detected in 15-MW9. Laboratory analyses detected naphthalene, 2-methylnaphthalene and 1-methylnaphthalene at concentrations of 8 ppb, 2 ppb, and 3 ppb, respectively. Air concentrations during the drilling process at 15-MW9 were quite high; however, there was no free product in the well. The presence of volatiles and some PAHs is consistent with the air monitoring. Several BTEX compounds were also detected in 15-MW5 (22 ppb benzene and 26 ppb ethylbenzene), 15-MW7 (300 ppb benzene and 79 ppb total xylene), and 15-MW15 (270 ppb benzene pond 270 ppb xylene). A trace amount of xylene (1 ppb) was detected in 15-MW10, but no volatile organic compounds were detected in 15-MW6, 15-MW8, 15-MW11, 15-MW12, 15-MW13, or 15-MW14. The non-detect results from these wells indicate that the down-gradient and side-gradient limits of the dissolved contaminant plume have been delineated.

Total petroleum hydrocarbons were present over a wider area than the BTEX compounds. TPH was detected at minimum concentrations of hundreds of parts per billion in all Site 15 monitoring wells with the exception of 15-MW8. The TPH concentrations were highest in 15-MW5 (3,000 ppb) and 15-MW6 (1,250 ppb) but were also elevated in 15-MW7 (960 ppb) and 15-MW9 (790 ppb). The TPH concentrations in the perimeter wells installed during the second phase were below the detection limit.

Lead was detected at low concentrations in all wells. The concentration of dissolved lead was lower than the concentration of total lead in each case. In the perimeter wells installed in October 1994, the dissolved lead concentrations were below the IDL of 1.0 ppb. Total lead concentrations in the wells were 9.6 to 73.3 ppb, whereas the dissolved lead concentrations were less than 4.8 ppb.

Although the Phase II activities were designed primarily to complete characterization of the outer extent of contamination, several tasks were intended to target potential free-product contamination. The free-product investigation, which included installation of six piezometers and excavation of six groups of test pits, revealed that the accumulation of free product on the water table is minimal. Figure 2-3-7 presents the piezometer and test pit locations. The piezometers were installed to 14 feet below-grade with 10 feet of PVC screen extending across the water table. The test pits were excavated to depths of 8 to 10 feet below-grade using a backhoe. Appendix A presents detailed observations, descriptions and stratigraphic cross-sections of the test pits.

During measurements with an oil-water interface probe in October 1994, free product was not detected in any of the piezometers or wells. In addition, no measurable free product was observed in any of the test pits; however, a petroleum sheen was observed on the water surface in test pit 15-TP6. The test pits were left as open trenches for a minimum of 12 hours to allow free product to accumulate on the water surface. The elevated OVM readings recorded during soil excavation and the sheen on sampling rods contrast with the absence of free product in the pits. These data support the conclusion that the shallow soils are partially saturated with petroleum hydrocarbons, but little to no recoverable free product has accumulated and persisted at the water table surface.

Figure 2-3-8 presents an approximate delineation of the dissolved phase contamination at Site 15 as determined from the analytical results. No evidence of free-phase hydrocarbons on the water table was found, except the sheen in test pit 15-TP6. TPH data from wells are shown for context. Both in-situ results and monitoring well data were used in defining the extent of dissolved contamination. The extent of petroleum hydrocarbon contamination in soils also is indicated in the figure. The extent of groundwater contamination generally has been well defined by the sampling to date; however, the BTEX contamination in the vicinity of 15-MW15 is an exception. The absence of detectable contamination at in-situ locations 15-GP21 and 15-GP22 lead samplers to believe this southeastern limit was characterized completely. Well 15-MW15 was installed to confirm this result. It contained

ONAS0368pgrd.dgn 1-63
ONAS0368sil1.dgn 1-59
ONAS0368grd.dgn
ONAS0368wgrd.dgn
ONAS0368bdr.dgn 3-4, 60-63
ONASt721182.dgn 1-49, 51-63
ONASp721192.dgn 1-59
ONASt724182.dgn 1-49, 51-59
ONASp724182.dgn 1-59
ASpc24189.dgn 1-59
ASt724189.dgn 1-49, 51-59
ASt721189.dgn 1-49, 51-59
ONASp721189.dgn 1-59
ONAS0368wr15.dgn 1-63
ONAS0368K152.dgn 1-63

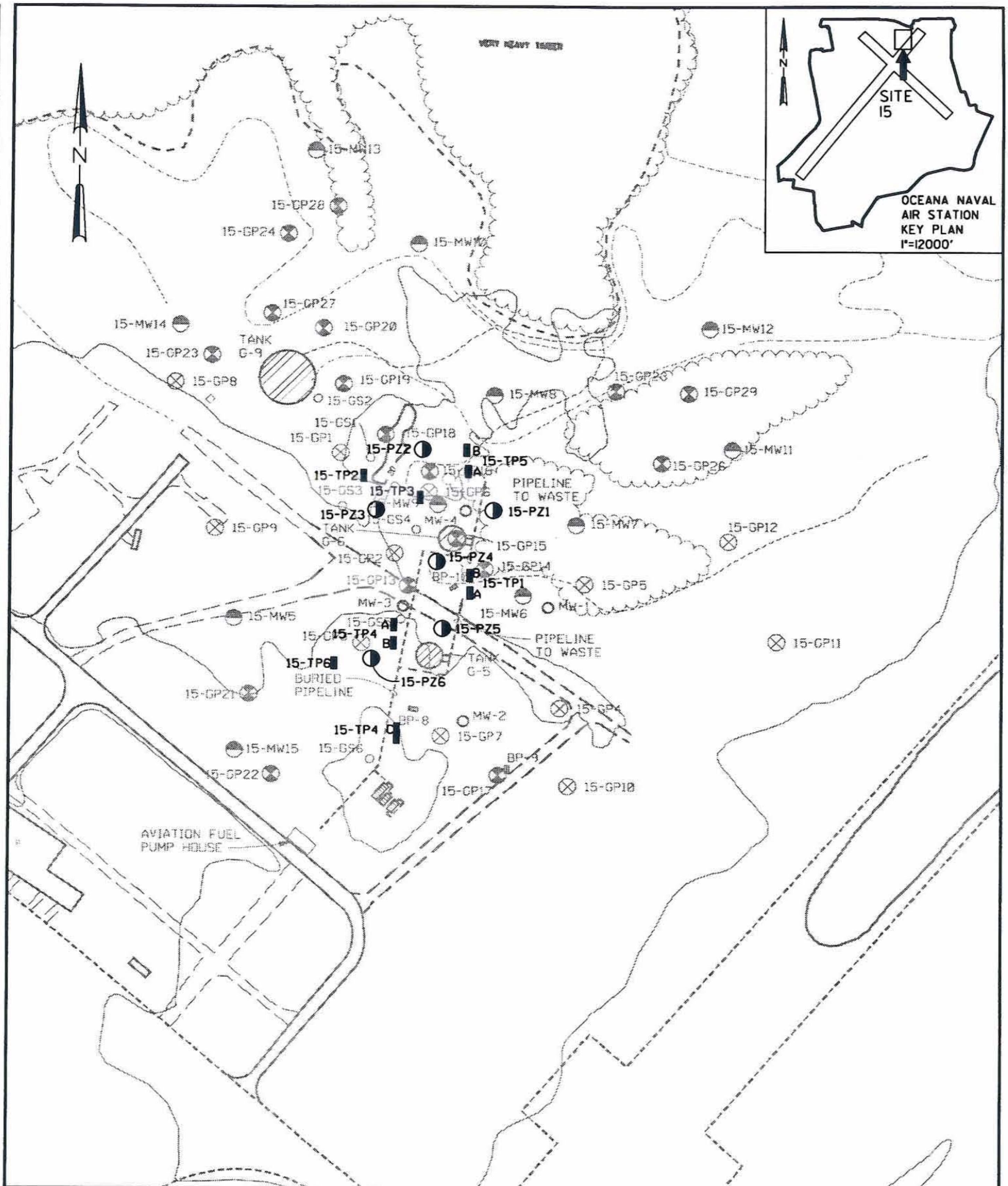


Figure 2-3-7
FREE-PRODUCT MONITORING LOCATIONS AT SITE 15

CH2M HILL

0368m255.dgn
23-Nov-1994

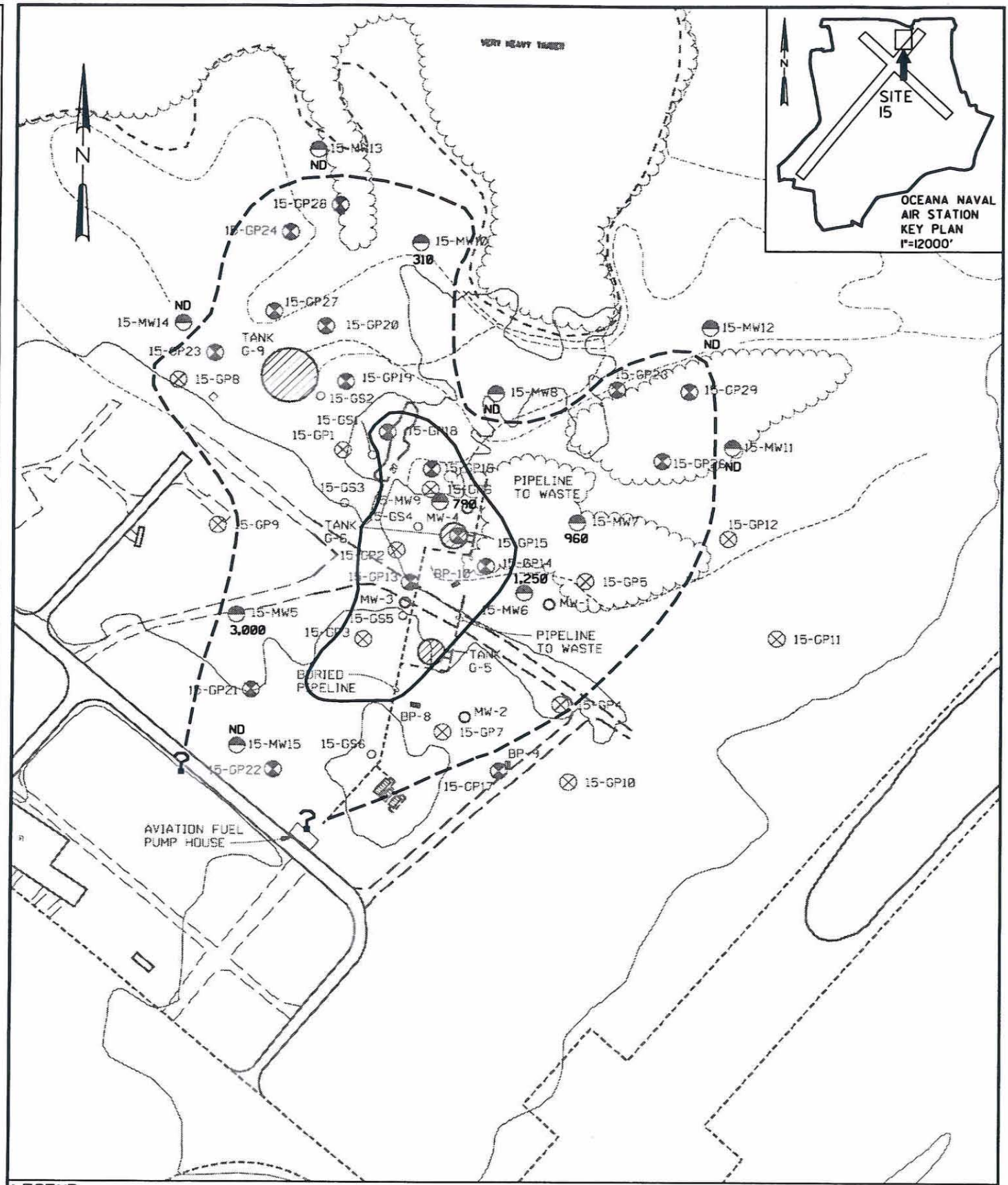


Figure 2-3-8
ESTIMATED DELINEATION OF PETROLEUM-CONTAMINATED SOILS AND DISSOLVED PHASE CONTAMINANT PLUMES AT SITE 15

CH2M HILL

0368m256.dgn
23-FEB-1995

270 ppb of benzene and 270 ppb of xylene but the TPH concentration was below the detection limit.

It is notable that patterns of contamination are in some cases inconsistent with the location of the tanks and piping if the generally northern flow direction were constant. For example, no contamination would be expected in well 15-MW5 on the basis of this flow direction because tank G-5 and the small tanks southeast of 15-GS6 are not upgradient. Contamination in 15-MW7 may have originated from tank G-5, and leakage from this tank is suspected because of high concentrations in 15-GP13 and other nearby locations, but the low concentrations in 15-MW6 are not consistent with direct flow from tank G-5 to well 15-MW7. In addition, the source of BTEX contamination in 15-MW15 is unknown but may be due to releases from the aviation fuel pump house to the southeast. Transport from the fuel pump house to 15-MW15 is not consistent with groundwater flow to the northeast. These anomalies support the hypothesis that groundwater flow directions is variable due to the low prevailing gradient.

Health and Environmental Assessment

Constituents that were detected at Site 15 in concentrations that exceed potentially applicable federal and state screening guidelines and standards are presented in Table 2-3-6. The MCL for benzene was exceeded in several in-situ groundwater and monitoring well samples. Xylene was present above the MCL in only two in-situ groundwater samples (15-GP6 and 15-GP13) but was above risk-based concentrations (RBCs) in several others. Toluene and ethylbenzene were above MCLs in two in-situ samples.

The concentrations of total lead in most wells were above proposed action levels, but all dissolved lead concentrations were below action levels. Concentrations of total lead in 15-MW5 (21.9 ppb), 15-MW6 (22.7 ppb), 15-MW7 (73 ppb), 15-MW9 (40 ppb) and 15-MW14 (17.8 ppb) exceeded proposed action levels. Dissolved lead was below the

Table 2-3-6
CONSTITUENTS IN SITE 15 GROUNDWATER AND SOILS THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
November 1994
(All data in ppb)

Groundwater

Compound	Location Detected	Concentrations (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)	Proposed RCRA Action Levels
Benzene	15-GP2 15-GP3 15-GP6 15-GP13 15-GP14 15-GP15 15-GP16 15-GP20 15-MW5 15-MW7 15-MW9 15-MW15	63 86 10,000 13,152 109 923 857 32 22 300 740 270	5	0	NS	0.36	NS
Toluene	15-GP6 15-GP13	6,900 11,527	1,000	1,000	NS	750	10,000
Ethylbenzene	15-GP6 15-GP13 15-GP15	13,000 8,835 706	700	700	NS	1,300	4,000
Xylene (total)	15-GP6 15-GP13 15-GP14 15-GP15 15-GP16 15-GP18 15-MW9	22,000 60,434 1,226 1,470 1,032 1,038 980	10,000	10,000	NS	520*/1400**	70,000
Total Petroleum Hydrocarbons (TPH)	15-MW5 15-MW6	3,000 1,250	NS	NS	1,000	NS	NS

Table 2-3-6
CONSTITUENTS IN SITE 15 GROUNDWATER AND SOILS THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS
November 1994
(All data in ppb)

Groundwater

Compound	Location Detected	Concentrations (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)	Proposed RCRA Action Levels	
Lead Total/Dissolved	15-GP6 15-MW5 15-MW6 15-MW7 15-MW9 15-MW14	668/25.8 21.9/<1.8 22.7/4.3 73.3/2.9 40.8/4.8 17.3/<1.0	15[d]	0 (at tap)	50	NS	15[c]	

Soil

Compound	Location Detected	Concentration (ppb)	Health-Based Criteria for Carcinogens	Health-Based Criteria for System Toxicants	Proposed RCRA Action Levels	Virginia Soil Guidance Level	Eastern United States Soil Mean	RBC (Industrial/ Residential Soil)
Total Petroleum Hydrocarbons (TPH)	15-GS14	259,000	NS	NS	NS	100,000	NS	NS

Notes:

Only compounds that were detected and exceeded established standards are presented in the table above.
[a]RBC in tap water for p-xylene.
[b]RBC in tap water for m- and o-xylene. Both RBC's provided for the basis of comparison.
[c]Source: 40 CFR 141 and 142, Vol. 56 (110), June 7, 1991, p. 26478.
[d]This is an action level applied at the tap of a drinking water system.
NS - No Standard Available
TT - Treatment technology. The lead MCL is based on sampling at the tap, and therefore, does not apply.
The MCLs and MCLCs are listed in the Drinking Water Regulations and Health Advisories dated December 1992.
The Health Based Criteria for carcinogenic and systemic toxicants were extracted from the RFI Guidance Document EPA 530/SW-89-031.
The proposed RCRA action limits were listed in the *Federal Register* dated July 27, 1990.
The Virginia soil guidance limit is used for determining when to implement a corrective action.

detection limit in several wells. The concentrations in the remaining monitoring wells were 2.3 ppb to 4.8 ppb, well below the proposed action level for lead.

The concentration of TPH was above the Virginia groundwater standard of 1,000 ppb in wells 15-MW5 and 15-MW6. The concentration of TPH in soil sample 15-GS14 (259,000 ppb) was above the Virginia guidance limit for soil disposal of 100,000 ppb. This sample was the only soil analyzed for TPH; however, the reasonable assumption is that some of the soils collected from areas where petroleum-saturated soil contamination was observed or suspected also contain high TPH concentrations.

Conclusions and Recommendations

Site 15 is contaminated with fuel products from the former tank farm. The shallow subsurface soils at the center of the site are contaminated and the dissolved-phase contaminant groundwater plume is widespread. Because of the extensive shallow soil contamination and the existence of benzene in groundwater above the MCL over a wide area of groundwater, a CMS of the site is warranted. The direction of flow was to the north during the investigation, but the distribution of the dissolved-phase plume suggests that flow directions may vary. Additional data may be required in the upgradient areas near 15-MW15 to complete site characterization and provide the data necessary for the CMS. The following site activities are recommended during the CMS investigation.

- Collect five in-situ groundwater samples west and south of 15-MW15 to define upgradient areas of contamination. Analyze for field VOCs detected previously at Site 15.

- Install and sample two additional shallow wells near well 15-MW15 to delineate the upgradient extent of dissolved contamination. Submit samples for TPH, PAH, and VOC analyses.

- Collect five surface soil samples and analyze them for PAHs, TPH, and BTEX.

- Collect three soil samples from approximately 3 feet and conduct a soil treatability study on the soil.

- Collect samples to determine soil properties to aid in screening remediation technologies.

- Conduct a soil gas study of select parameters using existing wells.

- Measure water levels after installing new wells to confirm the direction of groundwater flow.

- Perform a CMS of remediation alternatives at Site 15 to address the shallow subsurface soil contamination and groundwater contamination in areas where the MCL is exceeded.

Site 24—Bowser, Building 840

Site 24 was added to the list of RFI sites after a groundwater contamination problem was discovered during sampling in February and March 1994. The soil has been characterized and is being addressed under a CMS and stabilization action for the petroleum-contaminated sites (CH2M HILL, 1994). The RFI covers groundwater contamination only.

Site Conditions

Site 24 is the former location of a waste-oil bowser near Building 840 (see Figure 1-1). The Naval Construction Battalion (SEABEES) has been based in Building 840 since 1972. Waste solvents and oils generated at the equipment maintenance garage in Building 840 were routinely hand-carried and poured into the waste-oil bowser. The bowser, which was typically positioned in the southernmost corner of the SEABEE compound was periodically transported to the tank farm for disposal of the oil (RFA, 1988). The waste-oil bowser is no longer present at the site and has not been observed by CH2M HILL personnel conducting field investigation activities during any phase of the RFI since October 1992. In addition, Navy personnel based at the SEABEE Compound during the sampling activities had no knowledge of the bowser. The current practice dictates waste-oil disposal in drums that are subsequently transported to the base hazardous-waste lot and entered into the waste management program to ensure appropriate disposal or recycling.

Investigation Activities

As recommended by the RFI Phase I Final Report, additional soil sampling at Site 24 was performed during the CMS field investigation in February 1994 to delineate contaminant boundaries. The CMS report describing these soil results has been finalized (CH2M HILL, 1994) and the design of the remediation activities also has been completed (CH2M HILL, 1994). Some details of the soil investigation are described below to give context to groundwater results.

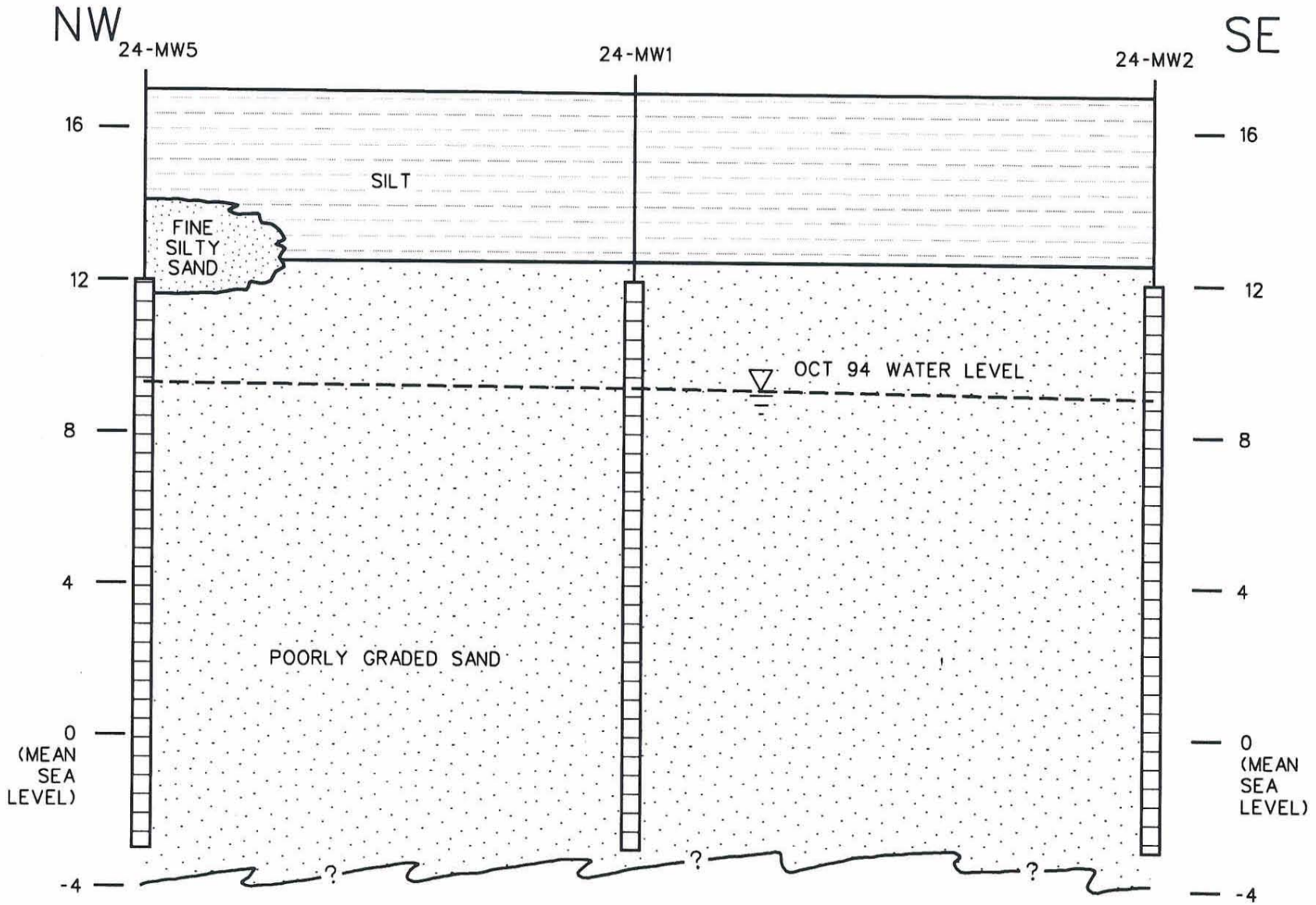
During the CMS field investigation, CH2M HILL personnel initially collected soil samples from three depths in six locations. The depths of soil sampling were 0.5 to 1.0 feet, 2 to 3 feet and 5 to 6 feet. After field screening, the two most-contaminated samples from each sampling location were submitted for analysis. While collecting the soil samples, especially the deepest sample from 5 to 6 feet, it was apparent that the contamination had leached through the vadose zone and intercepted the water table. At this point, four in-situ groundwater samples were added to the scope of work. The CMS groundwater sampling results indicated the need for additional site characterization of groundwater contamination before a CMS of the groundwater remediation could proceed. For this reason, Site 24 re-entered the RFI investigation for further study and characterization of the groundwater contamination.

The second field event in September and October 1994, consisted of an interactive investigation using a hydraulic probe sampler followed by the installation of permanent wells. Field personnel completed the following tasks during the field event:

- Collected 19 in-situ groundwater samples using a hydraulic-probe sampling device. The sampling occurred in 15 locations. At 4 of the 15 locations, groundwater samples were collected from two depths. The probe collected samples by screening across the water table. At locations where two samples were collected, the second sample was collected 5 feet deeper than the apparent water table.

- Installed and sampled six shallow monitoring wells. The wells were sampled for VOCs, TPH, PAHs, and total and dissolved metals.

A geologic cross section of Site 24 is illustrated in Figure 2-4-1. See Appendix A for data on well installation and geologic logging. The RFI sampling locations are shown in Figure 2-4-2.



SCALE:
1"=40' HORIZ.
1"=4' VERT.

Figure 2-4-1

GEOLOGIC CROSS SECTION
OF SITE 24
(SECTION TRENDS NORTHWEST - SOUTHEAST)

14-NOV-1994 0368I115.dgn

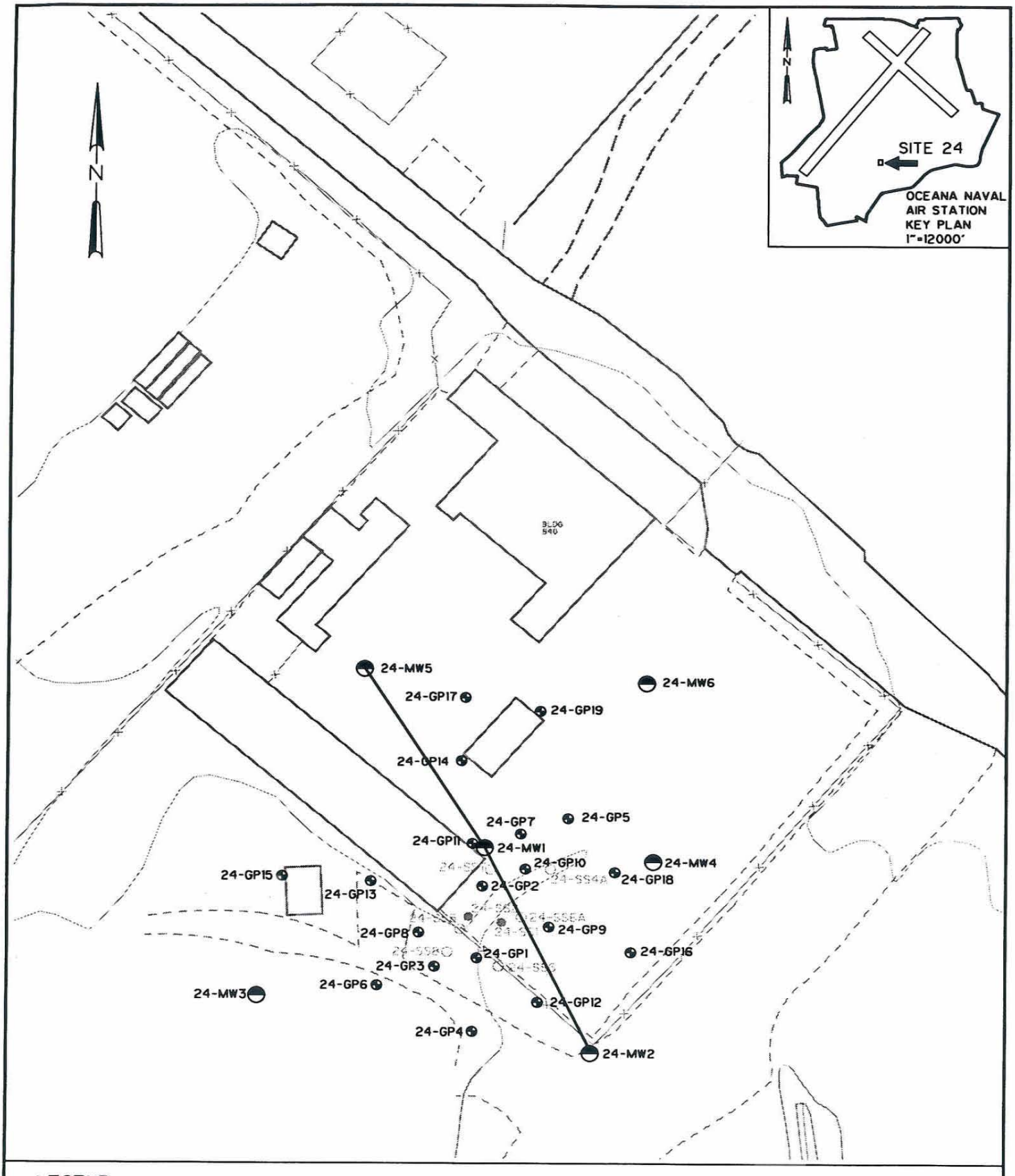


Figure 2-4-2
RFI PHASE II
SAMPLING LOCATIONS
AT SITE 24

CH2MHILL

0368k286.dgn
27-FEB-1995

Data Interpretation

The water levels measured on October 11, 1994, are listed in Table 2-4-1 and illustrated in Figure 2-4-3. These results show that groundwater flows uniformly to the south. This is in contrast to the water level measurements in the 3/4-inch ID piezometers installed in February and measured in March 1994. The March water levels suggested that groundwater flow was to the northeast. Because the wells were developed thoroughly and are easier to measure accurately, groundwater flow to the south is likely to be more representative of the site. This southerly flow direction is also the predominant flow direction in the eastern half of Oceana NAS.

No slug tests or aquifer tests were performed at Site 24 so the hydraulic conductivity of the sediments is not known. The geologic units are similar to other RCRA sites, however, so the hydraulic conductivity can be assumed to approximately 6 x 10^{-3} cm/sec to 2 x 10^{-2} cm/sec. The gradient at the site in October 1994, was approximately 0.002 ft/ft over the southern half of the monitoring network. At an assumed porosity of 25 percent, a gradient of 0.002, and a conductivity range of 6 x 10^{-3} cm/sec (17 ft/day) to 2 x 10^{-2} cm/sec (57 ft/day), the expected velocity of groundwater in the surficial aquifer is 50 to 160 feet per year.

The in-situ groundwater sampling results are listed in Table 2-4-2 and illustrated in Figure 2-4-4. The results indicate that a central area near 24-GP2, 24-GP10, and 24-GP11 contains both chlorinated and POL-related constituents. This is the area where the waste-oil bowser was parked. No chlorinated and POL-related constituents were detected in the outer in-situ samples in the south, east, and northeast so in-situ characterization was stopped in these areas.

Low or non-detected values also were characteristic of in-situ samples in the outermost samples in the north (24-GP17), northwest (24-GP14), and southwest (24-GP6 and

Table 2-4-1
SITE 24 WATER-LEVEL DATA
October 11, 1994

Well	Elevation of Survey Datum (feet)	Water-Level Distance Below Survey Datum (feet)	Water-Level Elevation (feet)
24-MW1	17.34	8.09	9.25
24-MW2	18.76	9.80	8.96
24-MW3	16.06	6.91	9.15
24-MW4	17.37	8.12	9.25
24-MW5	17.14	7.82	9.32
24-MW6	17.79	8.46	9.33

Note: All elevations are in feet above mean sea level.

WDCR893/002.WP5

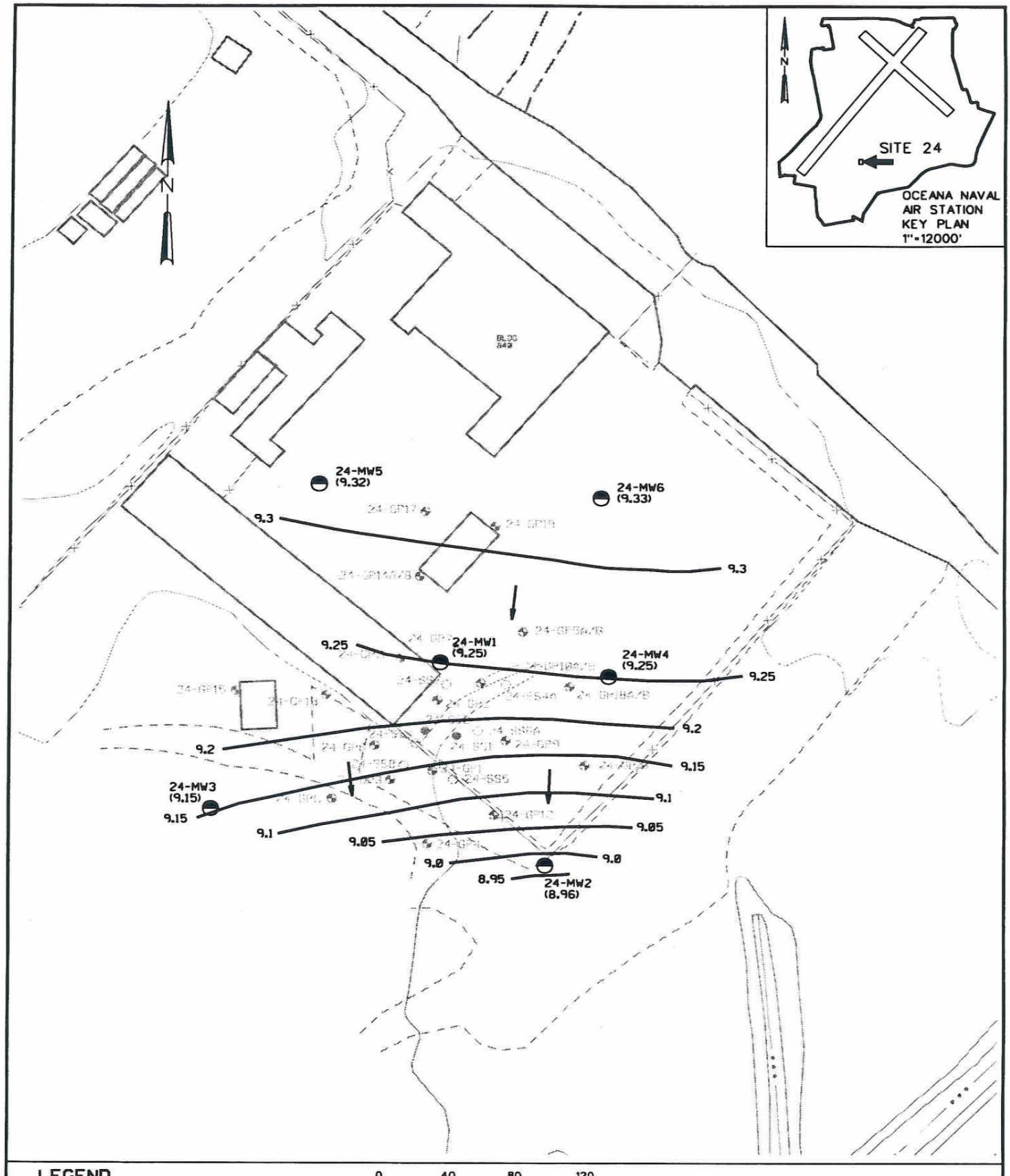


Figure 2-4-3
GROUNDWATER ELEVATIONS
AT SITE 24
OCTOBER 11, 1994

CH2MHILL

0368k283.dgn
06-DEC-1994

Table 2-4-2
ORGANIC COMPOUNDS *IN SITU* GROUNDWATER FROM SITE 24
February and March 1994
(All data in µg/l)

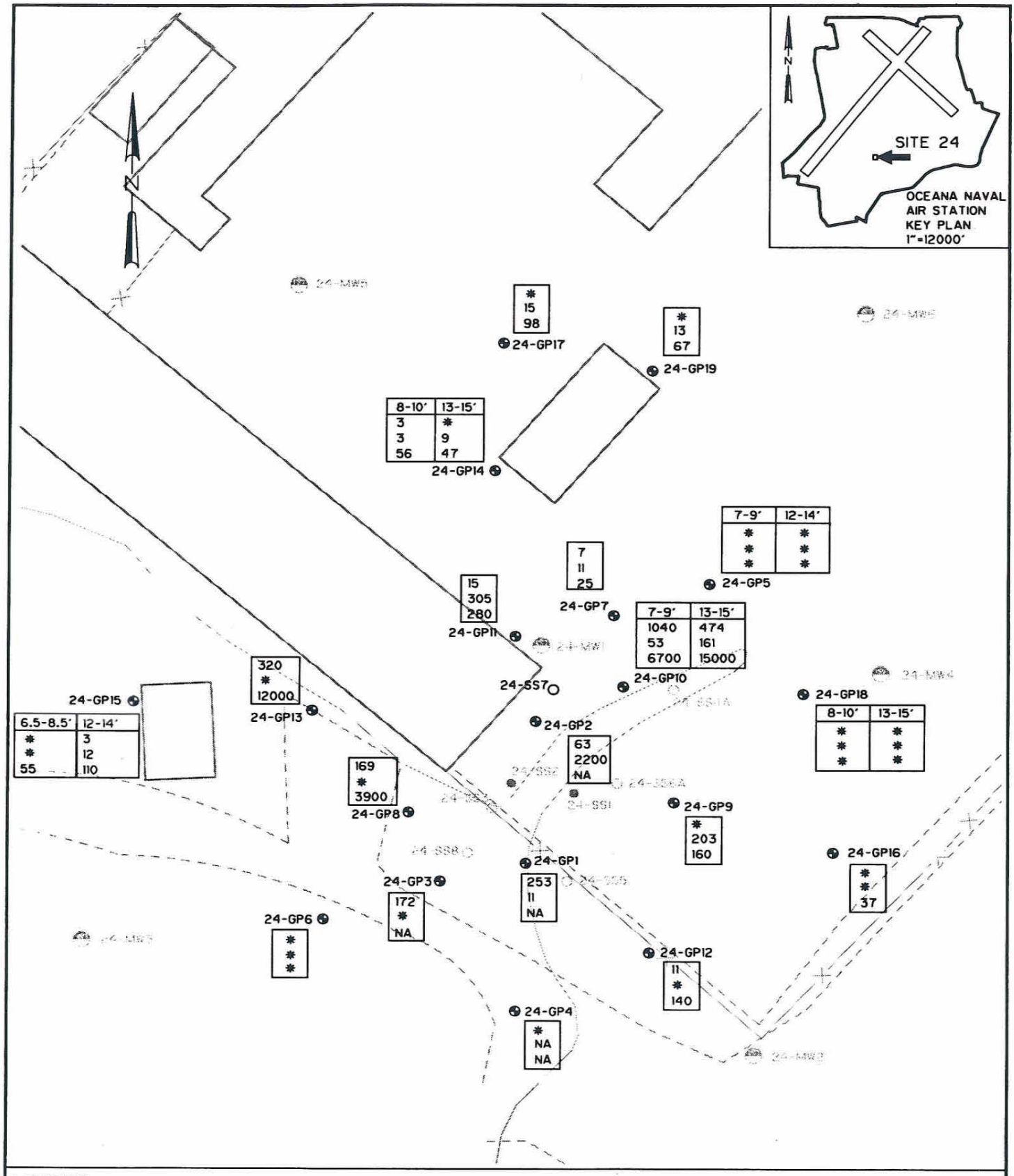
Analyte	Detection Limit	February and March 1994					September 1994								
		24-GP1	24-GP2		24-GP3	24-GP4	24-GP5		24-GP6		24-GP7	24-GP8	24-GP9	24-GP10	
			Initial	Duplicate			7-9 ft	12-14 ft	7-9 ft		7-4 ft	8-10 ft	7-9 ft	7-9 ft	13-15 ft
									Initial	Duplicate					
TPH	50	5,550	730	NA	34,000	*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds															
Acetone	10	20 b/6 jb	740 b	NA	7 jb/6 jb	7 jb/*	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	5	<10/1 jb	61 j	NA	*/1 jb	*/1 jb	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethylene	2	2 j/2 j	2,200	NA	<5/<5	<5/<5	*	*	*	*	10//*	*	180//20	43//4.6	130//26
2-Butanone	10	9 j/*	<500	NA	*/*	*/*	NA	NA	NA	NA	NA	NA	NA	NA	NA
TCE	0.2	<5	<250	NA	<5	<5	*	*	*	*	0.53	2.8	*	5.6	5.0
Benzene	2	8 j/7	<250	NA	4 j/3 j	<5/<5	*	*	*	*	2.5	11	*	98	36
Toluene	2	NA	NA	NA	NA	NA	*	*	*	*	*	6.5	*	22	8.3
Ethylbenzene	2	75/67	<250	NA	38/45	<5/<5	*	*	*	*	*	21	*	*	*
Xylene (total)	2	170/140	63 j	NA	130/110	<5/<5	*	*	*	*	4.5	130	*	920	430
Total Petroleum Volatiles	15	NA	NA	NA	NA	NA	*	*	*	*	*	3,900	160	6,700	15,000
Polynuclear Aromatic Compounds															
Naphthalene	2	290	49	64	350	<2	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	2	130	36	45	210	<2	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnapthalene	2	110	44	51	200	<2	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2-4-2
ORGANIC COMPOUNDS *IN SITU* GROUNDWATER FROM SITE 24
February and March 1994
(All data in µg/l)

Analyte	Detection Limit	September 1994												
		24-GP11	24-GP12	24-GP13	24-GP14		24-GP15		24-GP16	24-GP-17	24-GP18			24-GP19
		7-9 ft	6.5-8.5 ft	6.5-8.5 ft	8-10 ft	13-15 ft	6.5-8.5 ft	12-14 ft	7-9 ft	6.5-8.5 ft	8-10 ft		13-15 ft	8-10 ft
											Initial	Duplicate		
TPH	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds														
Acetone	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethylene	2	280//25	*	*	*	*	*	*	*	*//11	*	*	*	*//8.9
2-Butanone	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TCE	0.2	0.20	*	*	3.3	9.1	*	12	*	4	*	*	*	3.9
Benzene	2	7.2	*	*	*	*	*	2.7	*	*	*	*	*	*
Toluene	2	*	*	*	*	*	*	*	*	*	*	*	*	*
Ethylbenzene	2	*	*	*	2.9	*	*	*	*	*	*	*	*	*
Xylene (total)	2	7.6	11	320	*	*	*	*	*	*	*	*	*	*
Total Petroleum Volatiles	15	280	140	17,000	56	47	55	110	37	98	*	*	*	67
Polynuclear Aromatic Compounds														
Naphthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnapthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnapthalene	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

All volatile, semivolatile, and polynuclear aromatic compounds not reported were below detection limits in all samples.
'The detection limits provided for the volatile organic compounds detected at Site 24 apply to the September 1994 data, with the exception of the limits for acetone, methylene chloride, and 2-butanone. Due to the variability in IDLs for the February and March 1994 sampling events, the reporting limit for each compound is presented.
MCL - Maximum Contaminant Levels
RBC - Risk-Based Screening Concentration (EPA Region III, January 1994)
NA - Not analyzed.
TPH - Total Petroleum Hydrocarbons.
b compound found in laboratory blank as well as sample.
j Estimated value. Measured value is less than the accurately quantitative detection limit.
< The value was less than the detection limit or was not detected.
QC Sampling: 24-GP30 is a duplicate of 24-GP2 for PAHs only.
X/Y - Volatile samples were collected in February and again in March. The February samples (X) were collected through PVC piezometers immediately after installation by the in-situ probe sampler. The March samples (Y) were collected through the same piezometers.
A//B - 1,2-DCE results are listed by isomer for detected samples 24-GP5 to 24-GP19. "A" and "B" are the concentrations for the cis and trans isomers, respectively.
NS - No standard or guideline concentration.



LEGEND

- RFI PHASE 1 SOIL SAMPLING LOCATION
- LMS SOIL SAMPLING LOCATION
- HYDRAULIC PROBE GROUNDWATER SAMPLING LOCATION
- SHALLOW MONITORING WELL

NA NOT ANALYZED

* NOT DETECTED ABOVE IDL

0 20 40 60

SCALE IN FEET

BTEX
CHLOR. VOCS
TPV

ALL CONCENTRATIONS IN PPB

Figure 2-4-4

ORGANIC COMPOUNDS IN IN-SITU GROUNDWATER AT SITE 24

CH2MHILL

0368k284.dgn
15-DEC-1994

24-GP15). The assumption was that characterizations of these areas would be complete after installations of a well a conservative distance outward from existing in-situ samples.

Deep in-situ samples were collected from 12 to 14 or 13 to 15 feet at five locations. The selection of the five samples was biased towards the northeast because water-level measurements in March 1994 has shown that groundwater flowed to the northeast. The deeper samples at 24-GP5 and 24-GP18 contained no POL or chlorinated constituents. Chlorinated volatiles were detected is 24-GP14 and both POL and chlorinated constituents were detected in 24-GP15 and 24-GP10. Chlorinated volatile concentrations were higher in the deep samples than the corresponding shallow samples at 24-GP10, 24-GP14, and 24-GP15. This suggests that the chlorinated volatile plume is more concentrated 5 or more feet below the water table.

The organic results from the wells are illustrated in Figure 2-4-5 and the organic and inorganic data are listed in Tables 2-4-3 and 2-4-4. The extent of the petroleum compounds in groundwater has been defined in the surficial aquifer. No POL-related constituents were detected in the five outer monitoring wells but 19 ppb of ethylbenzene and 48 ppb of xylene were detected in the center well near the bowser storage area. The extent of fuel constituents in groundwater is indicated in Figure 2-4-6.

The primary chlorinated volatile is cis-1,2-DCE, with lesser amounts of trans-1,2-DCE and trichloroethylene (TCE). The first four in-situ samples and the wells were analyzed by method SW-8240 for total 1,2-DCE only, but all the remaining in-situ samples were analyzed for cis and trans isomers. The extent of the chlorinated compounds has not been defined fully in some areas. The source area of the chlorinated compounds is not known. The extent of contamination by chlorinated VOCs is shown in Figure 2-4-7. Total chlorinated VOC concentrations are shown for context.

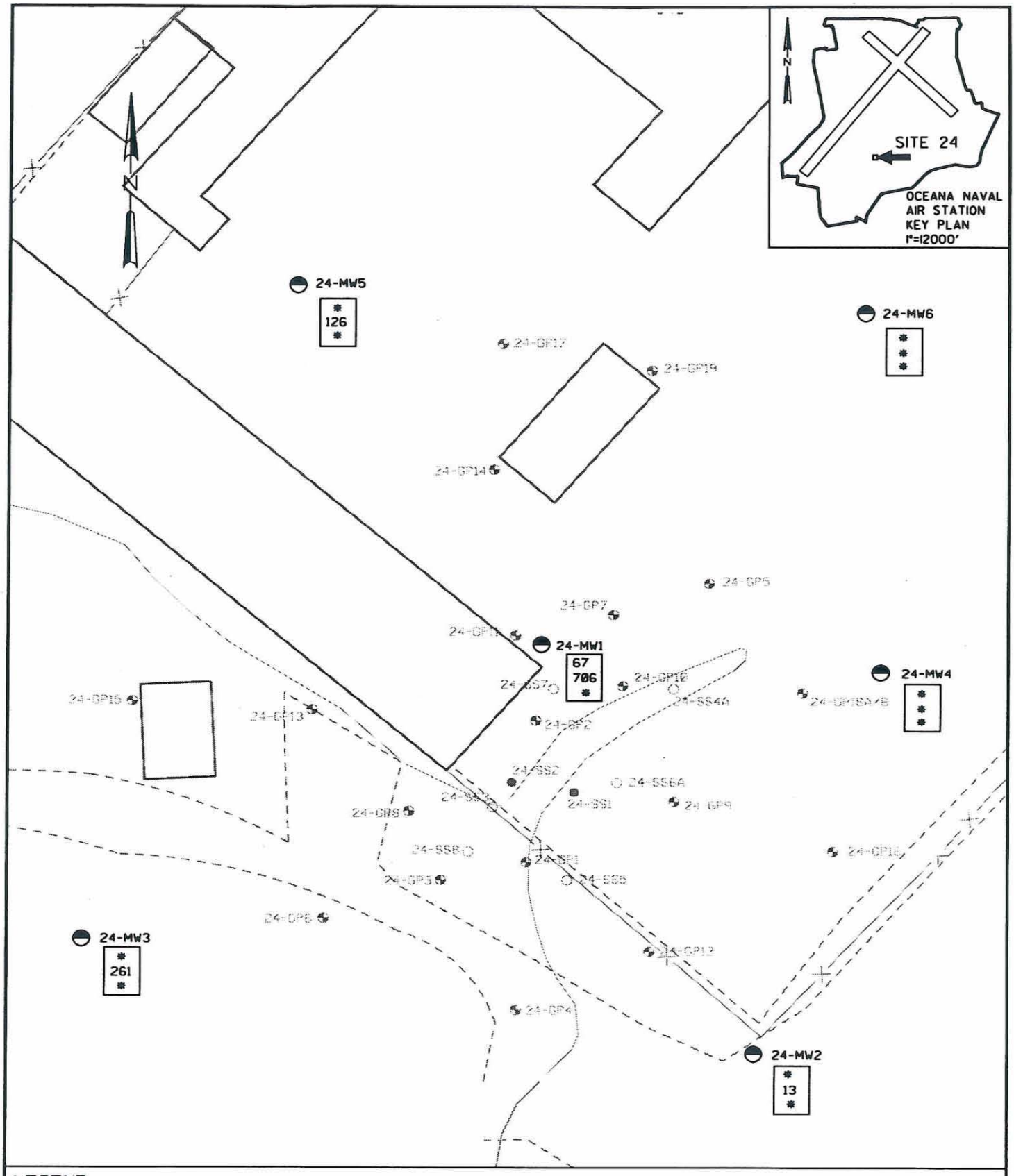


Figure 2-4-5

ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 24

CH2MHILL

0368k285.dgn
23-FEB-1995

Table 2-4-3
ORGANIC COMPOUNDS IN GROUNDWATER AT SITE 24
OCTOBER 1994
(All Date in μg/L)

Analyte	Detection Limit	24-MW1	24-MW2	24-MW3	24-MW4	24-MW5	24-MW6
TPH	1,000	*	*	*	*	*	*
Volatile Organic Compounds							
Methylene Chloride	10	5 bj	*	9 bj	9 bj	8 bj	*
1,2-Dichloroethylene (total)	10	700	6 j	180 d	*	110	*
Trichloroethylene	10	6 j	2 j	81	*	16	*
Chloroform	10	*	5 j	*	*	*	*
Ethylbenzene	10	19 j	*	*	*	*	*
Xylene (total)	10	48 j	*	*	*	*	*
Polynuclear Aromatic Hydrocarbons							
Naphthalene	10	52	*	*	*	*	*

Notes:

All volatile organic and polynuclear aromatic compounds not listed above were analyzed for but not detected.
* Compound not detected above the instrument detection limit.
j Indicates an estimated value.
b Indicates compound also found in the associated laboratory blank.
d Concentration from diluted GC run.

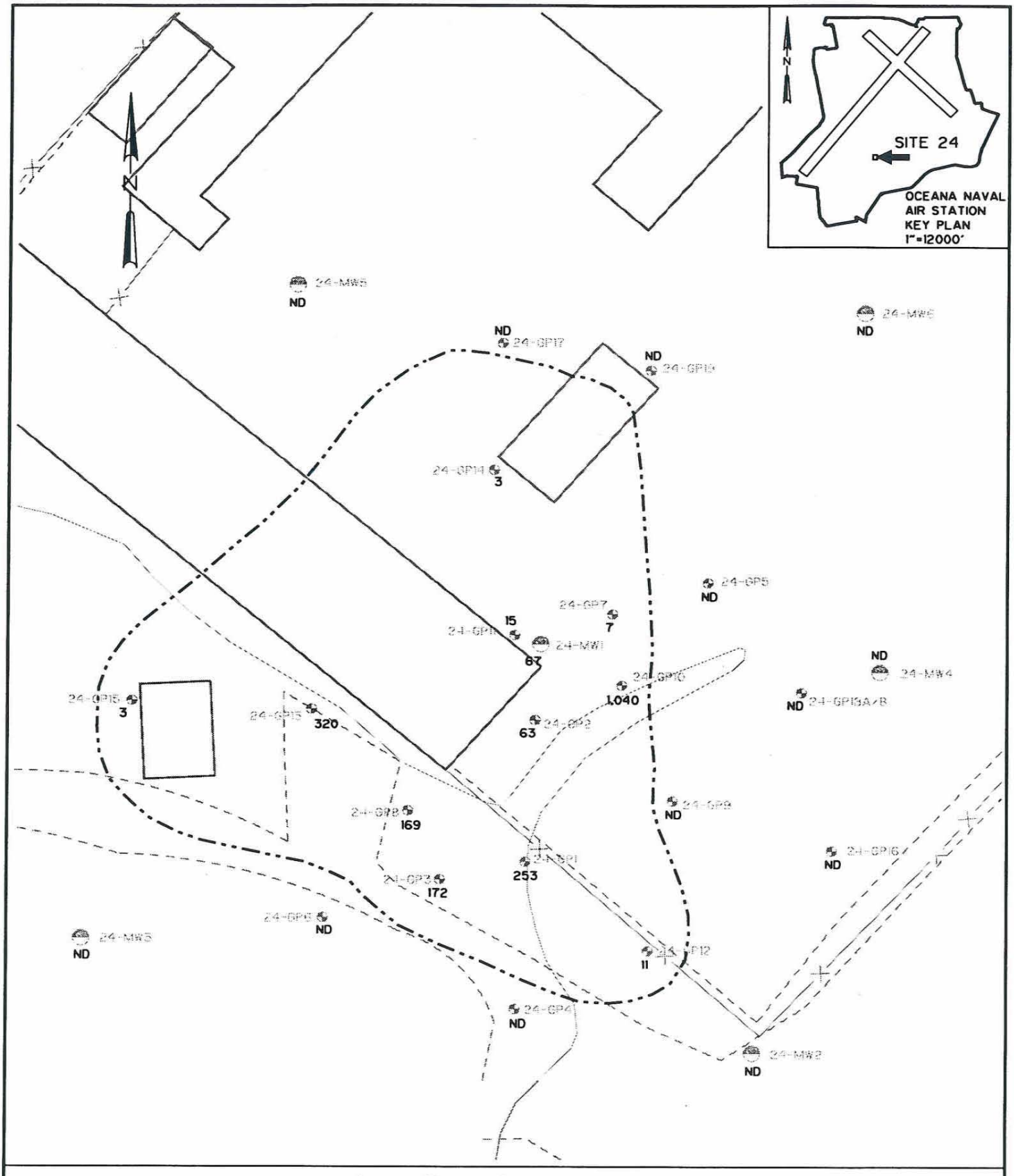
Table 2-4-4
INORGANIC COMPOUNDS IN GROUNDWATER AT SITE 24
September 94
(Concentrations in µg/L)

Analyte	September 94												
	24-MW1		24-MW2		24-MW3		24-MW4			24-MW5		24-MW6	
							Initial		Duplicate				
	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Dissolved	Total	Dissolved
Aluminum	9,730 jf	116 b	29,200 jf	< 38.5 c	3,720 jf	< 27.2 c	6,190 jf	114 b	5,780 jf	16,900 jf	< 58.4 c	14,100 jf	< 43.6 c
Antimony	< 37	< 37	<37	< 37	< 37	< 37	< 37	< 37	< 37	< 37	< 37	< 37	< 37
Arsenic	68.1	51	21.6	7.5 b	151.8	12	14.7	11.3	12.5	28.3	22	28.1	27.5
Barium	95 b	49 b	160 b	36.3 b	40.3 b	20.4 b	56 b	30 b	54.7 b	95.6 b	19.6 b	85.3 b	16.1
Beryllium	< 1	< 1	1.2 b	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cadmium	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Calcium	19,900 jf	17,200	18,500 jf	14,500	6,910 jf	5,600	8,210 jf	8,480	8,200 jf	9,180 jf	8,890	5,680 jf	5,020
Chromium	23.1	< 7	211	< 7	8 b	< 7	15.9	< 7	18.3	33	< 7	32.6	< 7
Cobalt	9.6 b	< 5	28 b	8.1 b	10.1 b	8.1 b	5.8 b	< 5	< 5	12.2 b	< 5	10.1 b	< 5
Copper	10.8 b	< 5	34.1	< 5	< 5	< 5	6.2 b	< 5	7.7 b	16.2 b	< 5	14.9 b	< 5
Iron	39,700 jf	27,300	32,600 jf	6,800	11,100 jf	6,270	13,300 jf	9,630	13,500 jf	23,700 jf	10,600	18,900 jf	6,750
Lead	< 4.1 c	< 1	17.6	< 1	< 1	< 1	< 2.2 c	< 1	< 1 c	5.6	< 1	5.4	< 1
Magnesium	10,600 jf	8,070	12,000 jf	5,920	6,340 jf	4,670 b	5,730 jf	5,080	5,710 jf	8,980 jf	6,050	7,170 jf	4,170
Manganese	352 jf	260	436 jf	236	250 jf	197	143 jf	126	145 jf	270 jf	188	226 jf	143
Mercury	0.30 jde	0.65	0.25 jde	1.3	0.16 jde	0.96	0.20 jde	0.25 b	1.2 jde	0.86 jde	0.66	0.25 jde	0.44
Nickel	24.1 b	< 12	145	12.4 b	12.9 b	< 12	15.5 b	< 12	15.6 b	28.4 b	< 12	33.1 b	< 12
Potassium	2,870 b	1,350 b	6,380	2,270 b	1,730 b	941 b	2,170 b	1,310 b	2,160 b	4,150 b	1,260	3,000 b	764

Table 2-4-4
INORGANIC COMPOUNDS IN GROUNDWATER AT SITE 24
September 94
(Concentrations in µg/L)

Analyte	September 94												
	24-MW1		24-MW2		24-MW3		24-MW4			24-MW5		24-MW6	
							Initial		Duplicate				
	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Total	Dissolved	Total	Dissolved
Selenium	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Silver	< 4 jd	< 4	< 4 jd	< 4	< 4 jd	< 4	< 4 jd	< 4	< 4 jd	< 4 jd	< 4	< 4 jd	< 4
Sodium	10,300 jf	8,850	20,600 jf	18,700	8,040 jf	6,210	7,410 jf	8,160	7,660 jf	9,390 jf	9,650	7,580 jf	7,960
Thallium	< 4.6 c	2.6 b	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Vanadium	25.1 b	4 b	60.9	< 2	8.6 b	< 3	14.3 b	< 3	14.8 b	38.2 b	< 3	37.1 b	< 3
Zinc	< 29.3 c	12.3 b	97.5	37.3	< 16.2 c	20.4	< 16.8 c	74	< 19.3 c	41.2	10.6 b	38.2	10.4

Notes:
< = Value less than IDL or was not detected
b = Value less than the CRDL, but greater than or equal to the IDL.
n = Spiked sample recovery not within control limits.
QC sampling: 24-MW30 is a duplicate of 24-MW4; however, no dissolved metals analysis was performed on 24-MW30.
\+ = Duplicate analysis not within control limits.
c = The result is qualified as non-detect as required by the EPA when the sample value is less than 5 times the preparation blank contaminant level.
d = The result is estimated because the matrix-spike recovery was either below the lower control limits or above the upper control limit.
e = Result is estimated because the duplicate analysis was outside control limits.
f = The result is qualified as estimated because the serial dilutions were outside the control limits.
j = The result is estimated.



LEGEND

ND	APPROXIMATE EXTENT OF POL-RELATED VOLATILES NOT DETECTED
172	BTEX CONCENTRATION

Figure 2-4-6

APPROXIMATE EXTENT OF FUEL-RELATED CONSTITUENTS IN GROUNDWATER AT SITE 24

CH2MHILL

0368k287.dgn
27-FEB-1995

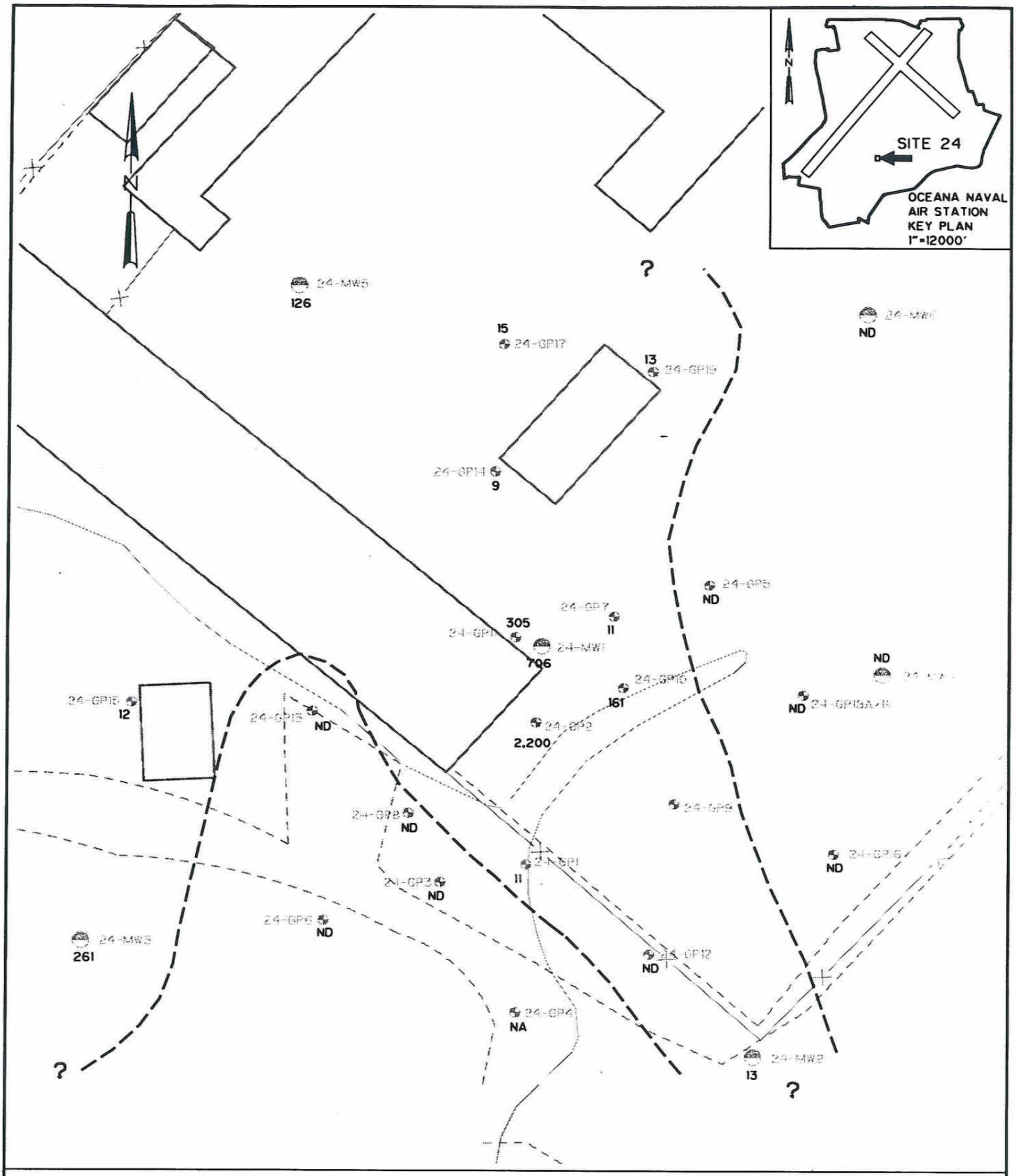


Figure 2-4-7

APPROXIMATE EXTENT OF CHLORINATED VOCS IN GROUNDWATER AT SITE 24

CH2MHILL

0368k288.dgn
27-FEB-1995

Health and Environmental Assessment

Groundwater concentrations that exceed potentially applicable state and federal standards and guidelines are listed in Table 2-4-5. Benzene concentrations were greater than RBCs or MCLs in seven in-situ samples collected near the center of the site. The MCL was exceeded in five of these samples, at locations 24-GP1, 24-GP8, 24-GP10, and 24-GP11, and presumably was exceeded at 24-GP2 also. The concentration of xylene in the 7- to 9-foot sample of 24-GP10 (920 ppb) was greater than the RBC but not the MCL of 10,000 ppb. The Virginia groundwater standard for TPH of 1,000 ppb was exceeded in two of the same locations that were above the benzene MCL (24-GP8 and 24-GP10) but also 24-GP13, located west of these other sampling points.

Several wells and in-situ sampling locations had concentrations of 1,2-DCE and TCE that exceeded MCLs or RBCs. Most of the samples within a 60-foot radius of 24-GP2 contained chlorinated VOCs above MCLs. All the samples in the northwest (24-GP14, 24-GP17, 24-GP19, 24-MW5) and west (24-GP15 [13-15 foot] and 24-MW3) exceeded RBCs and most exceeded MCLs also. The estimated concentrations of TCE in well 24-MW2 (2 ppb) exceeded the RBC of 1.6 ppb but not the MCL of 5 ppb.

Conclusion and Recommendations

A problem with moderately deep chlorinated VOCs and shallow POL-related VOCs was confirmed during this investigation. The POL contamination problem is well defined and does not appear to include any free product fuels or oils accumulated on the water table. POL residues accumulated in the soils in the central bowser area will be addressed during the ongoing CMS and remediation design for soils.

The contamination by chlorinated VOCs appears to be greater at a depth of 13 to 20 feet that at the water table at 8 feet. Additional characterization work is essential in the western half of the site. Because some samples are near the northwestern limit of the SEABEE

Table 2-4-5
CONSTITUENTS IN GROUNDWATER AT SITE 24 THAT EXCEED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS AND GUIDELINES
(All data in ppb)

Groundwater

Compound	Location Detected	Concentrations (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)	Proposed RCRA Action Levels
Benzene	24-GP1 24-GP7 24-GP8 24-GP10 (7-9 ft) (13-15 ft) 24-GP11 24-GP15	7 2.5 11 98 36 7.2 2.7	5	0	NS	0.36	NS
Xylene (total)	24-GP8 (7-9 ft.)	920	10,000	10,000	ns	520[a]/1400[b]	70,000
1,2-Dichloroethylene	24-GP2 24-GP9 24-GP10 (13-15 ft) 24-GP11 24-MW1 24-MW3 24-MW5	2,200 (total) 180 (cis) 130 (cis) 280 (cis) 700 (total) 180 (total) 110 (total)	70 (cis) 100 (trans)	70 (cis) 100 (trans)	NS	61 (cis) 120 (trans)	NS
Trichloroethylene	24-GP8 24-GP10 (7-9 ft) (13-15 ft) 24-GP14 (8-10 ft) (13-15 ft) 24-GP15 (12-14 ft) 24-GP17 24-GP19 24-MW1 24-MW2 24-MW3 24-MW5	2.8 5.6 5.0 3.3 9.1 12 4 3.9 6 j 2 j 81 16	5	0	NS	1.6	5

Table 2-4-5
CONSTITUENTS IN GROUNDWATER AT SITE 24 THAT EXCEED POTENTIALLY APPLICABLE FEDERAL AND VIRGINIA STANDARDS AND GUIDELINES
(All data in ppb)

Groundwater

Compound	Location Detected	Concentrations (ppb)	MCL	MCLG	Virginia Groundwater Standards	Risk-based Screening Concentrations (RBCs) (tap water)	Proposed RCRA Action Levels	
Total Petroleum Hydrocarbons (TPH)	24-GP8 24-GP10 (7-9 ft) (13-15 ft) 24-GP13	3,900 6,700 15,000 17,000	NS	NS	1,000	NS	NS	
Lead Total/Dissolved	24-MW2	17.6/<1	15 (action level at top)	0 (at tap)	50	NS	15[c]	
Zinc Total/Dissolved	24-MW2	97.5/37.3	NS	NS	50	11,000	NS	
Mercury Total/Dissolved	24-MW1 24-MW2 24-MW3 24-MW4 24-MW5 24-MW6	0.3/0.65 0.25/1.3 0.16/0.96 1.2/0.25 0.86/0.66 0.25/0.44	2	2	0.05	11	2	

Notes:

Only compounds that were detected and exceeded established standards are presented in the table above.
[a]RBC in tap water for p-xylene.
[b]RBC in tap water for m- and o-xylene. Both RBC's provided for the basis of comparison.
[c]Source: 40 CFR 141 and 142, Vol. 56 (110), June 7, 1991, p. 26478.
NS - No Standard Available
The MCLs and MCLCs are listed in the Drinking Water Regulations and Health Advisories dated May 1994.
The proposed RCRA action limits were listed in the *Federal Register* dated July 27, 1990.

compound, it is possible that the investigation will encompass areas outside the compound. The investigation should include sampling in the 13- to 25-foot range with the hydraulic probe sampler and installation of wells to a depth just above the clay layer typically found at 25 to 26 feet. The purpose of the deeper sampling is to determine the depth of the chlorinated VOCs.

This investigation phase can be handled either as a continuation of the RFI or as a first step of the CMS. Considering that a CMS is proposed for Sites 2E and 15 and Site 24 is the last site that has not been either dropped from consideration or advanced to the CMS, it may be advantageous to prepare a CMS for Site 24. The specific recommended elements of the field investigation are:

- Sample with the hydraulic probe sampler at approximately seven locations and collect a second deeper sample at three of these locations. Split one deep sample and one shallow sample and send the samples to the laboratory for confirmatory analysis for 8240 VOCs. Field samples will be analyzed for field VOCs.

- Install one deep well to determine if chlorinated VOCs have migrated to the Yorktown Formation. The analysis of the groundwater sample should be for VOCs, PAHs, and TPH.

- Install four shallow wells to 20 feet with screens from 5 to 20 feet. Analyze groundwater for 8240 VOCs, PAHs, and TPH.

- Conduct a 24-hour pump test of the shallow aquifer.

Site 25—Inert Landfill

Site Conditions

Site 25 is an inundated borrow pit and landfill for inert debris located north of Potters Road on 26 acres of land (see Figure 1-1). In 1979, NAS Oceana purchased the land and received a permit to dispose of inert solid waste. The landfill is currently a disposal site for concrete rubble that is being removed from the flightline around the MATWING and FITWING aircraft parking areas. The station has been accumulating concrete rubble at the site since 1993. The concrete pile covers the landfill area. Additional details on the site history and ecology are described in the Phase I RFI Report (CH2M HILL, 1993).

Investigation Activities

Prior to the RFI Phase I sampling in January 1993, there had been no environmental sampling at Site 25. During Phase I, sediment and surface water samples were collected from the banks of the borrow pit and creek that discharges from the pit.

The RFI Phase II field investigation revisited Site 25 because the Phase I results indicated that pesticides and metals were present in the pond sediment at concentrations above potentially applicable ecological guidelines. CH2M HILL field personnel collected three sediment samples (25-SD4, 25-SD5, and 25-SD6) from the borrow pit in February 1994. The sampling locations are presented in Figure 2-5-1. The sediment samples were submitted to the CH2M HILL analytical laboratory in Montgomery, Alabama for analysis of total organic carbon, Target Compound List (TCL) pesticides, and TAL metals analyses. VOCs and semivolatile organics were not analyzed because they were not found to be elevated in the Phase I samples.

Figure 2-5-1
RFI PHASE II
SAMPLING LOCATIONS
AT SITE 25

CH2MHILL

ONAS0368grd.dgn | ONAS0368mgrd.dgn | ONAS7718102.DGN 1-63 | ONAS0368W125.DGN 1-63

0368m253.dgn
18-NOV-1994

Data Interpretation

Tables 2-5-1 and 2-5-2 present the organic and inorganic laboratory results from the Phase I and Phase II surface water and sediment sampling. Total organic carbon concentrations were analyzed to give context to the Phase I and II sediment sampling results. The proposed limits for contaminants in sediment are based upon the percentage of organic carbon at the sampling location. This relationship required that TOC concentrations be measured when sampling. The TOC concentrations in the sediment at Site 25 were 44,400,000 ppb in 25-SD4, 38,900,000 ppb in 25-SD5, and 5,160,000 ppb and 4,150 ppb in 25-SD6. These concentrations equal 4.44, 3.89, 0.516, and 0.415 percent organic carbon by weight.

Pesticides were detected in 25-SD5. The detected pesticide compounds and respective concentrations were 4,4'-DDD (14 ppb), 4,4'-DDE (14 ppb) and 4,4'-DDT (7.5 ppb). No other TCL pesticides were detected in the Phase II sediment samples at Site 25.

Inorganic analyses of the sediment at Site 25 confirmed the Phase I detections of several heavy metals at low concentrations. The metals detected include: arsenic, barium, beryllium, chromium, cobalt, copper, lead, nickel, vanadium and zinc. Results are consistent with Phase I sampling.

Health and Environmental Assessment

The four TOC samples (25-SD4, 25-SD5, and 25-SD6 initial/duplicate) collected at Site 25 during February 1994 were collected and analyzed to give context to the analytical results from the three Phase II sampling locations. Because TOC samples were not collected during Phase I and it is not possible to resample at exactly the same locations, an assumption must be made about TOC concentrations at the Phase I locations on the basis of Phase II TOC sampling. Two criteria, the minimum and the average, were used for comparison to Phase I pesticide data. The minimum TOC concentration detected in the

ORGANIC COMPOUNDS IN SURFA /ATER AND SEDIMENT AT SITE 25
February 1993 and February 1994
(All data in ppb)

Analyte	Detection Limit[a]		Surface Water		Sediment						
			February 1993					February 1994			
			25-SW1	25-SW2	25-SD1	25-SD2	25-SD3	25-SD4	25-SD5	25-SD6	
										Initial	Duplicate
Total Organic Carbon	--	--	NA	NA	NA	NA	NA	44,400,000 (4.4%)	38,900,000 (3.89%)	5,160,000 (0.516%)	4,150,000 (0.415%)
Volatile Organic Compounds											
Methylene chloride	1	10	2 b	5 b	12 b	10 b	18 b	NA	NA	NA	NA
Acetone	10	10	5 j	9 bj	6 j	39	20	NA	NA	NA	NA
Benzene	5	6	*	1 j	*	*	*	NA	NA	NA	NA
Toluene	5	6	*	1 j	*	*	*	NA	NA	NA	NA
Semivolatile Organic Compounds											
Di-n-butylphthalate	10	390-410	*	*	240 bj	140 bj	52 bj	NA	NA	NA	NA
Phenanthrene	10	390-410	*	*	*	93 j	*	NA	NA	NA	NA
Fluoranthene	10	390-410	*	*	89 j	120 j	*	NA	NA	NA	NA
Pyrene	10	390-410	*	*	110 j	110 j	*	NA	NA	NA	NA
Benzo(b)fluoranthene	10	390-410	*	*	97 j	43 j	*	NA	NA	NA	NA
Benzo(k)fluoranthene	10	390-410	*	*	88 j	*	*	NA	NA	NA	NA
Benzo(a)anthracene	10	390-410	*	*	75 j	*	*	NA	NA	NA	NA
Chrysene	10	390-410	*	*	120 j	*	*	NA	NA	NA	NA
bis(2-ethylhexyl)phthalate	10	390-410	*	2 j	55 j	*	*	NA	NA	NA	NA
Naphthalene	10	390-410	3 j	*	*	*	*	NA	NA	NA	NA
2-Methylnapthalene	10	390-410	6 j	*	*	*	*	NA	NA	NA	NA

ORGANIC COMPOUNDS IN SURFA WATER AND SEDIMENT AT SITE 25
February 1993 and February 1994
(All data in ppb)

Analyte	Detection Limit[a]		Surface Water		Sediment						
					February 1993			February 1994			
			25-SW1	25-SW2	25-SD1	25-SD2	25-SD3	25-SD4	25-SD5	25-SD6	
Pesticide/PCB Compounds											
Dieldrin	0.02	--	*	*	56	<4.0	<0.8	<1.4	<1.2	<0.9	<0.9
4,4' DDD	0.04	--	*	*	<16	<7.7	<1.5	<2.7	14	<1.8	<1.8
4,4' DDE	0.02	--	*	*	27	<4.0	<0.8	<1.4	14	<0.9	<0.9
4,4' DDT	0.04	--	*	*	25	<7.7	<1.5	<2.7	7.5	<1.8	<1.8
Organophosphorus Pesticide Compounds	--	--	NA	<0.5-<2.5	NA	<200-<400	NA	NA	NA	NA	NA
Herbicide Compounds	--	--	NA	<1-<2	NA	<24-<120	NA	NA	NA	NA	NA
Dioxin/furan Compounds	--	--	NA	0.037-0.15	NA	<0.0046-<0.03	NA	NA	NA	NA	NA

Notes:

All volatile, semivolatile, pesticide/PCB, organophosphorus pesticide, herbicide, and dioxin/furan compounds not listed in the table above were analyzed for but not detected.
25-SD2 was submitted for the full series Appendix IX analysis of all parameters listed above.
QC Sampling: 25-SD40 is a duplicate of 25-SD6.
b This compound was found in the associated laboratory blank as well as the sample.
j This is an estimated value because it was detected below the accurately quantitative detection limit.
* The compound was analyzed for, but not detected.
NA Not analyzed.
[a]Where two detection limits are provided, the first one applies to the surface water data, and the second limit applies to the sediment data.
-- Due to variability in limits, refer to laboratory data sheets for exact detection limits. A range of limits is provided.

Table 2-5-2
INORGANICS IN SURFACE WATER AND SEDIMENT AT SITE 25

Analyte	Surface Water (µg/l)		Sediment (mg/kg)						
	January 1993					February 1994			
	25-SW1*	25-SW2*	25-SD1	25-SD2	25-SD3	25-SD4	25-SD5	25-SD6	
								Initial	Duplicate
Aluminum	288 +	NA	4,230	NA	2,270	11,000	11,000	11,200	19,000
Antimony	<16.4	<16.4	<4.5	<3.9 n	<3.8 n	<4.1 nr	<3.6 nr	<3.1 nr	<2.9 nr
Arsenic	0.88 bn	1.2 bn	0.65 b	0.91 b	1.0 b	1.5 j	2.0 j	1.7 j	2.0 j
Barium	38.5 b	38.2 b	17.7 b	17.4 b	7.5 b	98.8	52.5 b	37.9 b	56.0
Beryllium	<0.26	<0.26	0.14 b	0.17 b	0.07 b	0.48 b	0.32 b	0.17 b	0.28 b
Cadmium	<2.8	<2.8	1.3	<0.65	<0.65	<1.1	<1.00	<0.85	<0.80
Calcium	37,100	NA	689	NA	73.2 b	3,900	2,270	789 b	730 b
Chromium	<2.8	<2.8	6.0	4.3	3.9	10.2	12.2	12.5	21.4
Cobalt	<2.6	<2.6	<0.75	1.2 b	0.86 b	1.9 b	1.6 b	1.0 b	3.0 b
Copper	2.7 b	2.9 b	746	2.1 b	1.2 b	7.6 b	8.5	6.1 b	8.5
Iron	399 #	NA	2,200	NA	1,240	5,000	4,580	4,580	7,780
Lead	<1.7 n	<1.7 n	3.7	7.2 +	2.4 +	19.8	21.7	8.2	9.0
Magnesium	6,500	NA	376 b	NA	205 b	873 b	712 b	863 b	1,400
Manganese	29.7	NA	15.0	NA	8.1	168	43.0	19.1	29.8
Mercury	<0.07	<0.07	<0.07	<0.03	<0.03	0.06 b	<0.05	<0.04	<0.03
Nickel	13.7 b	<9.4	4.7 b	<2.2	<2.2	5.2 b	4.7 b	5.1 b	7.0 b
Potassium	10,600	NA	295	NA	<218	572 b	399 b	389 b	654 b
Selenium	<1.8 w,n	<1.8 n	0.45 b	<0.44	<0.43	< 0.55	<0.49	<0.41	<0.39
Silver	<2.0	<2.0	<0.31	<0.47	<0.47	<0.93	<0.82	<0.69	<0.66

Table 2-5-2
INORGANICS IN SURFACE WATER AND SEDIMENT AT SITE 25

Analyte	Surface Water (µg/l)		Sediment (mg/kg)						
	January 1993					February 1994			
	25-SW1[a]	25-SW2[a]	25-SD1	25-SD2	25-SD3	25-SD4	25-SD5	25-SD6	
								Initial	Duplicate
Sodium	26,200	NA	NA	NA	152 b	187 b	125 b	120 b	136 b
Thallium	<2.3	<2.3	<0.42	<0.55	<0.54	<0.48 n	<0.42 n	<0.36 n	<0.34 wn
Vanadium	<2.6	<2.6	6.9 b	5.7 b	3.7 b	14.6 buj	15.6 buj	18.2 uj	32.7 uj
Zinc	<9.0	15.7 b	723	9.0	4.9	48.1 +	65.1 +	27.6 +	17.8 +
Tin	NA	<12.7	NA	3.8 b	NA	NA	NA	NA	NA
Cyanide	NA	<1.4	NA	<0.08	NA	NA	NA	NA	NA

Notes:

< The constituent was not detected at this instrument detection limit.
25-SD2 and 25-SW2 were submitted for Appendix IX metals analysis.
[a]The nondetect results of selenium were rejected during the data validation process because of low spike recoveries less than 30 percent.
QC Sampling: 25-SD40 is a duplicate of 25-SD6.
b The reported value obtained was less than the contract required detection limit (CRDL), but greater than or equal to the IDL.
n Spiked sample recovery not within control limits.
+ Duplicate analysis not within control limits.
w Post digestion spike for furnace AA analysis is out of control limits (85 to 115%), while sample absorbance is less than 50% of spike absorbance.
Laboratory duplicate had poor precision; therefore, the value should be considered an estimate.
r The value was rejected during the data validation process because spike recovery was not within control limits.
uj The quantitation limit is estimated.
j The value is estimated because it is below the quantitation limit.

four Phase II samples was considered because using the minimum TOC concentration in the toxicological formulas creates the most stringent limit for the environmental assessment. An average TOC concentration also was used to determine if pesticides would be a problem at average TOC concentrations.

Table 2-5-3 lists constituents detected in the sediment at Site 25 that exceeded potentially applicable federal guidelines. Because there are few established criteria for contaminants in sediment, The National Oceanographic and Atmospheric Administration (NOAA) effects range median (ER-M) sediment guidelines and proposed ecological pesticide criteria were applied to give context to the contaminant concentrations. The two comparison criteria are described in Appendix A of the RFI Phase I report (CH2M HILL, 1993).

The Phase I detections of phenanthrene and fluoranthene were below the NOAA sediment guidelines and the proposed ecological sediment criteria as calculated from the conservative (0.415%) and average (2.315%) TOC values. The concentrations of 4,4'-DDE (27 ppb) and 4,4'-DDT (25 ppb) in 25-SD1 were above the NOAA ER-M guidelines of 15 and 7 ppb, respectively. The concentration of 7.5 ppb of 4,4'-DDT in 25-SD5 also was slightly above the ER-M guideline of 7.0 ppb. No ecological criteria have been proposed for these pesticide compounds.

Dieldrin is the only pesticide for which an ecological guideline has been proposed. Dieldrin was detected in 25-SD1 at 56 ppb during Phase I. The dieldrin concentration is above the NOAA ER-M guideline value of 8 ppb. Because no TOC sample was collected at 25-SD1 in 1993, it is not possible to determine whether the concentration exceeded the proposed sediment criterion of 37.35 ppb. This value is based upon the most conservative TOC value detected in the pond during Phase II of the RFI. If a more expected (i.e., average) value for TOC is used, the sediment criterion is 208 ppb. The dieldrin concentration in 25-SD1 is considerably below this value. Dieldrin was not detected in any other sediment samples during Phases I and II of the RFI.

Table 2-5-3
CONSTITUENTS DETECTED IN SEDIMENT AT SITE 25 THAT EXCEEDED POTENTIALLY APPLICABLE FEDERAL GUIDELINES
(All Data in ppb)

Compound	Location	Concentration (ppb)	NOAA ER-M Sediment Guideline[1]	Proposed Sediment Criteria for Protection of Benthic Organisms[2]	Proposed Sediment Criteria[3]	
					Criterion Derived From Most Conservative TOC Value[4]	Criterion Derived From Average TOC Value[5]
Fluoranthene	25-SD1 25-SD2	89 j 120 j	3,600	≤1,020 µg/g of organic carbon	≤4,233	≤23,613
Phenanthrene	25-SD2	93 j	1,380	≤120 µg/g of organic carbon	≤498	≤2,778
Dieldrin	25-SD1	50	8	≤9.0 µg/g of organic carbon	≤37.35	<208.35
4,4'-DDE	25-SD1	27	15	NS	NS	NS
4,4'-DDT	25-SD1 25-SD5*	25 7.5	7	NS	NS	NS
Zinc	25-SD1	723,000	270,000	NS	NS	NS
Copper	25-SD1	746,000	390,000	NS	NS	NS

NOTES:

Compounds that were detected and exceeded potentially applicable guidelines are included in this table.
*Sample collected in February 1994 during the RFI Phase II. All other samples collected in February 1993 during the RFI Phase I.
[1]Long and Morgan, National Oceanic and Atmospheric Administration, 1991.
[2]EPA, 1991.
[3]The proposed sediment criteria are based on percent organic carbon.

The Proposed Sediment Criteria figures were converted from the Proposed Sediment Criteria for protection of Benthic Organisms Using TOC Values.
[4]Criteria calculated using the lowest TOC result (0.415% organic carbon) from the Phase II sampling event. The lowest value was detected in the duplicate of 25-SD6.
[5]Criteria calculated by applying an average (2.315% organic carbon) of all RFI Phase II TOC sampling results from Site 25.

NS = No standard

The zinc and copper concentrations in the three Phase II sediment samples were considerably less than NOAA ER-M sediment guidelines values. Sediment sample 25-SD1 collected in 1993 contained 723,000 ppb of zinc and 746,000 ppb of copper. These concentrations were above ER-M screening guidelines. The maximum zinc and copper concentrations in the other five Phase I and II samples were 65,100 ppb and 8,500 ppb respectively. These concentrations are well below ER-M screening guidelines.

Because surface water flows gently out from the pond, transport of surface water and some sediment via the ditch is a potential transport mechanism. The contaminants are located within the sediment and not the surface water. The seasonal accumulation and addition of organic matter on the pond's bottom creates a containment mechanism which inhibits transport and erosion. Decomposing organic matter traps the contaminated sediment, further isolating the contaminants from erosion. In addition, it appears that the water in the borrow pond is generally stagnant and not moving swiftly enough towards the drainage ditch to significantly impact and erode the pond's bottom.

Conclusions and Recommendations

On the basis of the analytical data, no further action is recommended for Site 25. There are several general and specific reasons for this recommendation. The first is that the site is adjacent to a field that has been farmed for years. The reasonable assumption is that the farming rather than the landfill is the source of the pesticides DDE, DDT and dieldrin found at two of six sampling locations. These pesticides are highly persistent. DDT was banned over 20 years ago in the early 1970s, yet remains in the sediment along with its breakdown product DDE. It is unlikely that Navy activities are the source of the pesticides because the Navy purchased the land in 1979, several years after the DDT ban.

Concentrations of dieldrin and DDE were only slightly above NOAA guidelines in one out of the six samples and DDT was slightly above NOAA guidelines in two out of six samples. Average concentrations are well below NOAA guidelines. Furthermore, the

authors of the NOAA document (Long and Morgan, 1991), caution against the use of these values as regulatory standards. They are statistical effects data only.

This last comment also applies to the zinc and copper concentrations in 25-SD1, particularly considering that the NOAA values are from a variety of marine, brackish, and freshwater environments. A review of the NOAA data for other freshwater environments with mean concentrations close to the ones in 25-SD1 does show that there are sites with lower mean concentrations where some toxic effects to test species were observed. However, there also are freshwater environments within the NOAA database of zinc and copper effects where there were no effects even though the mean concentrations were above those in 25-SD1. In either case the basis for comparison to the NOAA database concentrations should be mean, rather than maximum, sediment concentrations.

The fact that only one of the six sediments had high concentrations and neither of the two surface water concentrations was elevated also are key considerations. The 25-SD1 values are clearly anomalous. The procedure in the NOAA study was to compare effects to mean concentrations. The mean and standard deviation of the sediment concentrations in the six samples were 146,000 $\pm$ 259,000 ppb for zinc and 129,000 $\pm$ 276,000 ppb for copper. Both means are below ER-M values. Because high zinc and copper were found in only one sample and the mean concentrations for the pond are below the non-regulatory ER-M screening guidelines, no additional study of this site is recommended.

Furthermore, the principle means of remediating the sediments at 25-SD1 if this were recommended probably would be to dredge them. This action would release the metals-laden sediments into the surface water and enhance their transport to other areas. Because remediation would tend to be destructive of the pond and there is evidence that constituents are not distributed broadly throughout the pond, no further action at Site 25 is recommended.

References

Bouwer, H. and R.C. Rice. 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. *Water Resources Research*, Volume 12, No. 3, pp. 423-428.

CH2M HILL. 1992. *RCRA Facility Investigation, Final Work Plan, Naval Air Station, Oceana*. June 1992.

CH2M HILL. 1993. *RCRA Facility Investigation, Final Report - Phase I, Naval Air Station, Oceana*. December 1993.

CH2M HILL. 1994. *Final Work Plan Addendum for the Phase II RCRA Facility Investigation of Sites 2D, 2E, 15, and 25, Oceana Naval Air Station*. March 1994.

CH2M HILL. 1994. *Final RCRA Work Plan Addendum for Corrective Measures Study at Petroleum Contaminated Sites, Oceana Naval Air Station*. March 1994.

CH2M HILL. 1994. *Final RCRA Work Plan Addendum for Corrective Measures Study at Sites 1, 2B, and 2C, Oceana Naval Air Station*. March 1994.

CH2M HILL. 1994. *Design for Remediation of Petroleum Contaminated Soil, Sites 11, 18, 19, 20, 24, at the Oceana Naval Air Station*. June 1994.

CH2M HILL. 1994. *Plan for Management of Investigation-Derived Wastes from the FRI Investigation at NAS Oceana*. April 1994.

CH2M HILL. 1994. *Final Corrective Measures Study for Petroleum Contaminated Sites, Oceana Naval Air Station, Virginia Beach, Virginia*. October 1994.

CH2M HILL. 1994. *Draft Final Corrective Measures Study for Sites 1, 2B, and 2C, Oceana Naval Air Station*. November 1994.

Jones. November 30, 1994. Senior Chief stationed at Building 23, Oceana Naval Air Station. Personal communication with Steven Brown of CH2M HILL.

Geraghty and Miller, Inc. 1989. *AQTESOLV, Aquifer Test Solver*, Version 1.00. Geraghty and Miller Modeling Group, 1895 Preston White Drive, Suite 301, Reston, Virginia 22091.

Long, Edward R. and Morgan, Lee G. August 1991. *The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration, National Ocean Service. NOS OMA 52 Seattle, Washington.*

NEESA. 1988. *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, NEESA 20.2-047B*. June 1988.

Smith, Roy L. January 7, 1994. *Risk-Based Concentrations Table, Fourth Quarter 1993, US EPA Region III*.

Tipton, Fred. February 1994. *Oceana Naval Air Station Public Works Department - Electrical Division.* Personal Communication to Darren Braccia of CH2M HILL.

U.S. Environmental Protection Agency. 1991. *Resource Conservation and Recovery Act Corrective Action Consent Order for Oceana NAS*. VA2170024606. May 1991.

U.S. Environmental Protection Agency. December 1993. *Drinking Water Regulations and Health Advisories.*

U.S. Environmental Protection Agency. May 1989. *Development of RFI Work Plan and General Considerations for RCRA Facility Investigations. Interim Final RCRA Facility Investigation (RFI) Guidance, Volume I or IV.* Office of Solid Waste, Waste Management Division. EPA 530/SW-89-031. OSWER Directive 9502.00-6D.

U.S. Environmental Protection Agency. 1991. *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis.* June 1991.

U.S. Environmental Protection Agency. 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis.* July 1988.

U.S. Environmental Protection Agency. 1991. 40 CFR Parts 141 and 142. (Vol. 56, No. 110), Friday, June 7, 1991.

WDCR836/029.WP5

Appendix A
Drilling Activities

Appendix A

Drilling Activities

Introduction

Forty-one shallow monitoring wells were installed at seven sites as part of the Oceana NAS Phase II RFI and CMS field investigations. Other drilling activities included 17 soil borings, installation of 20 piezometers, test-pit excavation, and augering using a small power auger at Site 2E. The drilling, well installation, and test-pit excavations were performed by Rock-Ray Drilling, Inc. under the supervision of CH2M HILL personnel. These activities occurred in four separate drilling phases due to weather complications and the need for iterative site characterization. The drilling activities of each phase are summarized below:

- **February 21 to March 9, 1994.** Most monitoring wells were drilled and installed at Site 1 (1-MW10); Site 2B (2B-MW17, 2B-MW18, and 2B-MW19); Site 2C (2C-MW14, 2C-MW15, 2C-MW16, 2C-MW17, and 2C-MW18); Site 2D (2D-MW4 and 2D-MW5); Site 2E (2E-MW4, 2E-MW5, 2E-MW6, 2E-MW7, and 2E-MW8); and Site 15 (15-MW5 and 15-MW9). In addition, 9 piezometers were installed for the Site 2B Air sparging pilot test and 17 soil borings were drilled and sampled for soil at Site 1.

- **April 11 to 15, 1994**. The remaining monitoring wells at Site 15 (15-MW6, 15-MW7, 15-MW8, and 15-MW10) were installed during this phase. The delay in the installation of these wells was necessary after an exceptional rainfall that flooded the Site 15 drilling locations and made the locations inaccessible.

- **May 11 to 12, 1994**. After receiving the analytical results from the newly installed monitoring wells and select existing wells, CH2M HILL and the Navy determined that additional contaminant characterization was necessary at Site 2B and Site 2C. Three shallow monitoring wells were installed at Site 2B (2B-MW20) and Site 2C (2C-MW19 and 2C-MW20) during this phase.

- **September 19 to October 5, 1994**. After additional review of the data for Sites 2E, 15, and 24, CH2M HILL and the Navy concurred that additional monitoring wells were necessary to enhance characterization of these sites. A total of 16 monitoring wells were installed during this field event at Site 2E (2E-MW9, 2E-MW10, 2E-MW11, 2E-MW12, and 2E-MW13), Site 15 (15-MW11, 15-MW12, 15-MW13, 15-MW14, and 15-MW15), and Site 24 (24-MW1, 24-MW2, 24-MW3, 24-MW4, 24-MW5, and 24-MW6). In addition, the following tasks were completed:

  - An extraction well (2B-EW4) and an observation well (2B-OW1) were installed at Site 2B

  - An extraction well (1-EW1) and five piezometers were installed at Site 1

  - Six piezometers were installed and ten test pits were excavated at Site 15

  The extraction wells are 6-inch-diameter PVC wells installed to 25 feet with 20 feet of screen.

Shallow Monitoring Wells

The boreholes and 2-inch-diameter PVC wells were drilled with 6-inch inner diameter (ID) hollow-stem augers (HSA) using either a Mobile B-37 drill rig or Acker AD-2 rig. The 6-inch-diameter PVC extraction wells were installed with 8-inch ID hollow stem augers. At some drilling locations, an all-terrain CME-55 drill rig was used due to limited access. CH2M HILL geologists recorded the lithologic and geotechnical characteristics of the split-spoon samples, which were collected at 5-foot intervals. This appendix includes the drilling logs for the newly installed monitoring wells and three existing wells at Site 15 that were installed by R. E. Wright Associates in 1982. It also includes the test pit logs from Site 15.

All monitoring wells were constructed and developed as described in the Phase I RFI Report (CH2M HILL, 1993) and as specified in the Phase I and Phase II RFI work plans (CH2M HILL, 1992 and 1994). Table A-1 describes the results of power augering at Site 2E. Table A-2 lists the construction specifications for the new monitoring wells. Fifteen-foot well screens were used in monitoring wells at Sites 1, 2E, and 15. The screens were installed across the water table to capture suspected floating free-phase contamination.

Test-Pit Excavation

Objectives

Because the shallow soils and several groundwater samples at Site 15 contained elevated contaminant levels, CH2M HILL and the Navy added a test-pit excavation task to confirm

Table A-1
SOIL BORING CHARACTERIZATION AT SITE 2E
February 1994

Soil Boring	Depth (ft.)	Instrument Reading (ppm)	Field Observations and Comments
2E-SB1	4.0 5.5 6.0	149 119 100	No free product evident. No product.
2E-SB2	2.5 5.0 6.0	43 395 153	
2E-SB3	4.7	NR	Diesel fumes; free product displaced from borehole during abandonment with grout.
2E-SB4	4.7	NR	No diesel odor.
2E-SB5	1.3	NR	No odor; refusal on a potential concrete slab.
2E-SB6	4.5	NR	Diesel fumes.
2E-SB7	4.5	NR	Clean, no odor.
2E-SB8	1.6	NR	Construction gravel with mild diesel odor.
2E-SB9	4.5	NR	Strong diesel odor.
2E-SB10	1.3	NR	No odor; concrete slab encountered, refusal.
2E-SB11	4.5	NR	Water table at 4.0 feet. No odor.
2E-SB12	4.7	NR	Strong diesel odor.
2E-SB13	3.0-3.5	NR	Gravel at bottom. No odor.
2E-SB14	4.5	12.7	Intersected water table with probe. No odor
2E-SB15	4.5	0	No indications of free product.
2E-SB16	4.5	0	No indication of free product.
2E-SB17	4.5	0	Intersected water table with probe. No odor
2E-SB18	4.5	0	No indication of free product.
2E-SB19	2.0	0	No indication of free product.
2E-SB20	3.0	NR	Slab encountered; refusal. Strong hydrocarbon odor. Sheen leaching from soil cuttings under influence of heavy rain. Hand augered.
2E-SB21	3.0	NR	Fuel odor apparent. Provisional rig boring.

Table A-1
SOIL BORING CHARACTERIZATION AT SITE 2E
February 1994

Soil Boring	Depth (ft.)	Instrument Reading (ppm)	Field Observations and Comments
2E-SB22	3.0-5.0	20	Heavily contaminated. Provisional rig boring. Split-spoon sample is saturated with hydrocarbons.
2E-SB23	3.0-5.0	40	Split spoon sample saturated with hydrocarbons. Provisional rig boring.
2E-SS11	4.0	NR	
2E-SS12	5.0	NR	
2E-SS13	3.0-4.0	NR	Strong fuel odor.

Notes:

Soil borings were advanced with a power auger with a few exceptions. 2E-SS11, 2E-SS12, and 2E-SB20 were bored with a manual hand auger. 2E-SB21, 2E-SB22, and 2E-SB23 were drilled with hollow-stem augers driven by a drill rig. 2E-SS13 was collected using a hydraulic probe.

All borings were abandoned with grout.

Field personnel recorded the instrument readings directly from the soil cuttings or the split-spoon samples.

The water table, which was elevated as a result of high seasonal precipitation, was typically encountered between 3.0 and 4.0 feet.

NR - Not recorded. Instrument readings were not recorded because the wet weather conditions at the time of the drilling and probing caused the instrument to malfunction.

Table A-2
INSTALLATION RECORD OF MONITORING WELLS INSTALLED DURING RFI PHASE II/CMS FIELD INVESTIGATION

Well	Ground Elevation (Ft. Above MSL)	Grout Interval (Feet)	Bentonite Interval (Feet)	Sand Interval (Feet)	Screened Interval (Feet)	Total Borehole Depth[a] (Feet)
1-MW10	17.1	0-2	2-2.8	2.8-18.2	3.2-18.2	18
2B-MW17	21.7	0-5	5-8	8-21	10-20	24
2B-MW18	21.0	0-5	5-7	7-20	10-20	24
2B-MW19	18.2	0-4.5	4.5-7	7-20	10-20	20
2B-MW20	19.1	0-5	5-7	7-20	9.5-19.5	20
2C-MW14	19.5	0-5	5-8	8-21	10-20	24
2C-MW15	18.2	0-6	6-8	8-20	10-20	24
2C-MW16	18.8	0-5	5-8	8-21	10-20	24
2C-MW17	18.4	0-6	6-8	8-20	10-20	20
2C-MW18	18.2	0-4	4-6	6-19	9-19	19
2C-MW19	20.6	0-5	5-7	7-20	9-19	20
2C-MW20	19.4	0-5	5-7	7-20	10-20	20
2D-MW4	22.4	0-1	1-2.7	2.7-20	8-20	20
2D-MW5	22.3	0-2	2-5	5-20	10-20	21
2E-MW4	20.7	0-1	1-2	2-22	4.5-19.5	22
2E-MW5	20.4	0-1	1-2	2-20	4-19	23
2E-MW6	20.5	0-1	1-2	2-20	4-19	23
2E-MW7	20.9	0-1	1-2	2-18	3-18	18
2E-MW8	20.4	0-1	1-2	2-20	3-18	20
2E-MW9	20.7	0-0.5	0.5-2	2-18.5	3.5-18.5	20
2E-MW10	21.4	0-1	1-3	3-20	5-20	20
2E-MW11	20.3	0-1	1-3	3-20	5-20	20
2E-MW12	20.6	0-1	1-3	3-20	5-20	20
2E-MW13	20.4	0-1	1-3	3-20	5-20	20
15-MW5	18.4	0-1	1-2	2-18	3-18	18
15-MW6	17.9	0-1	1-2	2-18	3-18	20
15-MW7	16.6	0-1	1-2.3	2.3-18	3-18	18
15-MW8	17.8	0-1	1-2	2-18	3-18	18
15-MW9	18.3	0-1	1-2	2-18.5	3-18	20
15-MW10	17.8	0-0.8	0.8-2.1	2.1-18	3-18	20
15-MW11	17.3	0-1	1-3	3-20	5-20	20
15-MW12	17.6	0-1	1-3	3-20	5-20	20
15-MW13	16.1	0-1	1-3	3-20	5-20	20
15-MW14	17.7	0-1	1-3	3-20	5-20	20
15-MW15	17.3	0-1	1-3	3-20	5-20	20
24-MW1	17.0	0-1	1-3	3-20	5-20	20
24-MW2	16.9	0-2	2-3	3-20	5-20	20
24-MW3	16.0	0-1	1-3	3-20	5-20	20
24-MW4	17.3	0-1	1-3	3-20	5-20	20
24-MW5	17.0	0-1	1-3	3-20	5-20	20
24-MW6	17.7	0-1	1-2.5	2.5-19	4-19	19

[a]Total borehole depths are estimated from the well logs and drilling field notes. At some wells, the borehole depth does not equal the bottom of either the screened interval or sand interval because the driller overdrilled to facilitate well installation.

the presence and extent of free-phase hydrocarbons at the site. The objectives of the test-pit excavations were to:

- Observe free product accumulation on the water table in the test pits.
- Observe any evidence of free product in the soil zone near the water table.
- Complete a visual inspection of each pit and use health and safety monitoring equipment to evaluate contaminant levels semi-qualitatively.
- Develop stratigraphic cross-sections of the shallow-subsurface geology to complement any potential remedial design operations in the future.

Excavation

The excavation of ten test pits at Site 15 was completed in two events on September 26-27, 1994, and on September 28-29, 1994. Rock-Ray Drilling of Virginia Beach performed the excavation using a backhoe. The final depths of excavation extended several feet below the water table, which was approximately 7 to 8 feet below grade during excavation. CH2M HILL provided health and safety monitoring over the course of the excavations. After excavating each location, CH2M HILL allowed the conditions on the exposed water table to stabilize for a minimum of 12 hours.

At the end of the stabilization period, CH2M HILL field personnel recorded observations, monitored the atmosphere in the pit, and completed test-pit logs documenting the stratigraphy of each pit. Detailed logs of the test pits are found in this appendix after the monitoring well logs. After the inspection, Rock-Ray Drilling promptly backfilled the test pits.

Health and Safety

CH2M HILL monitored the atmosphere continuously throughout the excavation work using an Organic Vapor Monitor (OVM) and explosimeter. The atmosphere monitoring targeted three locations to ensure worker safety. OVM readings were collected from:

- The breathing zone supporting the individuals involved in the work
- Within and immediately adjacent to the soil-cuttings pile where the excavated soils were placed temporarily
- At depth within the test pit, especially directly above the water table, to identify areas of volatile contamination

Because the continuous air monitoring results showed elevated concentration of organics, the test pits were excavated in Level C personal protective equipment (PPE). The OVM readings in the breathing zone ranged from background to 60 ppm. The highest readings were close to the soil cuttings pile. Elevated readings were also triggered by the soil removal and dumping action of the backhoe, which increased the release and dispersal of the vapors that were otherwise trapped in the soil-pore space. The OVM readings recorded directly from the soil cuttings were from 0 to 285 ppm; whereas the readings at depth in the test pits commonly ranged from 30 to 188 ppm during the excavation. The organic vapors in the pits dissipated somewhat with time such that upon return to the site after 12 hours, the readings had decreased to 0 to 81 ppm.

Contamination and Extent

On the basis of instrument readings recorded during excavation and geoprobe soil sampling, there appears to a significant amount of shallow sub-surface soil contamination; however, during observation of the test pits no free product was clearly evident in soil or

on the water surface. The pits were placed in six alignments. Several alignments had multiple test pits. The locations of the test pits are illustrated in Chapter 2. The overall pattern of contamination is summarized in Chapter 2 also. A synopsis of the field notes describing each test pit follows.

Test-Pit Alignment 15-TP1

This alignment consists of two test pits straddling the horse-trail near 15-MW6. The OVM at depth in 15-TP1A registered 143 ppm; however, there was no evident free product or sheen on the water table. Test pit 15-TP1B contained a bubbly material scattered intermittently across the water table; however, the material did not appear to be free product and its thickness could not be measured.

Test Pit 15-TP2

All monitoring of the soil cuttings and breathing-zone during excavation and inspection of this test pit indicated a background atmosphere. No free product or petroleum sheen evident on the water table during inspection.

Test Pit 15-TP3

This test pit, which was located near 15-MW9, contained heavily contaminated soil cuttings that produced OVM readings that ranged from 188 ppm to 285 ppm at a depth of 3 feet below-grade. The water table at this location had a bubbly, scum-laden appearance and exhibited a reddish-orange color. No free product was evident.

Test-Pit Alignment 15-TP4

This alignment, consisting of three test pits, extended approximately 200 feet across the southern portion of the site. No free product was evident in any of the test pits. At

15-TP4A, the silty sand cuttings from approximately 5 feet below grade to the water table contained brown, streaked patches and generated OVM readings of 175 ppm. At 15-TP4B, which was 15 feet north along the alignment, high OVM readings of 125 ppm were recorded from soils 3 feet below grade. During inspection of this location, brown bubbles and a scummy material were noted on the exposed water table; however, there was no petroleum sheen. A third test pit, 15-TP4C, was excavated approximately 150 farther south along the alignment. While the OVM registered 3 to 25 ppm above the cuttings and in the breathing zone during excavation, the water table appeared to be clear of free product. No iridescent sheen was observed on the water, and the OVM at depth in the pit registered 0 ppm. The water was gray, which was probably due to the natural silt in the formation.

Test-Pit Alignment 15-TP5

There were two test pits excavated along this alignment. The pits were approximately 15 feet apart. During inspection, 15-TP5A had contaminated soil cuttings and produced OVM readings of 57 ppm in the pit. The water table in 15-TP5A was slightly discolored, with reddish-orange bubbles. On the other hand, 15-TP5B, which was approximately 15 feet north along the alignment, had neither free product on the water table nor contaminated soil cuttings. All OVM readings were background during the excavation and inspection.

15-TP6

No free product was evident on the water table, but a slight rainbow-colored sheen was observed. The OVM registered 122 ppm at depth in the pit, and 25 to 110 ppm above the soil cuttings. Orange-red bubbles were observed along the edge of the test pit.

SOIL/ROCK CLASSIFICATION SHEET

oject Oceana Job No. 8280 Boring No. MW-1

cation Old Fuel Farm Classified by RCB Sheet 1 of 2

ractor Herbert Assoc. Driller R. Seage Ground Surf. Elev. 18.4'

thod of Advancing Boring Split-Spoon Augering Static Water Level 2.3'

te Started 11/22/82 Date Completed 11/24/82

Depth, Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
1	S1	2		ML	0.0'-1.0' Topsoil, sandy; dark brown, fine to coarse sand, moist, friable.			No fuel odor	18
		4			1.0'-2.0' Silt; Dark gray; fine sand, moist, stiff.			No fuel odor	
2	S2	4 5						No fuel odor	17
	S3	4		ML	2.0'-3.0' As above.				16
4	S4	5 5 3			3.0'-4.0' Silt; Medium brownish-gray; fine sand, very moist, soft.			No fuel odor	15
5	S5	2		ML	4.0'-5.0' As above, saturated, medium stiff.			No fuel odor	14
		2			5.0'-6.0' As above.			No fuel odor	
6	S6	2 3							13
7	S7	6		SM	6.0'-7.0' Sand; Medium brownish-gray; fine sand, little silt, moderately well sorted, very moist, medium stiff.			No fuel odor	12
		7			7.0'-8.0' As above, little to some silt in pockets.			No fuel odor	
8	S8	4 9						No fuel odor	11
9	S9	4		SW	8.0'-9.0' Sand; Light brownish-gray; medium to coarse sand, well sorted, some silt, medium stiff and cohesive.				10
		3			9.0'-10.0' As above, trace silt.			No fuel odor	
10	S10	7 10							9

r.e. wright associates, inc.

Project Oceana Job No. 8280 Boring No. MW-1

Location Old Fuel Farm . Classified by RCB Sheet 2 of 2

Contractor Herbert Assoc. Driller R. Seage Ground Surf. Elev. 18.4'

Method of Advancing Boring Split-Spoon Augering Static Water Level 2.3'

Date Started 11/22/82 Date Completed 11/24/82

Depth. Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
	S11	13			10.0'-11.0' As above.			No fuel odor	8
11		13		SW	11.0'-12.0' As above.			No fuel odor	
	S12	10							7
12		9			12.0'-13.0' As above.			No fuel odor	
	S13	7							6
13		11		SW	13.0'-14.0' As above			No fuel odor	
	S14	9							5
14		13			14.0'-15.0' As above.			No fuel odor	
	S15	20							4
15		18		SW	15.0'-16.0' As above.			No fuel odor	
	S16	20							3
16		22							

r.e. wright associates, inc.

BORE HOLE CLASSIFICATION SHEET

Project Oceana Job No. 8280 Boring No. MW-2

Location Old Fuel Farm . Classified by RCB Sheet 1 of 2

Contractor Herbert Assoc. Driller R. Seage Ground Surf. Elev. 17.6'

Method of Advancing Boring Split-Spoon Augering Static Water Level 1.3'

Date Started 11/22/82 Date Completed 11/30/82

Depth. Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
1	S1	1 1 3		ML	0.0'-1.0' Topsoil and Silt; Dark gray; little fine sand, slightly moist, friable, medium stiff.			No fuel odor	17
					1.0'-2.0' Silt as above.			No fuel odor ▽	
2	S2	2							16
	S3	2 3		ML	2.0'-3.0' Silt; Dark grayish-brown; little very fine sand, trace clay, slightly moist, friable, medium stiff.			No fuel odor	15
4	S4	2 3			3.0'-4.0' Silt as above.			No fuel odor	14
	S5	3 3		ML	4.0'-5.0' Silt as above; with part of light gray very fine silty sand, mottled, very moist, medium stiff.			No fuel odor	13
6	S6	10 13		SM	5.0'-6.0' Silty Sand; Light gray; very fine to fine sand, some silt, mottled, moist, slightly friable, medium stiff.			No fuel odor	12
	S7	6 7		SP	6.0'-7.0' Sand; Light gray; medium sand, well-sorted, trace silt, not mottled, moist, soft.			No fuel odor	11
8	S8	4 5		SW	7.0'-8.0' Sand; Medium gray; very fine to medium sand, very moist, friable, soft.			No fuel odor	10
	S9	4 6			8.0'-9.0' Sand as above.			No fuel odor	9
10	S10	8 7		SP	9.0'-10.0' Sand; Medium gray; medium sand, moderately well-sorted, moist, friable, soft.			Trace fuel odor	8

SOIL ROCK CLASSIFICATION SHEET

Project Oceana Job No. 8280 Boring No. MW-2

Location Old Fuel Farm Classified by RCB Sheet 2 of 2

Contractor Herbert Assoc. Driller R. Seage Ground Surf. Elev. 17.6'

Method of Advancing Boring Split-Spoon Augering Static Water Level 1.3'

Date Started 11/22/82 Date Completed 11/30/82

Depth, Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
11	S11	10		SP	10.0'-11.0' Sand as above.			No fuel odor	7
		8							
		5			11.0'-12.0' Sand as above.			No fuel odor	6
12	S12	6							
	S13	18		SP	12.0'-13.0' Sand as above.			Trace fuel odor	5
		7							
		18			13.0'-14.0' Sand as above.			Little fuel odor	4
14	S14	14							
	S15	24		SP	14.0'-15.0' Sand as above.			Trace fuel odor	3
		25							
15		25			15.0'-16.0' Sand as above.			Moderate fuel odor	2
16	S16	29							
	S17	25		SP	16.0'-17.0' Sand as above.			Moderate to strong fuel odor	1
		20							
17		21			17.0'-18.0' Sand as above.			Moderate to strong fuel odor	0
18	S18	20							
	S19	10		SP	18.0'-19.0' Sand as above.			No fuel odor	-1
		17							
19		25			19.0'-20.0' Sand as above.			No fuel odor	-2
20	S20	31							

SOIL ROCK CLASSIFICATION SHEET

Project Oceana — Job No. 8280 — Boring No. MW-3

Location Old Fuel Farm — Classified by JST — Sheet 1 of 2

Contractor Herbert Assoc. — Driller R. Seage — Ground Surf. Elev. 18.8'

Method of Advancing Boring Split-Spoon Augering — Static Water Level 2.7'

Date Started 11/23/82 — Date Completed 11/23/82

Depth, Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
1	S1	3 10	22		0.0'-1.0' Topsoil; Dark brown; sandy, fine to coarse sand, moist, friable.			Trace fuel odor	18
	S2	10 20		ML	1.0'-2.0' Silt; Dark grayish-brown; some very fine sand, moist, stiff, cohesive.			Trace fuel odor	17
2	S3	10 14	16	ML	2.0'-3.0' Silt as above.			Strong fuel odor; also a septic odor	16
3	S4	14 11		SM	3.0'-4.0' Silty Sand; Medium greenish-gray; fine sand, little silt, trace medium sand, moist, friable, soft.			Strong fuel odor	15
4	S5	6 4	16		4.0'-5.0' Silt; Dark grayish-brown; some very fine to fine sand, saturated, slightly cohesive, medium stiff.			Strong fuel odor (Driller says strong fuel odor is coming from well.)	14
5	S6	6 6		MH	5.0'-6.0' Sandy Silt; Grayish-green; some very fine to fine sand, little clay; very moist cohesive.			Strong fuel odor	13
6	S7	6 11	13	MH	6.0'-7.0' Sandy Silt as above.			Strong fuel odor	12
7	S8	13 6		SW	7.0'-8.0' Sand; Light greenish-gray; fine to medium sand, trace silt, saturated, friable, soft.			Strong fuel odor	11
8	S9	3 3	16	SW	8.0'-9.0' Sand as above.			Weak fuel odor	10
9	S10	6 13		SP	9.0'-10.0' Sand; Medium gray; medium sand, well-sorted, saturated, friable, soft.			Trace of fuel odor	9
10									

SOIL/ROCK CLASSIFICATION SHEET

Project Oceana Job No. 8280 Boring No. MW-3

Location Old Fuel Farm Classified by JST Sheet 2 of 2

Contractor Herbert Assoc. Driller R. Seage Ground Surf. Elev. 18.8'

Method of Advancing Boring Split-Spoon Augering Static Water Level 2.7'

Date Started 11/23/82 Date Completed 11/23/82

Depth, Ft.	Sample Occurrence and Number	Blows per 6 In.	Recovery In.	USCS	Sediment Description and Classification	Graphical Log	Well Construction	Construction Details and Remarks	Elevation, Ft.
11	S11	10 10	24	SP	10.0'-11.0' Sand as above, trace of silt.			Trace fuel odor	8
12	S12	9 7			11.0'-12.0' Sand as above.			No fuel odor	7
14	S13 S14	9 13 20 25	22	SP	12.0'-13.0' Sand as above. 13.0'-14.0' Sand as above.			Moderate fuel odor (smells like septic but may be weathered fuel) Weak odor (smells like septic but may be weathered fuel).	6 5
16	S15 S16	12 17 27 35	16	SP	14.0'-15.0' Sand as above, trace of fine sand, medium stiff, cohesive. Sand heaving. 15.0'-16.0' Sand as above, trace of silt. Cohesive.			Moderate fuel odor Weak fuel odor	4 3
18	S17 S18	14 20 27 38	11	SW	16.0'-17.0' Sand; Light greenish-gray; fine to medium sand, trace silt, saturated, medium stiff, slightly cohesive, tighter, mod. sorted. 17.0'-18.0' Sand as above, light to medium gray.			Strong fuel odor Strong odor (smells like septic, but may be weathered fuel).	2 1
20	S19 S20	0 7 24 32	10	SP	18.0'-19.0' Sand; Greenish-gray; medium to coarse sand, trace of silt and fine sand, saturated, friable, soft (loose). 19.0'-20.0' Sand as above.			Moderate fuel odor Moderate fuel odor	0 -1

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	1-MW10	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS LOCATION North of Site 1

ELEVATION _____ DRILLING CONTRACTOR Froehling & Robertson

DRILLING METHOD AND EQUIPMENT CME-55 ATV Rig with 6" HSA

WATER LEVELS _____ START 2-25-94 FINISH 3-3-94 LOGGER Braccia/Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 18' Screen = 3.2-18.2' Sand Pack = 2.8-18.2' Bentonite = 2.0-2.8' Grout Seal = 0-2.0' Stick-up
	5	1	1.6'	4-6-8-8 (14)	0-1.2' SANDY SILT (ML), pale yellow. brown (10YR4/2), moist, firm; 15% fines. 1.2-1.6' POORLY GRADED SAND with SILT (SP-SM), v.pale orange (10YR8/2), moist; fine to medium quartz sand with silt <5%.	
5.0	8					
	10	2	1.4'	8-8-10-12 (18)	POORLY GRADED SAND (SP), top 0.8 is grayish orange (10YR7/4) and bottom 0.6' is very pale orange (10YR8/2), wet, loose; fine to medium quartz sand with trace silt.	
10.0	13					
	15	3	1.5'	9-14-10-6 (24)	POORLY GRADED SAND (SP), same as above, but light gray (N7) to medium light gray (N6); grains are mostly fines.	
15.0	18					
	20	4	2.0'	5-2-3-3 (5)	POORLY GRADED SAND with SILT (SP-SM), medium gray (N5), wet, soft and loose; fine sand with silt <10%.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	1-EW1	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION 30 feet South of 1-MW4

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 With 8 1/4" ID HSA

WATER LEVELS _____ START 9-30-94 FINISH 9-30-94 LOGGER D. Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0					No logging	Well Construction Summary Total Depth = 25' Screen = 5-25' Sand Pack = 3-25' Bentonite = 1-3' Grout = few inches Riser = 0-5' Temporary flush mount
5.0						
10.0						
15.0						
20.0						
25.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	2B-OW1	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION 5 feet from 2B-EW4

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 HSA 6 1/4" ID

WATER LEVELS _____ START 9-21-94 FINISH 9-21-94 LOGGER S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	3					Well Construction Summary Total Depth = 25' Screen = 5-25' Sand Pack = 3-25' Bentonite = 1-3' Grout = 0-1' 2-inch diameter Stick Up Well
	5	SS-1	2.0'	3-2-3-3 (5)	SANDY SILT (ML), light olive gray (5Y6/1), soft to firm, dry, notable fuel odor.	
5.0	8					
	10	SS-2	1.6'	5-7-7-7 (14)	POORLY-GRADED SAND (SP), very light gray (N8) to medium light gray (N6), medium density, wet, medium sand, slight chemical odor.	
10.0	13					
	15	SS-3	2.0'	2-3-1-1 (4)	POORLY-GRADED SAND (SP), medium gray (N5), very loose, wet, 1" 5-10 % silt zone.	
15.0	18					
	20	SS-4	2.0'	3-4-6-8 (10)	POORLY-GRADED SAND (SP), medium gray (N5), medium density, wet, middle 2 inches have very fine gravel and minor shell fragments but most sand is fine (2-4 mm) to medium, possibly a beach deposit.	
20.0	23					
	25	SS-5	2.0'	5-11-13-12 (24)	POORLY-GRADED SAND (SP) with trace of very fine (1 mm) shell hash (aprox. 1% or less) and some very fine well rounded gravel, medium gray (N5), hard medium density, wet.	
25.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	2B-EW4	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION 5.5 feet from 2B-OW1

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 WITH 8 1/4" ID HSA

WATER LEVELS _____ START 9-23-94 FINISH 9-23-94 LOGGER S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0					No logging. See 2B-OW1 log for lithologic descriptions	Well Construction Summary Total Depth = 25' Screen = 5-25' Sand Pack = 3-25' Bentonite = 1-3' Grout = few inches 6" Diameter Well Manhole Cover
5.0						
10.0						
15.0						
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2B-MW17 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Behind Bldg 137-SWATSLANT

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 2-28-94 **FINISH** 2-28-94 **LOGGER** D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	1		1.0'		CONCRETE cored by Holes, Inc.	Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 8-20' Bentonite = 5-8' Grout Seal = 0-5' Flush Mount
	3					
	5	1	1.5'	6-7-4-6 (11)	0-1.0' FILL, clean sand and gravel under flightline concrete. 1.0-1.5' SILT (ML), dusky yellowish brown (10YR2/2), moist, firm; trace fine sand, non-elastic.	1 ppm in auger
5.0	8					
	10	2	1.0'	4-7-9-8 (16)	POORLY GRADED SAND with SILT (SP-SM), color grades from light bluish gray (5B7/1) to dark yellowish orange (10YR6/6), wet, loose; silt ranges from <5% to <10%.	
10.0	13					
	15	3	1.5'	5-4-6-7 (10)	POORLY GRADED SAND (SP), medium gray (N5), wet, loose; fine to medium, rounded quartz sand with silt <5%.	
15.0	18					
	20	4	1.0'	3-3-4-5 (7)	WELL GRADED SAND (SW), medium light gray (N6), wet, loose; fine to very coarse quartz sand with trace gravel and feldspar. Sub-angular to sub-rounded grains.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2B-MW18 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Beside Bldg. 137-SWATSLANT

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 2-24-94 **FINISH** 2-24-94 **LOGGER** D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 7-20' Bentonite = 5-7' Grout Seal = 0-5' Stick-up
	5	1	1.5	2-2-2-2 (4)	0-1.3' SILT with SAND (ML), dark yellow. brown (10YR4/2), dry, soft; very fine to fine sand <10%. 1.3-1.5' SILTY SAND (SM), dark yellowish brown (10YR4/2) to pale yellowish brown (10YR6/2), moist, loose; medium sand:silt = 70:30, orange mottle marks = 1 cm.	
5.0	8					
	10	2	1.5	6-6-7-8 (13)	0-0.5' POORLY GRADED SAND (SP), dark yellow. orange (10YR6/6), wet, loose; fine to medium quartz sand, silt <5%. 0.5-1.2' POORLY GRADED SAND (SP), light gray (N7), wet, loose; medium quartz sand, silt <5%. 1.2-1.5' POORLY GRADED SAND (SP), same as top of spoon except medium gray (N5).	
10.0	13					
	15	3	1.6	8-6-2-1 (8)	POORLY GRADED SAND (SP), same as above in bottom 3rd of spoon 2.	
15.0	18					
	20	4	2.0	3-2-3-12 (5)	WELL GRADED SAND (SW), medium light gray (N6), wet, loose; fine to coarse sands with trace: gravel, feldspar, biotite. No silt.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2B-MW19 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Behind C&P Telephone Bldg

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 2-21-94 **FINISH** 2-21-94 **LOGGER** A.Lloyd

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 7-20' Bentonite = 4.5-7' Grout Seal = 0-4.5' Flush Mount
	5					
5.0	7	1	1.3'	6-10-11-12 (21)	POORLY GRADED SAND (SP), dark yellowish orange (10YR6/6), wet, medium density; well-rounded, medium quartz sand with trace silt. Bottom 0.4' of spoon is light gray (N7) with trace opaques.	Background (BG), Breathing Zone (BZ) HNu - 1 ppm in augers no LEL or 02 problems
	10					
10.0	12	2		WT.-4-3-1 (7)	POORLY GRADED SAND (SP), medium dark gray (N4), wet, soft; medium quartz sand with trace opaques. No visible structures.	HNu borehole 2 ppm, BZ=BG, LEL - 0%, 92 - 22.4
	13					
	15	3	1.8'	WT.-4-3-1 (7)	POORLY GRADED SAND (SP), same as above in #2 spoon.	
15.0	18					
	20	4	1.85'	WT.-5-3-12 (8)	POORLY GRADED SAND (SP), medium gray (N5), wet, medium density; Medium to coarse, quartz sand with trace opaques and feldspars, some angular grains.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2C-MW14 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Behind Bldg 306

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 3-1-94 **FINISH** 3-1-94 **LOGGER** D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 8-21' Bentonite = 5-8' Grout Seal = 0-5' Flush Mount
	3					
	5	1	1.9'	3-3-4-4 (7)	0-0.9' SILTY SAND (SM), dark yellow. brown (10YR4/2) to moderate brown (5YR3/4), dry, soft; medium quartz sands with 25% silt. 0.9-1.9' SILT (ML), dusky yellowish brown (10YR2/2), dry, soft; elastic, clay = 10%.	
5.0						
	8					
	10	2	1.0'	2-5-5-5 (10)	POORLY GRADED SAND (SP), medium light gray (N6), wet, loose; medium, rounded, quartz sand. Top of sample is moderate yellow (5Y7/6).	
10.0						
	13					
	15	3	0.5'	WT. of Rod/24" (--)	POORLY GRADED SAND (SP), same as above, but fine to medium sand with trace gravel.	Cuttings at surface very runny, and most of sample lost when pulling out of borehole. Rod sank 2' from 13-15' without weight of hammer.
15.0						
	18					
	20	4	1.5'	3-7-11-13 (18)	POORLY GRADED SAND (SP), same as above in samples 2 and 3.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2C-MW15 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS LOCATION North side of Bldg. 520

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ START 2-28-94 FINISH 2-28-94 LOGGER D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 8-20' Bentonite = 6-8' Grout Seal = 0-6' Flush Mount
	3					
	5	1	1.0'	5-4-5-5 (9)	0-0.3' SILT (ML), grayish brown (5YR3/2), dry, firm; trace sand and organic. 0.3-0.7' SILT with SAND (ML), dark yellowish brown (10YR4/2), dry, firm; fine to medium sand = 10%, irregularly shaped mottles throughout, light brown (5YR5/6).	
5.0						
	8					
	10	2	1.4'	3-2-2-2 (4)	POORLY GRADED SAND (SP), medium dark gray (N4), wet, loose; medium, well-rounded, quartz sand with <5% silt.	
10.0						
	13					
	15	3	1.8'	4-7-5-6 (12)	WELL GRADED SAND (SW), medium light gray (N6), wet, loose; fine to coarse quartz sand with trace feldspars, well-rounded. Trace gravel.	Foam on outside of spoon.
15.0						
	18					
	20	4	1.6'	8-8-17-16 (25)	WELL GRADED SAND (SW), same as above, but silt <5%, same color.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2C-MW16 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS LOCATION In front of Bldg.423

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ START 2-25-94 FINISH 2-25-94 LOGGER D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 8-21' Bentonite = 5-8' Grout Seal = 0-5' Flush Mount
	5	1	2.0'	2-3-3-5 (6)	SILT with SAND and CLAY (ML), dark yellow. brown (10YR4/2), moist, soft; fine to medium sand <10%, clay = 30%, threads thin.	
5.0	8					
	10	2	1.0'	WT-2-2 (--)	POORLY GRADED SAND with SILT (SP-SM), medium dark gray (N4), wet, loose; fine, well-rounded quartz sand with 20% silt, trace mica.	
10.0	13					
	15	3	1.7'	3-1-2-2 (3)	WELL GRADED SAND (SW), medium light gray (N6), wet, loose; fine to coarse quartz sand with trace feldspar and gravel, moderately rounded.	
15.0	18					
	20	4	1.8'	3-4-5-3 (9)	POORLY GRADED SAND (SP), medium gray (N5) to medium light gray (N6), wet, loose; fine to medium sand, with fewer coarse grains than above.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2C-MW17 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** In parking lot, Bldg 520

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 3-1-94 **FINISH** 3-3-94 **LOGGER** D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 8-20' Bentonite = 6-8' Grout Seal = 0-6' Flush Mount
	5	1	1.0'	3-2-2-2 (4)	ELASTIC SILT (MH), dusky brown (5YR2/2), moist, soft; clay:silt is 50:50. Sample threads thin, no sand except some medium sand at top of spoon that was fill under asphalt.	
6.0	8					
	10	2	1.0'	WT. of Ham./24" (--)	SILTY SAND (SM), medium dark gray (N4), wet, very soft; fine to medium sand = 65-70% and silt = 30-35%, sticky.	
10.0	13					
	15	3	1.7'	WT-5-5-7 (10)	POORLY GRADED SAND (SP), medium light gray (N6), wet, loose; fine to medium quartz sand with trace coarse grains and trace gravel.	
15.0	18					
	20	4	1.3'	3-2-4-2 (6)	POORLY GRADED SAND (SP), same as above but with a greater coarse sand content of 5-10%.	1 ppm in auger

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2C-MW18 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Behind Bldg 403

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 3-8-94 **FINISH** 3-8-94 **LOGGER** S.Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 19' Screen = 9-19' Sand Pack = 6-19' Bentonite = 4-6' Grout Seal = 0-6' Flush Mount
	5	1	1.4'	5-5-7-8 (12)	SANDY CLAY (CL), brownish gray (5YR4/1) with dark yellowish orange (10YR6/6) mottling at base; fine, quartz sand, some sections sandier than others.	
5.0	8					
	10	2	1.2'	3-2-1-3 (3)	POORLY GRADED SAND (SP), olive gray (5Y4/1), wet, very loose, well- sorted, subrounded, fine quartz sand.	
10.0	13					
	15	3	0.8'	WT-3-2-4 (5)	POORLY GRADED SAND (SP), same as above.	
15.0	18					
	20	4	1.5'	5-4-6-1 (10)	POORLY GRADED SAND (SP), same as above, some clay rip-up clasts elongated in horizontal direction.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.13	2C-MW19	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS **LOCATION** Site 2C Building 500

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Hollow-stem Auger Acker AD-2 rig

WATER LEVELS _____ **START** 5-9-94 **FINISH** 5-9-94 **LOGGER** M. Clasen

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 20' Screen = 9-19' Sand Pack = 7-20' Bentonite = 5-7' Grout Seal = 0-5' Flush Mount
	3					
	5	S-1	1.5'	4-6-5-7 (11)	3-4.5 SILTY SAND (SM), medium gray N-5, medium to coarse quartz, wet. 4.5-5 CLAYEY SILT (MC) medium gray N-5, stiff, plastic.	
5.0						
	8					
	10	S-2	1.8'	9-19-19-20 (38)	SAND (SP), medium gray, N-5, medium quartz, subrounded, trace silt, trace black mineral, wet.	
10.0						
	13					
	15	S-3	2.0'	4-6-6-4 (12)	SAND (SP), medium gray N-5, medium quartz, subrounded, trace coarse, trace black mineral, wet.	
15.0						
	18					
	20	S-4	2.0'	WT of rods	SAND (SP), medium gray N-5, medium quartz, subrounded, moderate sorted, trace black mineral, wet.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.13	2C-MW20 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA CMS LOCATION Site 2C Building 513

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Hollow-stem Auger Acker AD-2 rig

WATER LEVELS _____ START 5-10-94 FINISH 5-10-94 LOGGER M. Clasen

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 7-20' Bentonite = 5-7' Grout Seal = 0-5' Flush Mount
	3					
	5	S-1	1.5'	3-2-2-2 (4)	3-4.5' SAND (SP), light brown, medium to coarse quartz, trace silt. 4.5-5' CLAYEY SILT (SM), gray, soft, plastic, trace fine sand, damp.	
5.0						
	8					
	10	S-2	2.0'	4-7-9-8 (16)	8.9' CLAYEY SILT (SM), gray, soft, plastic, trace fine sand, damp. 9-10' SAND (SP), dark yellowish orange 10YR6/6, medium quartz, subrounded, well sorted, damp, bottom 2" gray.	
10.0						
	13					
	15	S-3	2.0'	10-10-9-10 (19)	SAND (SP), medium gray N-5, medium quartz, subrounded, moderate well sorted, trace phosphorite, wet, runny.	
15.0						
	18					
	20	S-4	0.0'	10-12-15-15 (27)	NO RECOVERY, drilled like wet runny sand as above.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2D-MW4 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI PHASE II LOCATION Near Line Shack 125

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ START 2-21-94 FINISH 2-21-94 LOGGER S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	3					Well Construction Summary Total Depth = 20' Screen = 8-20' Sand Pack = 2.7-20' Bentonite = 1-2.7' Grout = 0-1' Flush Mount
	5	1	1.9'	12-14-14-14 (28)	0-0.6' FILL 0.6-1.2' SILTY SAND (SM), olive gray (5Y3/2), dry, medium density, medium sand. 1.2-1.9' POORLY GRADED SAND (SP), olive gray (5Y3/2), moist, medium density, medium sand, like above but with very little silt.	
5.0	8					
	10	2	2.0'	3-3-9-15 (12)	0-0.5' same as bottom of S1. 0.5-1.5', LEAN CLAY/SILT (CL/ML), yellowish gray (5Y7/2) to brownish gray (5Y4/1) to dark yellowish orange (10YR6/6), moist, firm. 1.5-2.0' same as bottom of S1.	
10.0	13					
	15	3	2.0'	4-3-3-5 (6)	Same as bottom of S2, but clam shell fragments, with some very fine gravel.	
15.0	18					
	20	4	2.0'	5-5-6-8 (11)	Same as S3, but no shells, cleaner, well-sorted, medium beach sand.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2D-MW5 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Near Line Shack 125

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 2-22-94 **FINISH** 2-22-94 **LOGGER** A.Lloyd

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
0	3				FILL: Construction fill under asphalt consisting of sand-gravel-silt.	
	5	1	1.4	4-2-3-4 (5)	0-0.3 SILT with SAND (SW-SM), olive gray (5Y4/1), moist, soft; some gravel, possibly fill. 0.3-0.6 POORLY GRADED SAND (SP), yellowish gray (5Y7/2), moist, soft: medium, quartz sand. 0.6-1.4 SANDY SILT (SM), olive gray (5Y4/1), moist to wet, soft, slightly mottled.	Well Construction Summary Total Depth = 20' Screen = 10-20' Sand Pack = 5-20' Bentonite = 2-5' Grout Seal = 0-2' Flush Mount
5.0	8					
	10	2	1.6	4-7-8-11 (15)	POORLY GRADED SAND (SP), dusky yellow (5Y6/1) and medium light gray (N6), wet, soft to medium density; medium, quartz sand with trace silt and opaques.	
10.0	13					
	15	3	1.9	WT./18"-5 (--)	POORLY GRADED SAND (SP), same as above in spoon #2 except all medium gray (N5).	
15.0	18					
	20	4	1.3	WT./12"-5-6 (--)	POORLY GRADED SAND (SP), same as above except there is a 1" thick silt layer at 0.7'.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW4 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI PHASE II **LOCATION** Behind Line Shack 109

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 2-22-94 **FINISH** 2-22-94 **LOGGER** S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 4.5-19.5' Sand Pack = 2-20' Bentonite = 1-2' Flush Mount
	5	1	1.4'	2-2-3-3 (5)	FILL, loose, med-coarse beach sand with strong fuel odor 0-1.4' SILT w/ SAND (ML), olive gray (5Y3/2), slightly moist, soft to firm; wood fragments, very fine sand, slight to no fuel odor. Driller notes few inches of sand fill under asphalt.	Cutting to 29 ppm OVM
5.0	8					
	10	2	1.5'	4-4-5-7 (9)	POORLY-GRADED SAND (SP), greenish gray (5GY6/1), moist to wet, loose; well rounded, fine to medium sand, fuel odor, 17 ppm in spoon.	Borehole = 1.1 ppm, Cuttings to 57 ppm
10.0	13					
	15	3	2.0'	2-1-2-3 (3)	POORLY-GRADED SAND (SP), light olive gray (5Y6/1), wet, very loose; medium beach sand, fuel odor and sheen.	
15.0	18					
	20	4	2.0'	1-3-2-10 (5)	Same as above in SS3.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW5 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI PHASE II LOCATION Between Bldgs 109 and 110

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ START 2-23-94 FINISH 2-23-94 LOGGER D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	1		1.0'		0-1.0' Concrete, cored by Holes, Inc.	Well Construction Summary Total Depth = 20' Screen = 4-19' Sand Pack = 2-20' Bentonite = 1-2' Flush Mount
	3					
	5	1	1.5'	1-1-2-3 (3)	0-0.4' FILL, dark yellowish orange (10YR6/6), moist; loose; med. sand. 0.4-1.5' SILT with SAND (ML), dusky brown (5YR2/2), moist, soft; fine to very fine sand is <3% to trace.	
6.0	8					
	10	2	1.8'	WT/12"-6-5 (--)	0-0.8' POORLY GRADED SAND with SILT (SP-SM), mod. brown (5YR3/4), wet, very soft; silt = 30% with 1 cm. clay balls, fine sand. 0.8-1.8' POORLY GRADED SAND with SILT (SP-SM), medium gray (N5), wet, loose; fine to med. quartz sand with <10% silt. Noticeably cleaner sand than top of spoon.	
10.0	13					
	15	3	1.5'	WT/12"-3-3 (--)	POORLY GRADED SAND with SILT (SP-SM), same as above in bottom of SS2 except less silt and trace gravel.	
15.0	18					
	20	4	1.8'	2-2-3-5 (8)	WELL GRADED SAND (SW), medium light gray (N6), wet, loose; quartz sand ranges from very fine to coarse with trace gravel. Trace biotite and feldspar.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW6 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI PHASE II **LOCATION** Beside Building 110

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 2-22-94 **FINISH** 2-23-94 **LOGGER** D.Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 4-19' Sand Pack = 2-20' Bentonite = 1-2' Flush Mount
	5	1	1.5'	2-1-1-1 (2)	SILT with SAND (ML), dusky yellowish brown (10YR2/2), dry, very soft; fine sand = 15%, bottom of spoon is wet, slight odor and black stains.	
6.0	8					
	10	2	1.2'	1-1-5-5 (6)	0=0.6' (ML) same as above except olive gray (5Y4/1), moist. 0.6-1.2' POORLY GRADED SAND with SILT (SP-SM), olive gray (5Y4/1), wet, soft consistency; very fine to fine quartz sand, trace mica.	
10.0	13					
	15	3	1.3'	Wt/18"-5 (-)	0-0.9' SILTY SAND (SM), olive gray (5Y4/1), wet, very soft; silt=40%, very fine to fine sand=60%. 0.9-1.3' POORLY GRADED SAND (SP), olive gray (5Y4/1), wet, loose; medium to coarse sand with trace gravel.	
15.0	18					
	20	4	1.4'	H.WT-2-3-5 (5)	POORLY GRADED SAND (SP), same as above except sample grades into finer sand at bottom. Bottom sand is medium gray (N5), wet and loose.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW7 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION NW of Bldg 23

ELEVATION _____ DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ START 3-12-94 FINISH 3-12-94 LOGGER S.Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						Well Construction Summary Total Depth = 18' Screen = 3-18' Sand Pack = 2-18' Bentonite = 1-2' Flush Mount
	3					
	5	1	2.0'	5-2-3-3 (5)	FILL, sand and clay layers, pale yellowish brown (10YR6/2) and brownish black (5YR2/1), moist, soft; med, subrounded to subangular, quartz sand. Clay layers are 0.05' thick with roots and wood frags.	1 ppm in auger 40 ppm in spoon
5.0						
	8					
	10	2	1.0'	1-4-3-5 (7)	SAND with SANDY CLAY and CLAY LAMINAE, color grades from dark yellow. orange (10YR6/6) to intermediate gray (N4), saturated, soft; med. quartz sand, subrounded to subangular, moderately sorted. Clayey laminae are 0.05' thick.	
10.0						
	13					
	15	3	1.7'	3-1-1-1 (2)	SANDY CLAY to CLAYEY SAND, brownish gray (5YR4/1) to medium gray (N5), wet, soft, SANDY CLAY is massive, sharp lower contact is between the SANDY CLAY and CLAYEY SAND, predominates (1.5'of spoon), sand: clay is 8:2. Fine, quartz sand, subrounded to subangular soft, almost liquid	
15.0						
	18					
	20	4	2.0'	3-5-7-11 (12)	POORLY GRADED SAND (SP), light olive gray (5Y6/1), wet, loose; fine, quartz sand, subrounded to subangular, well-sorted, clean sand.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW8 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** In front of Bldg 109

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 Rig with 6" HSA

WATER LEVELS _____ **START** 3-7-94 **FINISH** 3-7-94 **LOGGER** S.Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 20' Screen = 3-18' Sand Pack = 2-20' Bentonite = 1-2' Flush Mount
	5	1	1.8'	1-2-3-3 (5)	0-0.6' SILTY CLAYEY SAND (SM), olive gray (5YR4/1), moist, medium grained, WELL GRADED QUARTZ SAND, some brown staining on bottom 0.1'. 0.6-1.3' POORLY GRADED SAND (SP), moderate yellowish brown (10YR4/5), wet, subrounded to subangular, medium quartz sand, some brown staining on bottom of spoon. 1.3-1.8' CLAY (CL), brownish gray (5YR4/1), wood fragment in top 0.1'.	
5.0	8					
	10	2	2.0'	3-3-5-6 (8)	POORLY GRADED SAND (SP), light brownish gray (5YR6/1), wet, very soft; subrounded to subangular, fine quartz sand, some fuel odor.	
10.0	13					
	15	3	2.0'	WT-WT-WT-3 (--)	POORLY GRADED SAND (SP), same as above except slightly clayey in sections, some fuel odor in borehole.	
15.0	18					
	20	4	--	2-2-6-14 (8)	POORLY GRADED SAND (SP), light brownish gray (5Y6/1), wet; fine to medium quartz sand, subrounded to subangular, moderately sorted.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	2E-MW9	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION Near SWMU 18

ELEVATION 20.74 ft. DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6 1/4" ID

WATER LEVELS START 9-21-94 FINISH 9-21-94 LOGGER D. Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	3					Well Construction Summary Total Depth = 18.5' Screen = 3.5-18.5' Sand Pack = 2-18.5' Bentonite = 0.5-2' Grout = 0-0.5' Flush mount
	5	SS-1	0.2'	2-2-2-2 (4)	SILTY SAND (SM), dark yellowish brown (10YR4/2), dry, firm. Fine quartz sand = 70%, Silt = 30%. Poor recovery.	
5.0	8					
	10	SS-2	2.0'	6-5-4-4 (9)	0-1.3' FAT CLAY (CH), medium bluish gray (5B5/1), wet, stiff. Grades into a sand below. 1.3'-2.0' WELL-GRADED SAND WITH SILT (SW), medium light gray (N5) loose, wet, very fine to med. quartz sand.	
10.0	13					
	15	SS-3	0.7'	2-3-4-7 (7)	WELL-GRADED SAND WITH SILT (SW-SM), medium light gray (N6) to medium gray (N5), loose, wet. Very fine to med. quartz sand w/ 5% coarse. Moderately coarse.	
15.0	18					
	20	SS-4	1.7'	3-5-4-8 (9)	WELL-GRADED SAND (SW), Same as SS-3, but slightly greater percentage of coarse quartz sand (15%).	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	2E-MW10	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** South side of Air Ops building in grass

ELEVATION 20.74 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 with 6 5/8" HSA

WATER LEVELS **START** 9-22-94 **FINISH** 9-22-94 **LOGGER** D. Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	3					Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush mount
	5	SS-1	1.2'	3-2-2-3 (4)	SILT WITH TRACE SAND (ML), dusky yellow brown (10 YR 2/2), moist, soft, fine sand <5%, trace clayey material.	
5.0	8					
	10	SS-2	1.3'	2-4-4-6 (8)	0-0.7' SILTY SAND (SM), light gray (N7) with brownish gray (5 YR 4/1) streaks and 1" balls, wet, soft. Silt = 35%, sand = 65%, but in balls ratio is silt = 70%, sand = 30%. 0.7'-1.3' POORLY-GRADED SAND WITH SILT (SP-SM), light gray (N7), wet, soft. Silt = 10% fine to very fine quartz sand.	
10.0	13					
	15	SS-3	1.7'	1-1-1-2 (2)	POORLY-GRADED SAND WITH SILT (SP-SM), medium dark gray (N4), wet, soft. Fine to very fine quartz sand. Silt content is 20% more than above.	
15.0	18					
	20	SS-4	1.4'	5-6-12-14 (18)	WELL-GRADED SAND (SW), light gray (N7), wet, medium desity. Very fine to coarse quartz sand. Moderately rounded, trace gravel.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW11 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** West of Hanger 23

ELEVATION 21.64 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37 With 6" ID HSA

WATER LEVELS **START** 9-26-94 **FINISH** 9-26-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
					SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush Mount
	3					
	5	SS-1	1.0'	2-2-2-3 (4)	0-0.2' POORLY-GRADED SAND (SP), moderate yellow-brown (10 YR 5/4), moist, very loose density, grains range from fine to medium quartz sand, <5% silt. 0.2'-1.0' LEAN CLAY WITH SILT (CL), brownish-gray (5 YR 4/1), moist, soft to very soft consistency, highly plastic, <10% silt.	
5.0						
	8					
	10	SS-2	2.0'	2-2-5-7 (7)	0-1.1' LEAN CLAY WITH SILT (CL), brownish-gray (5 YR 4/1), moist, soft to very soft consistency, highly plastic, <10% silt. 1.1'-2.0' WELL-GRADED SAND (SW), medium gray (N5), wet, loose density, well graded sand, fine-coarse quartz sand.	
10.0						
	13					
	15	SS-3	1.4'	2-4-2-3 (6)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), wet, loose, well graded, fine to very coarse quartz sand, some gravel.	
15.0						
	18					
	20	SS-4	2.0'	10-20-22-25 (42)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), wet, loose, fine to very coarse quartz sand, some gravel.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW12 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** On ramp between Hanger 23 & Building 200

ELEVATION 20.60 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37

WATER LEVELS **START** 9-23-94 **FINISH** 9-23-94 **LOGGER** D. Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	3					Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush mount
	5	SS-1	2.0'	3-5-6-7 (11)	0-0.7' SANDY SILT (ML), dark yellowish brown (10YR4/2), dry, firm. Medium quartz sand = 35%. 0.7'-2.0' SANDY SILT (ML), dusky yellowish brown (10YR2/2) with light brownish gray (5YR6/1) to medium gray (N5). Mottled throughout ranging in size from 1" to 3". Irregular, dry, firm. The interbedded sand mottles have 10% silt but dark yellowish brown is 90% silt.	
5.0	8					
	10	SS-2	1.0'	1-1-1-2 (2)	SILTY SAND (SM), medium light gray (N6), wet, soft. Fine to medium quartz sand.	
10.0	13					
	15	SS-3	1.0'	1-2-4-6 (6)	WELL-GRADED SAND WITH SILT (SW-SM), medium dark gray (N4), wet, loose. Fine to coarse quartz sand. Moderately well-rounded.	
15.0	18					
	20	SS-4	1.0'	2-2-3-6 (5)	WELL-GRADED SAND (SW), medium light gray (N6), wet, loose. Fine to coarse quartz sand.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	2E-MW13 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** 200 feet South of 2E-MW8

ELEVATION 20.35 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, 6 1/4" ID HSA

WATER LEVELS **START** 9-26-94 **FINISH** 9-26-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-3' Flush mount
	3					
	5	SS-1	1.9'	4-3-6-7 (9)	0-0.5' WELL-GRADED SAND (SW-SM), moderate yellowish brown (10 YR 5/4), moist, loose density, fill, fine to medium quartz with <25% silt and clay. 0.5'-1.1' SILT (ML), grayish black (N2), moist, very soft, black silt with some roots. 1.1-1.9' CLAY (CL), olive gray (5Y 4/1), moist, very soft, lean clay, fewer roots, plastic.	
5.0						
	8					
	10	SS-2	1.5'	2-4-6-6 (10)	POORLY-GRADED SAND (SP), medium gray (N5), wet, <10% silt, fine quartz sand.	
10.0						
	13					
	15	SS-3	1.5'	2-3-2-3 (5)	WELL-GRADED SAND (SW), medium gray (N5), wet, loose, fine to coarse quartz sand, <5% silt.	
15.0						
	18					
	20	SS-4	2.0'	6-6-8-20 (14)	WELL-GRADED SAND WITH GRAVEL (SW), medium light gray (N4), wet, medium, fine sand to gravel quartz, <5% silt.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW5 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15, Background Well

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Acker AD2 Rig with 6" HSA

WATER LEVELS _____ **START** 3-9-94 **FINISH** 3-9-94 **LOGGER** S.Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					
	5	1	0.8'	2-3-3-4 (6)	0-0.5' SILTY SANDY CLAY (ML-CL), grayish brown (5YR3/2), moist, soft, friable topsoil. 0.5-0.8' CLAY (CL), dark yellowish orange (10YR6/6), moist, soft, high plasticity; some mottling, pale yellowish brown (10YR6/2).	Well Construction Summary Total Depth = 18' Screen = 3-18' Sand Pack = 2-18' Bentonite = 1-2' Grout Seal = 0-1' Stick-up
5.0	8					
	10	2	1.5'	2-1-3-4 (4)	POORLY GRADED SAND (SP), light olive gray (5Y5/2) with dark yellowish orange (10YR6/6) and medium dark gray (N4), wet; medium-grain, quartz sand, subrounded to subangular, well-sorted, friable. Gray sand has trace clay clasts.	
10.0	13					
	15	3	2.0'	4-4-9-12 (13)	WELL GRADED SAND (SW), light olive gray (5Y6/1), wet, soft; friable, fine to coarse sand with coarse sand concentrated in several beds.	
15.0	18					
	20	4	--	7-9-18-20 (27)		

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW6 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 4-13-94 **FINISH** 4-13-94 **LOGGER** S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth of Drilling = 20' Screen = 3-18' Sand Pack = 2-18' Bentonite = 1-2' Pad fills 1' at center. Stick-up = 2.5'
	5	S1	1.8'	1-2-3-5 (5)	0-1':LEAN CLAY/SILT (CL/ML), grayish brown (5YR3/2), soft, moist; 1-1.8': SANDY SILT (ML), pinkish gray (5YR8/1) to pale yellowish orange (10YR8/6), soft, moist, sand is very fine.	
6.0	8					
	10	S2	1.2'	3-5-8-7 (13)	POORLY GRADED SAND (SP), medium light gray (N6), loose, wet, sand is medium, slight odor, possibly of fuel.	
10.0	13					
	15	S3	2.0'	8-8-10-8 (18)	POORLY GRADED SAND (SP), same as S2 but coarser sand, medium to coarse, slight odor of weathered fuel, OVM reads it as zero.	
15.0	18.5					
	20	S4	--	8-10-11 (21)	POORLY GRADED SAND (SP), same as S3 but fuel odor is stronger, odor has an edge of pesticides perhaps (?), 1 ppm OVM on sand with worst odor.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW7 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 4-12-94 **FINISH** 4-12-94 **LOGGER** S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						2nd Drilling Location Well Construction Summary Total Depth = 18' Screen = 3-18' Sand Pack = 2.3-18' Bentonite = 1-2.3' Grout Seal = 0-1' Stick-up = 2.5'
	3					
	5	SS1	1.2'	5-6-5-6 (11)	0-0.9' LEAN CLAY/SILT (CL/ML), grayish brown (5YR3/2), pale yellowish orange (10YR8/6), pinkish gray (5YR8/1) mottled color, firm, moist to wet; 0.9-1.2: POORLY GRADED SAND (SP), pinkish gray (5YR8/1), loose, dry to moist, sand is fine to medium.	Monitoring: OVM, explosimeter at background (BG), breathing zone (BZ) 7 ppm BH
5.0						
	8					
	10	SS2	1.6'	4-6-5-6 (11)	0-0.6' SILT (ML), same color as clay in SS1, moist, firm, sand is very fine; 0.6-1.6": POORLY GRADED SAND (SP), medium light gray (N6), loose, wet, slight odor but instruments at background.	1 ppm BH
10.0						
	13					
	15	SS3	1.4'	9-10-10-11 (20)	POORLY GRADED SAND (SP), same as bottom of SS2 but has distinct slight to moderate fuel odor, 2 ppm OVM on sample of sand in spoon.	2 ppm BH
15.0						
	16					
	18	SS4	1.2'	3-5-6-7 (11)	POORLY GRADED SAND (SP), light gray (N6), loose, wet, same as SS3 but sand is medium to coarse beach sand.	3 ppm BH 2 ppm on spoon

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW8 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 4-12-94 **FINISH** 4-12-94 **LOGGER** S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0						2nd drilling location Well Construction Summary Total Depth = 18' Screen = 3-18' Sand Pack = 2-18' Bentonite = 1-2' Pad fills 1' at center. Stick-up = 2.5'
	3					
	5	SS1	1.8'	2-3-5-7 (8)	0-0.6' LEAN CLAY/SILT (CL/ML), grayish brown (5YR3/2), 0.6-1.4': LEAN CLAY (CL) yellowish gray (5Y8/1) with orange mottled streaks, both clays moist, soft to firm; 1.4-1.8": POORLY GRADED SAND (SP), yellowish gray (5Y7/2), dry to moist, loose, sand is very fine to fine.	
5.0						
	8					
	10	SS2	0.6'	3-4-4-4 (8)	14 inches of clay/silt at top of spoon. 0-6": POORLY GRADED SAND (SP), medium light gray (N6), loose, wet, sand is fine to medium; beach sand.	Hole comes up wet at about 6 ft.
10.0						
	13					
	15	SS3	0.5'	4-5-7-9 (12)	POORLY GRADED SAND (SP), same as SS2, wet.	
15.0						
	16					
	18	SS4	1.0'	7-8-10-10 (18)	POORLY GRADED SAND (SP), same as SS3.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	15-MW9	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 3-10-94 **FINISH** 3-11-94 **LOGGER** S.Brand

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Total Depth = 18' Screen = 3-18' Sand Pack = 2-18.5' Bentonite = 1-2' Grout Seal = 0-1' Stick-up
	5	1	1.5'	5-6-7-50/1" (13)	0-0.7' SANDY CLAYEY SILT (ML-CL), dark yellowish brown (10YR4/2), moist, soft, organic material and organisms. 0.7-1.5' POORLY GRADED SAND (SP), moderate yellowish brown, wet, soft; fine to medium quartz sand, subrounded to subangular, clay clasts.	
5.0	8					
	10	2	1.5'	5-5-7-9 (12)	0-1.0' CLAY (CL), dark yellowish brown (10YR4/2), wet, soft. 1.0-1.5' POORLY GRADED SAND (SP), olive gray (5Y4/1), wet; subrounded to subangular, medium quartz sand with some clay clasts.	5 ppm in auger 100 ppm in auger, 3-4 ppm BZ Had to upgrade to Level "C", strong pesticide smell.
10.0	13					
	15	3	2.0'	5-5-5-7 (10)	WELL GRADED SAND (SW), light olive gray (5Y6/1), wet, soft; fine to very coarse quartz sand, subrounded to subangular, moderately sorted, clean w/ some rock frags, some granule sized clasts concentrated in several 0.5" thick beds.	100 ppm in auger
15.0	18					
	20	4	--	7-7-9-12 (16)	WELL GRADED SAND (SW), light olive gray (5Y6/1), wet, soft; fine to very coarse quartz sand same as above with one 2-4 mm laminae of clay in ea. of 3 fine zones.	Negative Vinyl Chloride, Benzene as read on drueger tubes. 50-100 ppm in auger

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW10 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15

ELEVATION _____ **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT ATV Rig with 6" ID HSA

WATER LEVELS _____ **START** 4-13-94 **FINISH** 4-13-94 **LOGGER** S.Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0	3					Well Construction Summary Sampling to = 20' Screen = 3-18' Sand Pack = 2.1-18' Bentonite = 10"-2.1' Pad fills 10" at center. Stick-up = 2.5'
	5	SS1	1.8'	4-6-7-9 (13)	0-1.2': LEAN CLAY/SILT (CL/ML), mottled grayish brown (5YR3/2), pinkish gray (5YR8/1) and pale yellowish orange (10YR8/6), fine, moist; 1.2-1.8': SANDY SILT (ML), grayish orange, dry, firm to stiff.	
5.0	8					
	10	SS2	1.6'	4-4-3-3 (7)	POORLY GRADED SAND (SP), medium light gray (N6), wet, loose, sand is medium.	
10.0	13					
	15	SS3	2.0'	9-10-20-45 (30)	POORLY GRADED SAND (SP), same as SS2 but stiffer - No odor.	
15.0	18					
	20	SS4	2.0'	8-15-28-38 (43)	POORLY GRADED SAND (SP), same as SS3. No odor.	

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	15-MW11	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II LOCATION Site 15, East of 15-MW7

ELEVATION 19.16 ft. DRILLING CONTRACTOR Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, 6 1/4" ID HSA

WATER LEVELS START 9-28-94 FINISH 9-28-94 LOGGER R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout Seal = 0-1' Stick Up Well
	3					
	5	SS-1	1.9'	3-2-2-4 (4)	0-0.7' LEAN CLAY (CL), pale yellowish brown (10 YR 6/2), moist, soft, plastic, gradational. 0.7'-1.6' LEAN CLAY (CL), pale yellowish brown (10 YR 6/2), moist, soft, orange mottling, semi-plastic. 1.6-1.9' WELL-GRADED SAND (SW), light gray (N7), moist, very loose, <20% silt, fine to medium quartz sand.	
5.0						
	8					
	10	SS-2	1.3'	2-3-3-3 (6)	WELL-GRADED SAND (SW), medium gray (N5), wet, loose, fine to very coarse quartz sand, <5% silt.	
10.0						
	13					
	15	SS-3	2.0'	8-13-18-19 (31)	POORLY-GRADED SAND (SP), medium gray (N5), moist, dense, fine to coarse sand, mainly medium quartz sand, well rounded.	
15.0						
	18					
	20	SS-4	1.8'	5-6-1-11 (20)	0-0.7' WELL-GRADED SAND WITH GRAVEL (SW) medium light gray (N6), wet, medium, fine to very coarse quartz sand, <10% gravel. 0.7'-1.8' POORLY-GRADED SAND (SP), medium gray (N5), moist, dense, fine to medium quartz sand.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
MAE20368.M0.11	15-MW12	SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15, East of 15-MW8

ELEVATION 19.16 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6 1/4" ID

WATER LEVELS **START** 9-27-94 **FINISH** 9-27-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout Seal = 0-1' Stick Up Well
	3					
	5	SS-1	1.4'	4-3-4-6 (7)	0-0.8' SILT WITH SAND (ML), grayish brown (5 YR 3/2), dry, firm. 0.8'-1.4' SILT WITH SAND (ML), medium light gray (N6), moist, firm, orange mottling, <25% sand.	
5.0						
	8					
	10	SS-2	1.5'	3-5-6-4 (11)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), moist, medium, very fine sand to gravel, mainly quartz.	
10.0						
	13					
	15	SS-3	2.0'	10-11-10-8 (21)	WELL-GRADED SAND (SW), medium gray (N5), wet, medium, very fine sand to gravel, gravel interspersed.	
15.0						
	18					
	20	SS-4	1.8'	17-28-46-x (74)	WELL-GRADED SAND (SW), medium gray (N5), wet, medium, very fine sand to gravel, gravel interspersed.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW13 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15, North of 15-GP20

ELEVATION 18.60 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6 1/4" ID

WATER LEVELS **START** 9-28-94 **FINISH** 9-28-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout Seal = 0-1' Stick Up Well
	3					
	5	SS-1	1.6'	4-6-9-13 (15)	0-0.9' SILT WITH SAND (ML), yellowish gray (5 Y 8/1), moist, stiff, some mottling, fine quartz sand <25%, some clay, plastic (slightly). 0.9'-1.1' POORLY-GRADED SAND (SP), very light gray (N8), moist, medium density, very fine to fine quartz sand, well rounded, well sorted clean contacts - upper and lower very distinct layer. 1.1'-1.6' SILT WITH SAND (ML), pale yellowish-brown (10 YR 6/1), moist, stiff, some orangish mottling, fine quartz sand <25%.	
6.0						
	8					
	10	SS-2	1.7'	3-3-2-5 (5)	0-0.3' LEAN CLAY (CL), pale yellowish-brown (10 YR 6/2), moist, firm, plastic, <5% sand. 0.3'-1.7' POORLY-GRADED SAND (SP), medium gray (N5), wet, loose, fine to medium quartz sand, well rounded, <15% silt.	
10.0						
	13					
	15	SS-3	1.8'	8-13-17-18 (30)	0-0.9' WELL GRADED SAND WITH GRAVEL (SW), medium light gray (N4), moist, medium, fine to very coarse quartz sand, <10% gravel. 0.9'-1.8' POORLY-GRADED SAND (SP), medium gray (N5), moist, medium, fine to medium quartz sand, <5% silt.	
15.0						
	18					
	20	SS-4	1.7'	3-3-4-9 (7)	POORLY-GRADED SAND (SP), light gray (N7), moist, loose, fine to medium quartz sand, <5% silt.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW14 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Site 15, West of 15-GP20

ELEVATION 19.37 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Acker AD-2, HSA 6 1/4" ID

WATER LEVELS **START** 9-27-94 **FINISH** 9-27-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout Seal = 0-1' Stick Up Well
	3					
	5	SS-1	2.0'	5-3-5-3 (8)	0-0.7' SILT (ML), moderate yellowish-brown (10 YR 5/4), dry, firm consistency, soil zone with roots. 0.7'-1.2' LEAN CLAY (CL), light gray (N7) with pale yellowish orange mottling, moist, firm, some roots. 1.2'-2.0' SILT WITH SAND (ML), light gray (N7), moist, firm, very fine sand, equal silt and clay.	
5.0						
	8					
	10	SS-2	1.5'	3-4-4-2 (8)	0-0.2' SILT WITH SAND (ML), light gray (N7), moist, firm, very fine sand, equal silt and clay. 0.2'-1.5' POORLY-GRADED SAND (SP), medium light gray (N6), wet, loose, fine to medium quartz sand.	
10.0						
	13					
	15	SS-3	1.4'	2-5-7-11 (12)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), wet, medium density, very fine sand to gravel quartz, <5% silt.	
15.0						
	18					
	20	SS-4	2.0'	5-7-13-17 (20)	WELL-GRADED SAND (SW), light gray (N7), wet, medium density, very fine to coarse sand, <%5 silt.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	15-MW15 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** South of 15-MW5, near road

ELEVATION 18.8 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Acker AD-2, HSA 6 1/4" ID

WATER LEVELS **START** 9-27-94 **FINISH** 9-27-94 **LOGGER** R. Doucette

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout Seal = 0-1' Stick Up Well
	3					
	5	SS-1	2.0'	2-1-2-4 (3)	0-0.8' SILT WITH SAND (ML), grayish brown (5 YR 3/2), moist, soft consistency, roots, density inc. with depth. 0.8'-1.6' CLAY WITH SAND (CL), light gray (N7) with pale yellowish orange mottling, moist, soft consistency, some roots <20% sand. 1.6'-2.0' POORLY-GRADED SAND (SP), medium gray (N5), moist, loose, fine grain quartz sand with <20% fines.	
5.0						
	8					
	10	SS-2	1.6'	4-3-4-3 (7)	0-0.4' CLAY (CL), dusky brown (5 YR 2/2), moist, firm, dense clay. 0.4'-1.6' WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), moist, loose, fine grained sand to gravel quartz, <10% fines.	
10.0						
	13					
	15	SS-3	1.6'	3-5-11-16 (16)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), moist, loose, fine grained sand to gravel quartz, <10% fines.	
15.0						
	18					
	20	SS-4	2.0'	3-5-6-13 (11)	WELL-GRADED SAND WITH GRAVEL (SW), medium gray (N5), moist, medium density, fewer gravel, more fine sand ~50%.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW1 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Next to slab, near center of site

ELEVATION 17.34 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, 6 1/4" ID HSA

WATER LEVELS **START** 9-20-94 **FINISH** 9-20-94 **LOGGER** S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush Mount
	3					
	5	SS-1	2.0'	2-1-2-6 (3)	0-1.2' SILT (ML), brownish gray (5 YR 4/1), dry, soft; 1.2-2.0: SILTY SAND/SANDY SILT (SM/ML), same color, soft, dry	
5.0						
	8					
	10	SS-2	1.0'	3-4-3-3 (7)	POORLY-GRADED SAND (SP), olive gray (5 Y 5/1), wet, loose. Fuel odor is very slight, OVM does not detect.	
10.0						
	13					
	15	SS-3	1.0'	2-2-1-2 (3)	POORLY-GRADED SAND (SP), olive gray (5 Y 5/1), wet, very loose, no fuel odor.	
15.0						
	18					
	20	SS-4	0.8'	1-1-3-3 (4)	POORLY-GRADED SAND (SP), olive gray (5 Y 5/1), wet, very loose. Some (10") silty sand in spoon but this is judged to be runup or out-of-place sediments.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW2 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Near telephone pole, SE corner of fence

ELEVATION 18.76 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6" ID

WATER LEVELS **START** 9-19-94 **FINISH** 9-19-94 **LOGGER** S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 2-3' Grout = 1-2' Stick up well
	3					
	5	SS-1	2.0'	2-1-3-4 (4)	0-1.4' COARSE SILT (ML), olive gray (5 Y 4/1), dry, soft; 1.4-2.0': POORLY-GRADED SAND WITH TRACE SILT (SP-SM), yellowish gray (5 Y 7/2), dry, very loose.	
5.0	7	SS-2	1.3'	1-1-4-8 (5)	0-0.4' POORLY-GRADED SAND (SP), same as bottom of SS-1; 0.4-1.3' POORLY-GRADED SAND (SP), pinkish gray (5 YR 8/1), dry, loose, pure medium beach sand, almost white. No odor.	
	8					
	10	SS-3	1.6'	2-2-4-5 (6)	POORLY-GRADED SAND (SP), medium light gray (N6), wet, very loose to loose. Same as bottom of SS-2 but wet, darker.	
10.0	13					
	15	SS-4	1.4'	2-2-2-1 (4)	POORLY-GRADED SAND (SP), medium gray (N5), wet, very loose.	
15.0	18					
	20	SS-5	2.0'	2-1-1-2 (2)	0-1.0' POORLY-GRADED SAND (SP), same as SS-4; 1.0-1.2' SILT (ML), brownish gray (5 YR 4/1), moist, soft. 1.2-2.0' POORLY-GRADED SAND (SP), same as SS-4.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW3 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** 20 ft southwest of playground sub tower

ELEVATION 16.06 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6" ID

WATER LEVELS **START** 9-20-94 **FINISH** 9-20-94 **LOGGER** S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush Mount
	3					
	5	SS-1	2.0'	5-9-9-12 (18)	POORLY-GRADED SAND (SP), grayish yellow (5 Y 8/4), dry, stiff to very stiff. Unusual surficial lithology. May be fill.	
6.0	7	SS-2	1.6'	5-8-9-9 (17)	POORLY-GRADED SAND (SP), dusky yellow (5 Y 6/4), wet, very stiff, sand is fine to medium.	
	8					
	10	SS-3	2.0'	2-4-6-9 (10)	POORLY-GRADED SAND (SP), olive gray (5 Y 4/1), wet, stiff, sand is medium.	
10.0	13					
	15	SS-4	1.5'	1-1-2-2 (3)	POORLY-GRADED SAND (SP), same as SS-3 but soft.	
15.0	18					
	20	SS-5	1.0'	8-15-8-2 (23)	POORLY-GRADED SAND (SP), same as SS-3 but blow counts are questionable because sample was collected through 1 foot of runup.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW4 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** 15 ft north of 24-GP18, East-central

ELEVATION 17.37 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6" ID

WATER LEVELS **START** 9-20-94 **FINISH** 9-20-94 **LOGGER** S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush Mount
	3					
	5	SS-1	1.8'	2-2-2-2 (4)	SILT AND SANDY SILT (ML), olive gray (5 Y 4/1), dry, soft.	
5.0						
	8					
	10	SS-3	1.2'	3-4-5-5 (9)	POORLY-GRADED SAND (SP), medium gray (N5), wet, loose, sand is medium.	
10.0						
	13					
	15	SS-4	2.0'	2-3-2-4 (5)	POORLY-GRADED SAND (SP), olive gray (5 Y 5/1), wet, loose, sand is medium.	
15.0						
	18					
	20	SS-5	2.0'	3-4-7-4 (11)	POORLY-GRADED SAND (SP), (with trace silt in zones), same as SS-3.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW5 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** Western end of SEABEE Compound

ELEVATION 17.14 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6" ID

WATER LEVELS **START** 9-21-94 **FINISH** 9-21-94 **LOGGER** S. Brown

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0						Well Construction Summary Total Depth = 20' Screen = 5-20' Sand Pack = 3-20' Bentonite = 1-3' Grout = 0-1' Flush Mount
	3					
	5	SS-1	1.0'	3-3-8-12 (11)	POORLY-GRADED SAND (SP), yellowish gray (5 Y 7/2), dry, medium density, sand is fine and appears natural.	
5.0						
	8					
	10	SS-3	1.3'	2-3-3-3 (6)	POORLY-GRADED SAND (SP), olive gray (5 Y 4/1), wet, loose, sand is medium.	
10.0						
	13					
	15	SS-4	2.0'	4-5-6-6 (11)	POORLY-GRADED SAND (SP), medium light gray (N6), wet, medium density.	
15.0						
	18					
	20	SS-5	1.8'	3-3-2-1 (5)	POORLY-GRADED SAND (SP), medium light gray (N6), wet, loose.	
20.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER
MAE20368.M0.11	24-MW6 SHEET 1 OF 1

SOIL BORING LOG

PROJECT OCEANA RFI Phase II **LOCATION** North-central SEABEE Compound

ELEVATION 17.79 ft. **DRILLING CONTRACTOR** Rock-Ray Drilling, Inc.

DRILLING METHOD AND EQUIPMENT Mobile B-37, HSA 6" ID

WATER LEVELS **START** 9-21-94 **FINISH** 9-21-94 **LOGGER** D. Braccia

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.0	3					Well Construction Summary Total Depth = 19' Screen = 4-19' Sand Pack = 2.5-19' Bentonite = 1-2.5' Grout = 0-1' Riser = 0-4' Flush Mount
	5	SS-1	2.0'	2-1-2-3 (3)	0-1.8' SILT WITH SOME CLAY (ML), dusky yellow brown (10 YR 2/2), dry, soft, non-elastic, silt ~80%, clay ~20%. 1.8'-2.0' SILTY SAND (SM), dusky yellow brown (10 YR 2/2) to dark yellowish orange (10 YR 6/6), dry, soft, medium to fine quartz grains with 30% silt.	
5.0	8					
	10	SS-3	1.5'	5-7-8-10 (15)	WELL-GRADED SAND (SW), medium gray (N5), wet, loose. Trace silt. Very fine to fine quartz sand. Moderately rounded.	
10.0	13					
	15	SS-4	1.2'	4-3-6-7 (9)	WELL-GRADED SAND (SW), medium light gray (N6), to medium gray (N5), wet, loose. Quartz sand, very fine to medium trace quartz. No silt. Water drains from spoon.	
15.0	18					
	20	SS-5	2.0'	1-1-3-3 (4)	0-1.6' Same as above, then bottom 0.4' of spoon is silty. 1.6-2.0' SILT (ML), medium dark gray (N4), wet, sticky and very soft, mushy. Silt = 95%, Sand = ~5%. Possible silt lense.	
20.0						

CH2M HILL

PROJECT NO.	TEST PIT NO.	
MAE2Ø368.MØ.DR	15-TP1A & 1B	SHEET 1 OF 1

TEST PIT WALL LOG

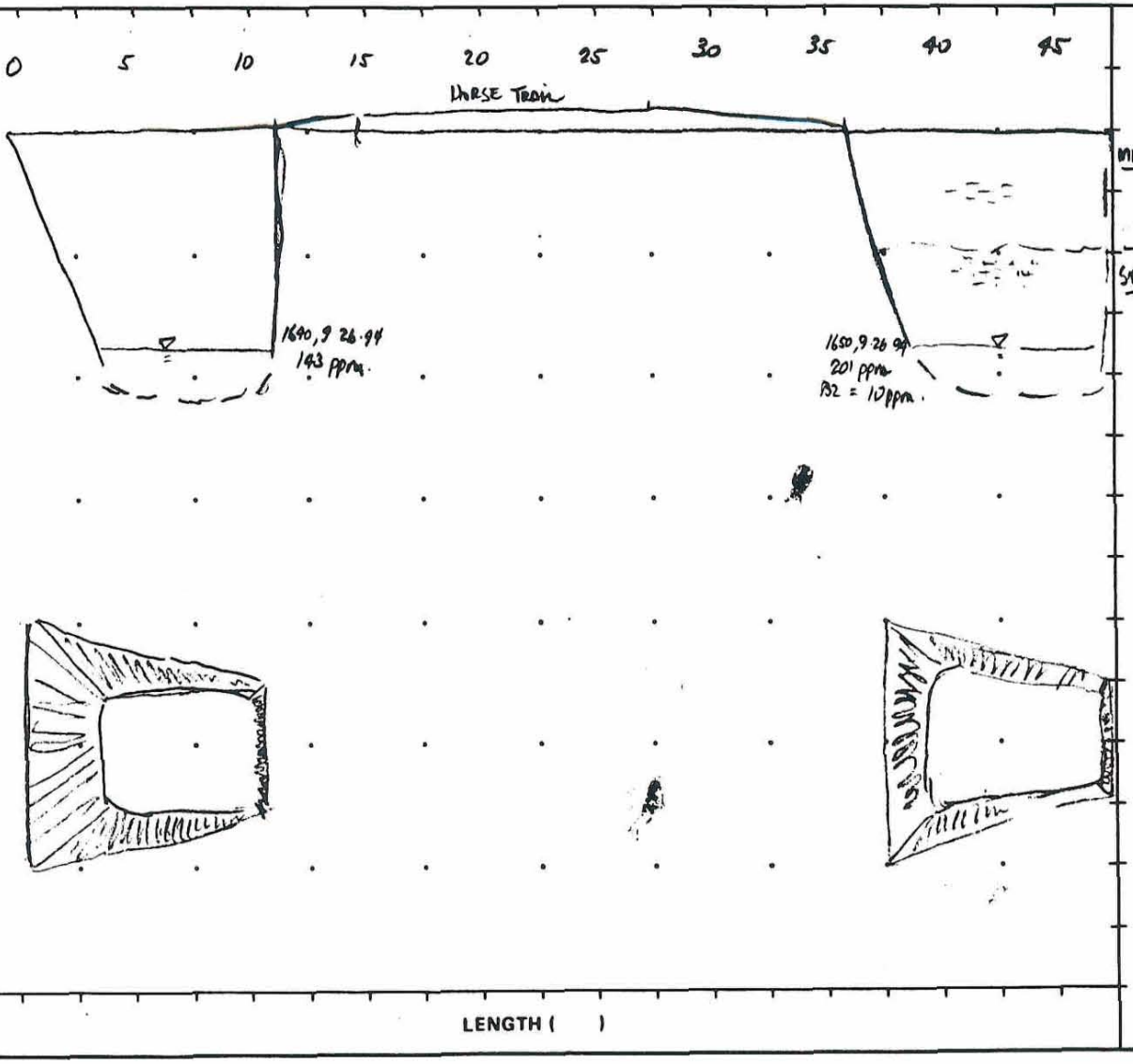
PROJECT NAS OCEANA RFI PHASE 3 LOCATION SITE 15 - FORMER TANK FARM MAP OF S WALL OF PIT

ELEVATION _____ CONTRACTOR ROCK-RAY DRILLING - A. BIELINSKI DATE EXCAVATED 9·26·94

WATER LEVEL AND DATE _____ EXCAVATION METHOD BACKHOE LOGGER DARREN BRACCIA

APPROXIMATE DIMENSIONS: LENGTH _____ WIDTH _____ DEPTH _____ REMARKS _____

ELEVATION	DEPTH BELOW SURFACE ( )	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER



COMMENTS

ML SILT, MODERATE BROWN 5YR 3/4

APPROXIMATE DEPTH OF CONTACT

SM SILTY SAND, MEDIUM GRAY N5.

1/83 D1599

CH2M HILL

PROJECT NO.	TEST PIT NO.	
MAE2ϕ368, MϕDR	15-TP2 & 15-TP3A	SHEET 1 OF 1

TEST PIT WALL LOG

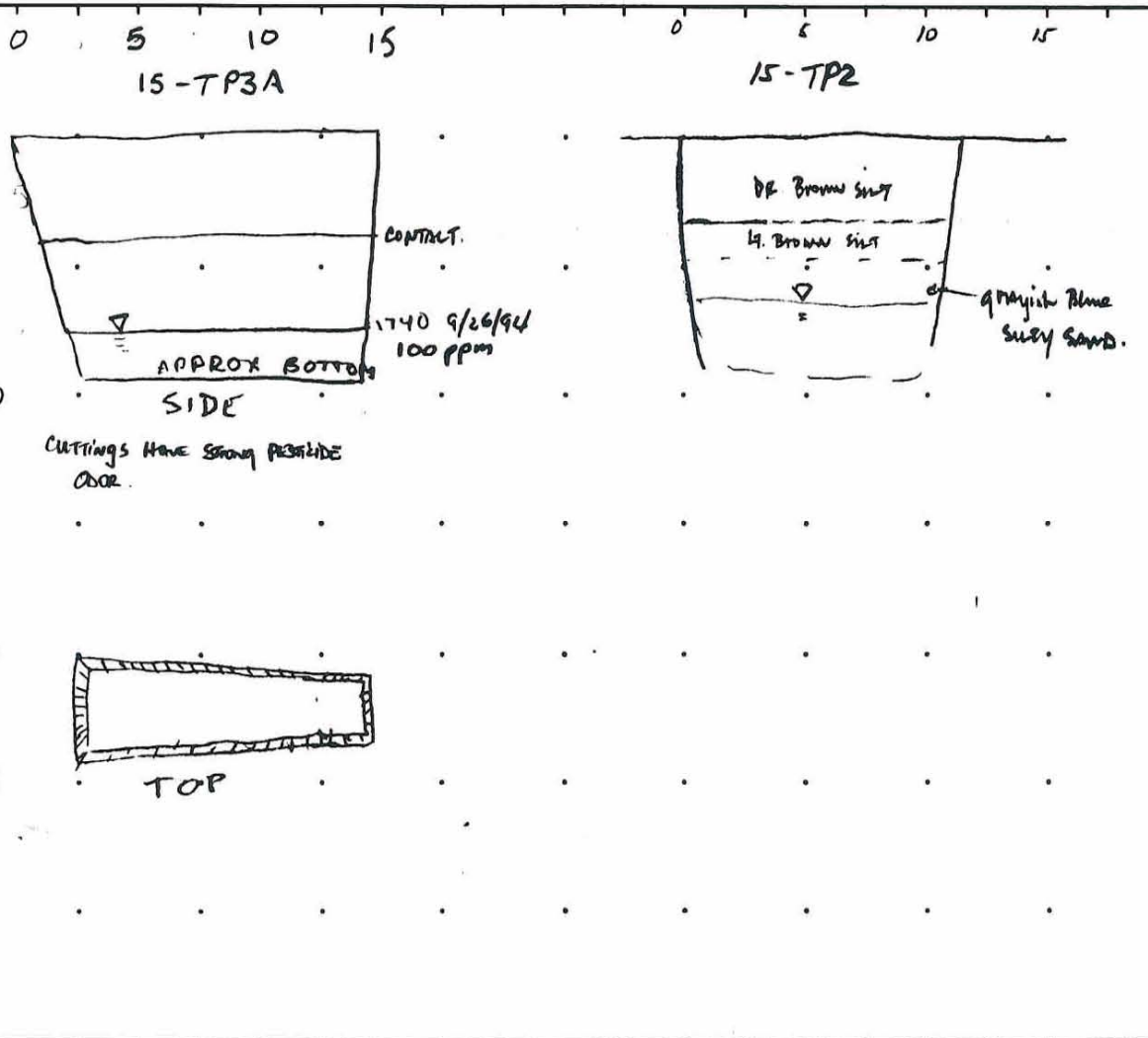
PROJECT NAS OCEANA RFI PHASE 3 LOCATION _____ MAP OF _____ WALL OF PIT

ELEVATION _____ CONTRACTOR _____ DATE EXCAVATED _____

WATER LEVEL AND DATE _____ EXCAVATION METHOD _____ LOGGER RICH DOUCETTE

APPROXIMATE DIMENSIONS: LENGTH _____ WIDTH _____ DEPTH _____ REMARKS _____

ELEVATION	DEPTH BELOW SURFACE ( )	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER



COMMENTS

MOD. BROWN 5YR 3/4 SILT (ML)

~~~ APPROX. BOUNDARY

GRAY (N5) SILTY SAND SM SOME MOTTLING

1/83 D1599
~~~

CH2M HILL

PROJECT NO.	TEST PIT NO.	
MAE 20368.MP.DR	TEST PIT 4A + 8	SHEET 1 OF 1

TEST PIT WALL LOG

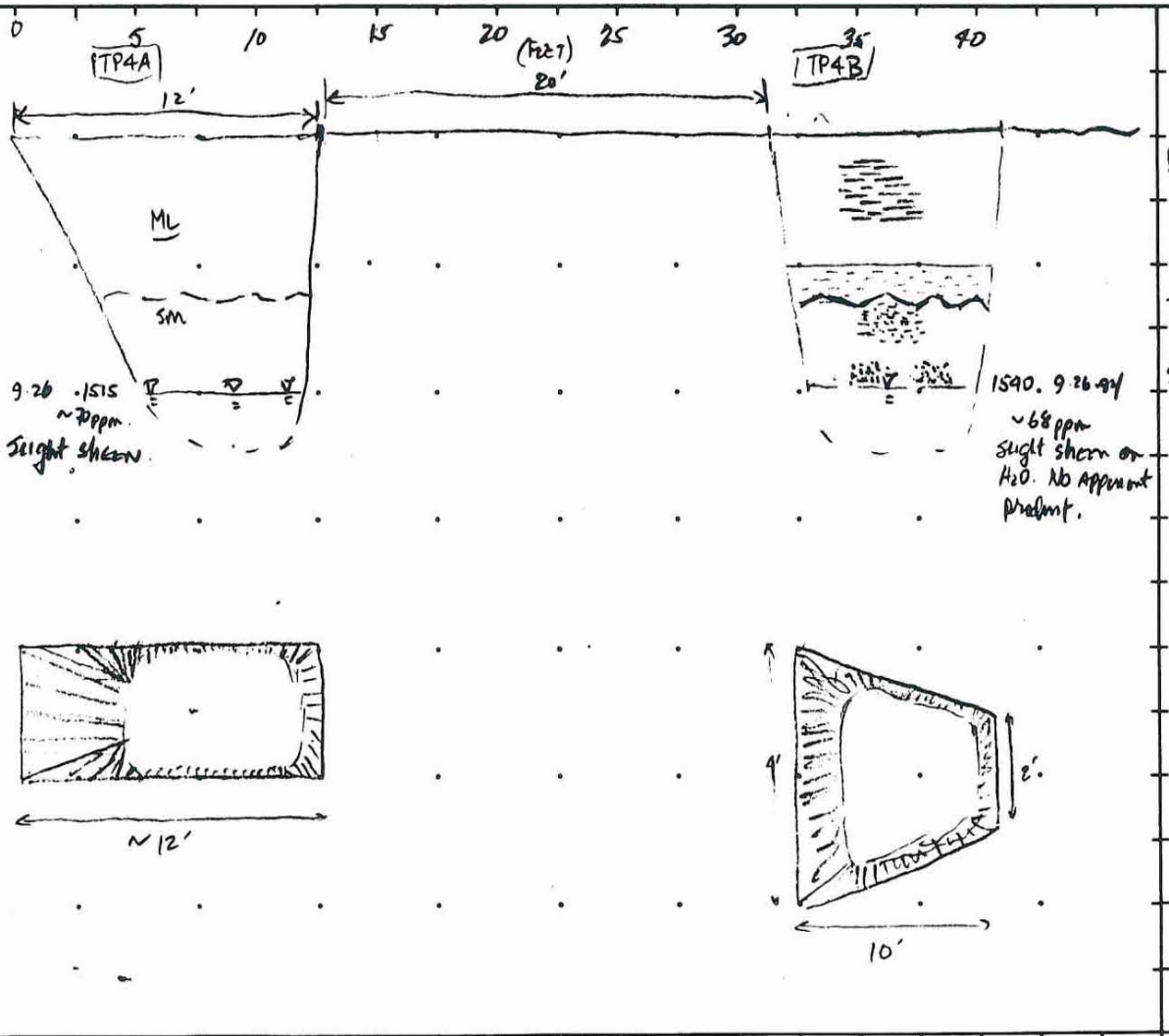
PROJECT _____ LOCATION SITE 15 - FORMER FUEL FARM. MAP OF 5 WALL OF PIT

ELEVATION _____ CONTRACTOR ROCK-RAY DRILLING DATE EXCAVATED 9.26.94

WATER LEVEL AND DATE _____ EXCAVATION METHOD BACKHOE LOGGER D. BRADDA

APPROXIMATE DIMENSIONS: LENGTH _____ WIDTH _____ DEPTH _____ REMARKS _____

ELEVATION | DEPTH BELOW SURFACE ( ) | SAMPLE: INTERVAL | SAMPLE: TYPE AND NUMBER



COMMENTS

ML SILT, MODERATE BROWN 5YR3/4

APPROXIMATE LOCATION OF CONTACT

SM SILTY SAND, MEDIUM GRAY, MED QTZ.

SP-SM to SP, F to med gtz sand. MEDIUM GRAY NS

LENGTH ( )

1/83 D1599

PROJECT NO.	TEST PIT NO.	
MAE2Ø368.MØ.11	15-TP4C	SHEET 1 OF 1

TEST PIT WALL LOG

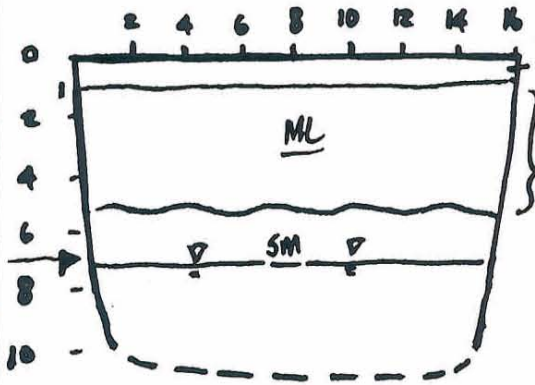
PROJECT _____ LOCATION SITE-FORMER FUEL FARM MAP OF _____ WALL OF PIT

ELEVATION NA CONTRACTOR ROCK-RAY 15 DRILLING DATE EXCAVATED 9.28.94

WATER LEVEL AND DATE ~7', 9.29.94 EXCAVATION METHOD BACKHOE LOGGER D. BRACCIA

APPROXIMATE DIMENSIONS: LENGTH 16' WIDTH 4-5' DEPTH 8-10' REMARKS _____

ELEVATION	DEPTH BELOW SURFACE ( )	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER

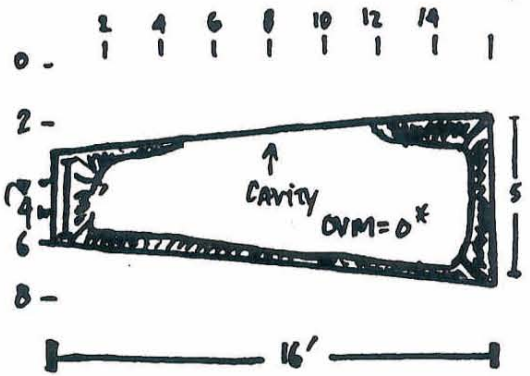


ML SILT w/ TRACE SAND, DK. YELL. BROWN 10YR4/2, DRY, SOFT, ROOT ZONE. FILL, MOD. YELL. BROWN, COARSE SAND w/ 2" DIA. TRACE GRAVEL.

ML SILT, GRADES FROM DUSKY YELL. BRN 10YR2/2 to LIGHT GRAY, N7 THEN BACK TO D. YELL. BROWN.

SM, SILTY SAND probably grading into An SW-SM Around ∇ based upon cuttings. MEDIUM GRAY, NS, to MED. LT. GRAY N6. TOP OF SM ZONE IS MARKED BY MOTTLING w/ DK. YELL. ORANGE 10YR6/6 MARKS & PATCHES THROUGHOUT.

H_2O → grayish, NO NOTICEABLE SHEEN. *OVM in pit = 0, but some cuttings had hits. See page 62 & 63. PHOTOS 9, 8, 7 (counting down from 27).



TEST-PIT LOG - 15-TP4C

LOCATION → 100' S of 15-TP4A & 4B

ROCK-RAY DRILLING: BACKHOE OPERATOR

EXCAVATED: 9.28.94 @ 1630

LOGGED: 9.29.94 @ 0700 by D. BRACCIA

LENGTH ( )

COMMENTS

CH2M HILL

PROJECT NO.	TEST PIT NO. 15-TPSA & B	SHEET 1 OF 1

TEST PIT WALL LOG

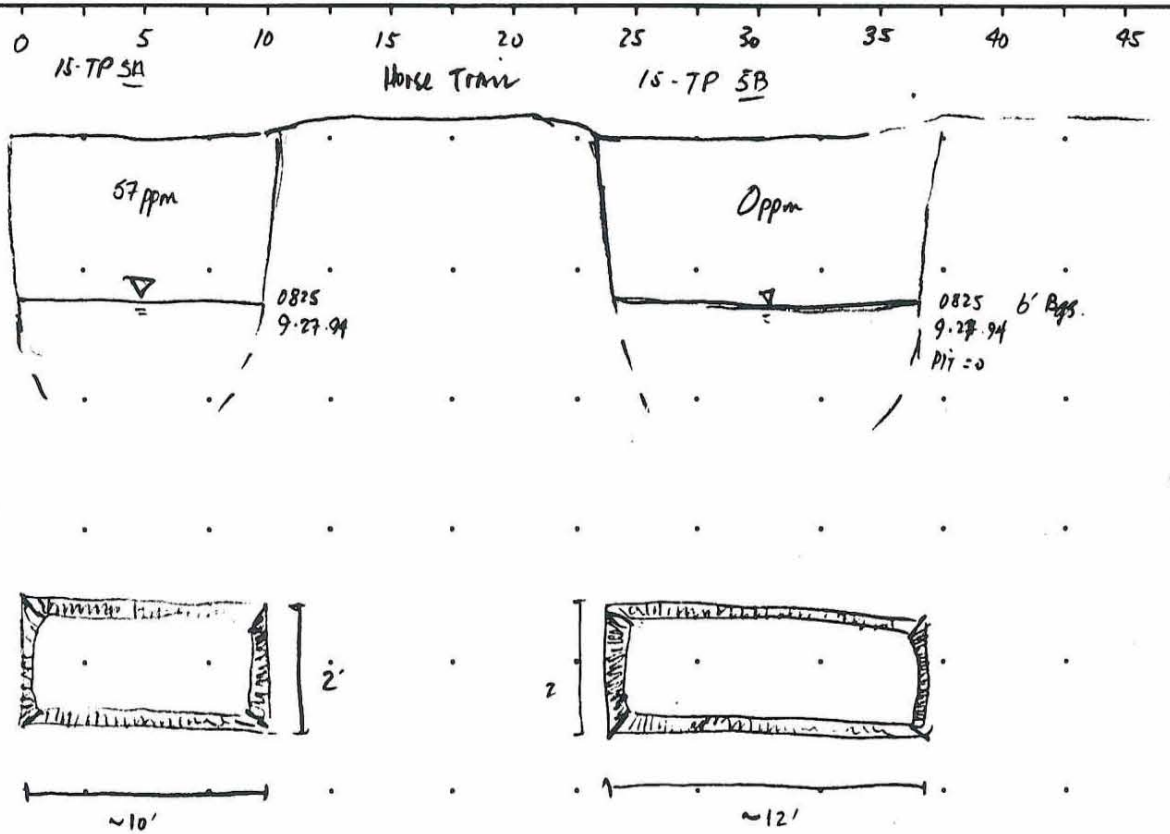
PROJECT _____ LOCATION 15-TPSA/B MAP OF _____ WALL OF PIT

ELEVATION _____ CONTRACTOR _____ DATE EXCAVATED 9.26.94

WATER LEVEL AND DATE _____ EXCAVATION METHOD _____ LOGGER BRACCIA / DOULETTE

APPROXIMATE DIMENSIONS: LENGTH _____ WIDTH _____ DEPTH _____ REMARKS _____

ELEVATION	DEPTH BELOW SURFACE ( )	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER



LENGTH ( )

COMMENTS

Stratigraphy is mostly as seen before with the exception of 15-TPSB where no sand was encountered at depth to H_2O per R.D, may have encountered sands below ∇. Refer to 15-TPSA & B for sketch.

CH2M HILL

PROJECT NO.	TEST PIT NO.	
MAE2Ø368.MØ.11	15-TP6	SHEET 1 OF 1

TEST PIT WALL LOG

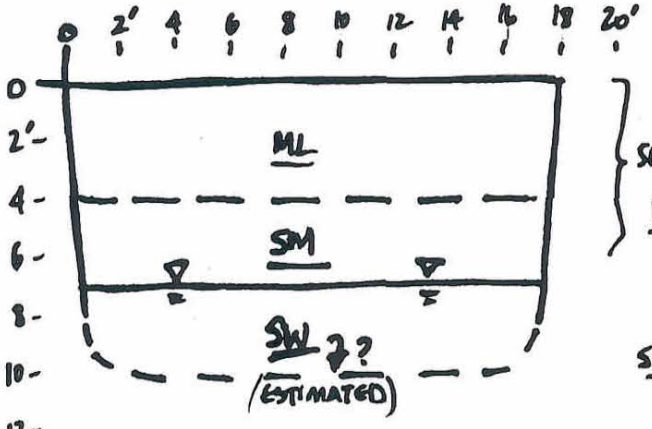
PROJECT _____ LOCATION SITE 16 - FORMER FUEL FARM MAP OF _____ WALL OF PIT

ELEVATION NA CONTRACTOR ROCK-RAY DRILLING DATE EXCAVATED 9.28.94

WATER LEVEL AND DATE _____ EXCAVATION METHOD BACKHOE LOGGER D. BRACCIA

APPROXIMATE DIMENSIONS: LENGTH 18' WIDTH 3-5' DEPTH 8-10' REMARKS _____

ELEVATION | DEPTH BELOW SURFACE ( ) | SAMPLE: INTERVAL | SAMPLE: TYPE AND NUMBER



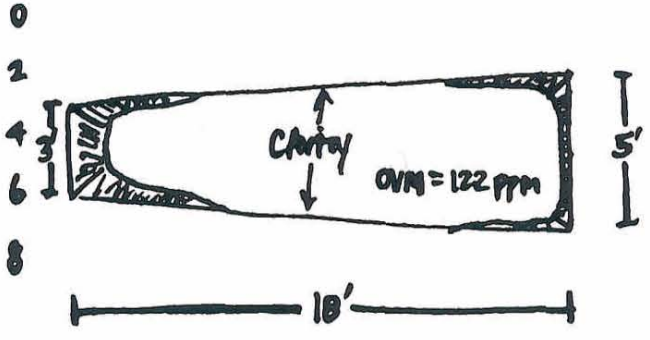
15-TP6

SEE STRAT. SECTION ON PAGE 65

NOTE → HEAVY ZONE OF MOTTLING BEGINS AT BREAK BETWEEN ML & SM. APPEARS MORE EVIDENT THAN IN PREVIOUS LOCATIONS, but MAY BE A RESULT OF GREATER AMOUNT OF CAVING.

SW - WELL GD. SAND AS ESTIMATED FROM CUTTINGS MED. DK. GRAY N4 to N5 MED. GRAY. SAND FROM FINE TO MED.

H_2O - NO FREE PRODUCT EVIDENT. SHEEN ON ▽. SOME BUBBLES, WITH ORANGE-RED BUBBLES ALONG EDGES OF WALL. OVM in HOLE = 122 ppm. CUTTINGS FROM 25 → 110 ppm. BZ FLUCTUATING IN LEVEL C.



TEST PIT LOG - 15-TP6

LOCATION → 100' SW OF 15-TP4A & 4B

ROCK-RAY DRILLING → BACKHOE OPERATOR.

EXCAVATED: 9.28.94 @ 1630

LOGGED: BY D. BRACCIA @ 0800 on 9.29.94

PHOTOS: 6, 5, 4, 3 (COUNTING DOWN FROM 27)

COMMENTS

LENGTH ( )

1/83 D1599

Appendix B
Environmental Sampling

Appendix B

Environmental Sampling

Environmental samples of soil, sediment, surface water, and groundwater at the 12 POL/CMS/RFI Phase II sites were collected from February to October 1994. The general progression of the work was:

- *In-situ* soil and groundwater sampling with a hydraulic probe and onsite analysis in a mobile laboratory
- Manual sampling of soils, sediments, and surface water
- Sampling during drilling at Site 1 and Site 2D
- Monitoring well sampling of wells installed February through May, 1994
- Drum sampling following the drilling phase
- Additional *in situ* groundwater sampling
- Monitoring well sampling of wells installed in September and October, 1994

Table 1-2 in Chapter 1 of this report details the types of samples and quantity collected at each site during the investigations. The sampling also is summarized by medium in Tables 1-3 to 1-5 in Chapter 1.

CH2M HILL personnel performed all sampling in accordance with the procedures described in the RFI Phase I work plan (CH2M HILL, 1992) and revised in the RFI

Phase II work plan (CH2M HILL, 1994). The RFI Phase I Report (CH2M HILL, 1993) also contains details on standard sampling procedures.

A total of 57 monitoring wells were sampled by varying methods such as disposable bailers, positive displacement bladder pumps, and submersible pumps. The use of the submersible pumps for sampling and purging deep monitoring wells during this investigation was approved by the U.S. EPA Region III. Positive displacement pumps were used in most wells except the deep wells and the wells suspected of containing free product. Disposable bailers were used when sampling free-phase wells and submersible pumps were used to sample deep wells and a few shallow wells. Table B-1 presents the parameters recorded during groundwater sampling.

Quality assurance samples (duplicates, trip blanks, field blanks, and equipment blanks) were collected using ratios established in the work plans. The results of duplicate analyses are presented along with the original sample results in Chapter 2. The trip blank and equipment blank results are presented in Tables B-2, B-3, and B-4. Trip blanks accompanied shipments containing field samples to be analyzed for volatile organic compounds.

CH2M HILL field personnel adhered to sample handling protocols such as maintenance of custody, sample preservation, and daily shipment via Federal Express Priority Overnight Service. Refer to the RFI Phase I Report (CH2M HILL, 1993) for additional details.

All sampling equipment was thoroughly decontaminated between samples in accordance with the decontamination process listed in the RFI Phase I Report (CH2M HILL, 1993); however, as approved in the RFI Phase II work plan (CH2M HILL, 1994), the hexane rinse was removed from the decontamination process due to an inability to completely rinse the hexane from the sampling equipment.

Table B-1
SUMMARY OF PARAMETERS MEASURED DURING RFI PHASE II/CMS GROUNDWATER SAMPLING
NAS OCEANA
1994

Sample Location	Sampling Date	Total Depth* of Well	Depth to* Water	Approx. Volume of Well (gal)	Approx. Volume of Purge (gal)	Method[1] of Purge/ Sampling	Conductivity (μmho/cm)	Temp (°C)	pH	Comments
1-MW6	3/16/94	23.05	8.56	2.5	10	PQ/PQ	290	13.0	7.70	
1-MW7D	3/16/94	55.25	7.00	8	24	SP/SP	460	15.6	8.52	
1-MW8	3/16/94	24.32	9.37	2.5	7.5	PQ/PQ	465	14.8	7.49	
1-MW8D	3/16/94	57.10	7.65	8.5	25.5	SP/SP	590	16.5	7.63	
1-MW9D	3/16/94	60.52	6.31	10	50	SP/SP	550	16.5	7.83	
1-MW10	3/16/94	19.85	7.72	2	10	PQ/PQ	248	12.4	7.48	
2B-MW1D	3/15/94	46.40	5.83	6.6	19.8	SP/SP	325	18.4	7.92	
2B-MW5D	3/15/94	47.60	6.05	6.7	20.1	SP/SP	360	18.8	7.77	
2B-MW14	3/15/94	22.26	5.26	2.8	5.6	PQ/PQ	387	16.3	6.71	
2B-MW17	3/15/94	20.24	5.74	2.4	12	PQ/PQ	425	16.0	6.42	
2B-MW18	3/15/94	21.88	6.90	2.5	10	PQ/PQ	370	15.4	6.53	
2B-MW19	3/16/94	20.20	2.90	2.8	12	PQ/PQ	275	15.6	5.77	
2B-MW20	5/13/94	-	5.36	2.3	7	SP/SP	162	17.4	6.17	
2C-MW1D	3/15/94	55.05	5.17	8.1	24.3	SP/SP	500	18.6	7.39	
2C-MW9D	3/15/94	54.10	4.85	8.0	24	SP/SP	490	16.5	7.40	
2C-MW10	3/14/94	20.41	2.94	2.8	8.4	PQ/PQ	450	16.5	6.31	
2C-MW11	3/14/94	23.1	4.27	3	12	PQ/PQ	420	16.2	6.89	

Table B-1
SUMMARY OF PARAMETERS MEASURED DURING RFI PHASE II/CMS GROUNDWATER SAMPLING
NAS OCEANA
1994

Sample Location	Sampling Date	Total Depth* of Well	Depth to* Water	Approx. Volume of Well (gal)	Approx. Volume of Purge (gal)	Method[1] of Purge/ Sampling	Conductivity (μmho/cm)	Temp (°C)	pH	Comments
1-MW6	3/16/94	23.05	8.56	2.5	10	PQ/PQ	290	13.0	7.70	
2C-MW12	3/14/94	23.24	4.37	3.07	9.3	PQ/PQ	245	14.7	6.03	
2C-MW13	3/14/94	21.13	5.17	2.6	10.4	PQ/PQ	350	16.1	7.22	
2C-MW14	3/15/94	20.18	4.18	2.6	10.4	PQ/PQ	520	15.5	6.97	
2C-MW15	3/15/94	20.19	5.64	2.37	9.6	PQ/PQ	222	15.1	6.43	
2C-MW16	3/16/94	20.30	6.30	2.3	9.2	PQ/PQ	310	15.2	6.33	
2C-MW17	3/16/94	19.94	6.74	2.2	8.8	PQ/PQ	248	17.3	5.25	
2C-MW18	3/16/94	18.88	4.02	2.4	11.6	PQ/PQ	590	16.0	5.07	
2C-MW19	5/13/94	19.5	9.26	1.7	6.8	SP/SP	472	18.3	6.61	
2C-MW20	5/13/94	20.0	8.35	1.9	8.0	SP/SP	420	21.1	6.24	
2D-MW1	3/15/94	20.1	5.13	2.4	7.2	SP/SP	305	19.1	5.9	
2D-MW2	3/15/94	19.90	5.76	2.3	6.9	SP/SP	510	17.2	6.31	
2D-MW3	3/15/94	19.85	5.36	2.4	7.2	SP/SP	225	27.2	6.16	
2D-MW4	3/16/94	19.2	6.06	2.1	8.4	PQ/PQ	1600	16	4.1	
2D-MW5	3/16/94	19.6	5.72	2.3	9.2	PQ/PQ	435	14	3.87	
2E-MW4	3/17/94	20.5	7.5	2.2	6.6	DB/DB	475	16	6.65	3.25' of free product
2E-MW5	3/17/94	19.10	4.66	2.4	7.2	DB/DB	410	14.7	7.2	1/10" of free product

Table B-1
SUMMARY OF PARAMETERS MEASURED DURING RFI PHASE II/CMS GROUNDWATER SAMPLING
NAS OCEANA
1994

Sample Location	Sampling Date	Total Depth* of Well	Depth to* Water	Approx. Volume of Well (gal)	Approx. Volume of Purge (gal)	Method[1] of Purge/ Sampling	Conductivity (μmho/cm)	Temp (°C)	pH	Comments
1-MW6	3/16/94	23.05	8.56	2.5	10	PQ/PQ	290	13.0	7.70	
2E-MW6	3/17/94	19.10	4.45	2.4	7.2	DB/DB	520	13.2	7.05	Slight fuel sheen, no free product
2E-MW7	3/21/94	18.22	4.91	2.2	6.6	DB/DB	460	14.6	6.23	No free Product
2E-MW8	3/17/94	18.2	4.2	2.3	6.9	DB/DB	580	15.2	6.33	Strong fuel odor, very thin layer of free product
2E-MW9	10/11/94	18.50	8.33	1.7	5.1	SP/SP	488	21.1	5.98	
2E-MW10	10/11/94	20.16	8.74	1.9	6	SP/SP	360	21.2	6.36	
2E-MW11	10/11/94	20.10	7.47	2.0	6	SP/SP	670	21.9	6.21	
2E-MW12	10/11/94	20.09	8.06	2	6	SP/SP	480	24.7	6.19	
2E-MW13	10/11/94	20.3	7.88	2	6	SP/SP	570	22.6	6.14	
15-MW5	4/21/94	20.04	5.45	2.4	7.5	DB/DB	110	14.0	6.0	
15-MW6	4/21/94	20.9	6.35	2.4	9.6	DB/DB	103	12.7	5.08	
15-MW7	4/21/94	20.56	4.38	2.6	7.8	DB/DB	167	13.0	5.95	
15-MW8	4/21/94	19.60	5.15	2.4	7.2	PQ/PQ	65	14.3	5.24	
15-MW9	4/21/94	19.90	5.39	2.4	9.6	DB/DB	190	13.7	7.31	Odor in well, fuel/solvent
15-MW10	4/21/94	20.58	5.62	2.5	7.5	PQ/PQ	85	14.2	5.74	
15-MW11	10/12/94	22.04	8.62	2.2	6.6	SP/SP	100	16.6	5.79	

Table B-1
SUMMARY OF PARAMETERS MEASURED DURING RFI PHASE II/CMS GROUNDWATER SAMPLING
NAS OCEANA
1994

Sample Location	Sampling Date	Total Depth* of Well	Depth to* Water	Approx. Volume of Well (gal)	Approx. Volume of Purge (gal)	Method[1] of Purge/ Sampling	Conductivity (μmho/cm)	Temp (°C)	pH	Comments
1-MW6	3/16/94	23.05	8.56	2.5	10	PQ/PQ	290	13.0	7.70	
15-MW12	10/12/94	22.08	8.74	2.2	6.6	SP/SP	83	16.7	5.75	
15-MW13	10/12/94	22.05	8.57	2.2	8.8	SP/SP	137	17.2	5.94	
15-MW14	10/12/94	22.13	9.25	2.1	6.4	SP/SP	158	17.4	5.94	
15-MW15	10/12/94	20.92	8.05	2.1	6.4	SP/SP	153	17.4	6.18	
24-GP1	3/17/94	6.86	3.35	0.156	1.5	PP/PP	131	10.7	7.43	Sheen on purge water
24-GP3	3/17/94	7.72	3.35	0.2	1.5	PP/PP	260	10.6	8.14	
24-GP4	3/17/94	7.70	2.94	0.2	2	PP/PP	85	10.9	5.21	
24-MW1	10/12/94	20.44	8.09	2	6.0	SP/SP	280	20.4	6.30	
24-MW2	10/12/94	22.14	9.80	2	3	SP/SP	225	18.0	6.08	
24-MW3	10/12/94	20.22	6.91	2.2	6.6	SP/SP	138	18.1	5.87	
24-MW4	10/12/94	20.40	8.12	2	6.0	SP/SP	149	20.5	6.04	
24-MW5	10/12/94	20.22	7.82	2	6.0	SP/SP	178	21.4	6.24	
24-MW6	10/12/94	18.94	8.46	1.7	5.1	SP/SP	133	21.6	5.94	

Notes: [1]Method of purge sampling: DB = Disposable Bailer SP = Submersible Pump
NM = Not Measured PP = Peristatic pump or foot valve PQ = Portable QED Well Wizard Positive Displacement Bladder Pump
*Water-level measurements are from top of casing, not from ground surface.

Table B-2
RESULTS OF LABORATORY ANALYSIS OF TRIP BLANKS
NAS OCEANA RFI PHASE II/CMS/POL FIELD INVESTIGATIONS
February to October 1994
(All data in µg/l)

Analyte	TB-208 #	TB-208B #	TB-209	TB-211	TB-212	Trip Blank	TB-01	TB-224	TB-225	TB-33	TB-314	TB-316	TB-317	TB-421	TB-1	TB10-11	TB10-12
Date Sampled	**2/8/94**	**2/8/94**	**2/9/94**	**2/11/94**	**2/12/94**	**2/16/94**	**2/23/94**	**2/24/94**	**2/25/94**	**3/3/94**	**3/14/94**	**3/16/94**	**3/17/94**	**4/21/94**	**5/13/94**	**10/11/94**	**10/12/94**
Methylene Chloride	4 j	3 j	4 j	3 j	*	1 jb	*	3 jb	*	*	*	4 jb	1 jb	6 b	2 jb	3 jb	*
Acetone	9 jb	8 jb	9 jb	10 b	20 b	25 j	22 b	12 b	24 b	26 b	33 b	23 b	24 b	23	19	11	*
Chloromethane	*	*	*	*	*	*	1 j	*	*	*	*	*	*	*	*	*	*
2-Butanone	*	*	*	*	*	*	*	*	*	*	*	*	*	8 j	*	*	*

Notes:

j Indicates an estimated value.
b The analyte was found in the associated blank as well as the sample.
* Compound analyzed, but not detected above the Instrument Detection Limit (IDL). The quantitation limit of dichlorodifluoromethane in TB-33 was qualified as estimated during the data validation process.
# On 2/8/94 an Appendix IX VOC trip blank and an 8240 VOC trip blank were collected.

ORGANIC RESULTS OF EQUIPMENT BLANK SAMPLING
NAS, OCEANA RFI PHASE II/CMS/POL
February-April 1994

Analyate	1-EQBSED	1-EQBW	2B-EQBW	2C-EQBW	2CEQB-1	11-EQB	15-EQ1	18-EQB	20-EQB	25-EQB	15-EQB10	2E-EQB10	15-EQB20
Total Petroleum Hydrocarbons	NA	NA	NA	NA	NA	<60	<70	<50	<50	NA	*	<1,000	NA
Volatile Organic Compound													
Methylene Chloride	1 j	2 jb	2 jb	1 j	2 jb	NA	1 j	NA	NA	NA	2 jb	4 jb	NA
Acetone	13 b	6 j	9 jb	9 jb	14	NA	*	NA	NA	NA	*	7 j	NA
Chloroform	*	7	*	7	*	NA	22	NA	NA	NA	*	*	NA
Bromodichloromethane	*	2 j	*	*	*	NA	5	NA	NA	NA	*	*	NA
2-Butanone	*	*	30	8 j	20	NA	100	NA	NA	NA	*	5 j	NA
Trichlorofluoromethane	*	*	*	*	*	NA	3 j	NA	NA	NA	*	*	NA
Polynuclear Aromatic Compounds	*	*	NA	NA	NA	*	*	* d	NA	NA	*	*	*
Pesticide Compounds	NA	NA	NA	NA	NA	NA	*	NA	NA	*	NA	NA	NA
Total Organic Carbon	NA	NA	NA	NA	NA	NA	*	NA	NA	80,500	NA	NA	NA

Notes:
All volatile organic, polynuclear aromatic, and pesticide compounds not listed in the table above were analyzed but not detected.

d All quantitation limits for all PAH compounds were qualified as estimated.
*The compound was analyzed but not detected above the Instrument Detection Limit.
j Indicates an estimated value.
b The compound was found in the laboratory method blank as well as the sample.

Because equipment blanks are a measure of decontamination efficiency between sampling points, the environmental samples that precede and follow the equipment blank are listed below

1-EQBSED: After 1-SD5 and before 1-SD6, 1-SD7.
1-EQBW: After 1-MW8D and before 1-MW7D.
2B-EQBW: After 2B-MW17 and before 2B-MW18.
2C-EQBW: After 2C-MW13 and before 2D-MW1.
11-EQB: After 11-GS2 and before 11-GS1.
15-EQ1: After 15-MW10 and before 15-MW8.
18-EQB: After 18-SS4-1 and before 11-SS12.
20-EQB: After 20-SS9-3 and before 20-SS7-1.
25-EQ8: After 25-SD5 and before 25-SD4.
15-EQB10: After 15-MW12.
2E-EQB10: After 2E-MW9 and before 2E-MW13.
15-EQB20: After 15-MW13 and before 15-MW14.

Table B-4
INORGANIC RESULTS OF EQUIPMENT BLANK SAMPLING
NAS, OCEANA RFI PHASE II/CMS/POL
February-April 1994

Analyte	11-EQB	15-EQ1	25-EQB	2E-EQB10	15-EQB10	24-EQB10
Aluminum	39.0 b	NA	48.7 b+j	NA	NA	60.1 b
Antimony	<11.1 n	NA	<11.1	NA	NA	<37.0
Arsenic	<1.3 n	NA	<1.3	NA	NA	<2.0
Barium	0.73 b	NA	1.0 bc	NA	NA	6.8 b
Beryllium	<0.14	NA	<0.14	NA	NA	<1.0
Cadmium	<3.1	NA	<3.1	NA	NA	<4.0
Calcium	64.6	NA	4,530 b	NA	NA	45,000
Chromium	<2.3	NA	<2.3 +uj	NA	NA	10.2
Cobalt	<1.6	NA	<1.6	NA	NA	<5.0
Copper	3.8 b	NA	8.1 bc	NA	NA	9.1 b
Iron	67.3 b	NA	26.7 b+j	NA	NA	712
Lead	<2.0	<1.8	<2.0 +uj	<1.0	<1.0	<1.0
Magnesium	28.3 b	NA	24,500	NA	NA	12,900
Manganese	0.91 b	NA	13.8 bj	NA	NA	108
Mercury	<0.07	NA	<0.07	0.18 b	NA	<0.14 n
Nickel	24.1 b	NA	<7.3	NA	NA	13.8 b
Potassium	<738	NA	2,410 b	NA	NA	7,910
Selenium	2.8 bn	NA	<1.5	NA	NA	<4.0 n
Silver	<2.5	NA	<2.5	NA	NA	<4.0 n
Sodium	28,100	NA	7,670	NA	NA	18,900
Thallium	<1.3	NA	<1.3	NA	NA	<2.0
Vanadium	<2.3	NA	<2.3	NA	NA	<3.0
Zinc	<3.0 n	NA	8.4 b+j	4.6 b	NA	34.8

Notes:

Because equipment blanks are a measure of decontamination efficiency between sampling points, the environmental samples that precede and follow the equipment blanks are listed below.

11-EQB: After 11-GS2 and before 11-GS1.
15-EQ1: After 15-MW10 and before 15-MW8.
25-EQB: After 25-SD5 and before 25-SD4.
15-EQB10: After 15-MW12.
2E-EQB10: After 2E-MW9 and before 2E-MW13.
2E-EQB20: After 15-MW13 and before 15-MW14.

< Value was not detected at the listed detection limit.
b Value was less than the CRDL but greater than or equal to the IDL.
n Spiked sample recovery not within control limits.
+ Duplicate analysis not within control limits.
15-EQ1 and 15-EQB10 were sampled for total lead only.
j Value qualified.
c Compound detected in the blank as well as the sample.
uj Quantitation limit qualified as estimated.

Appendix C
In Situ Hydraulic Conductivity Analysis

Appendix C

In-Situ Hydraulic Conductivity Analysis

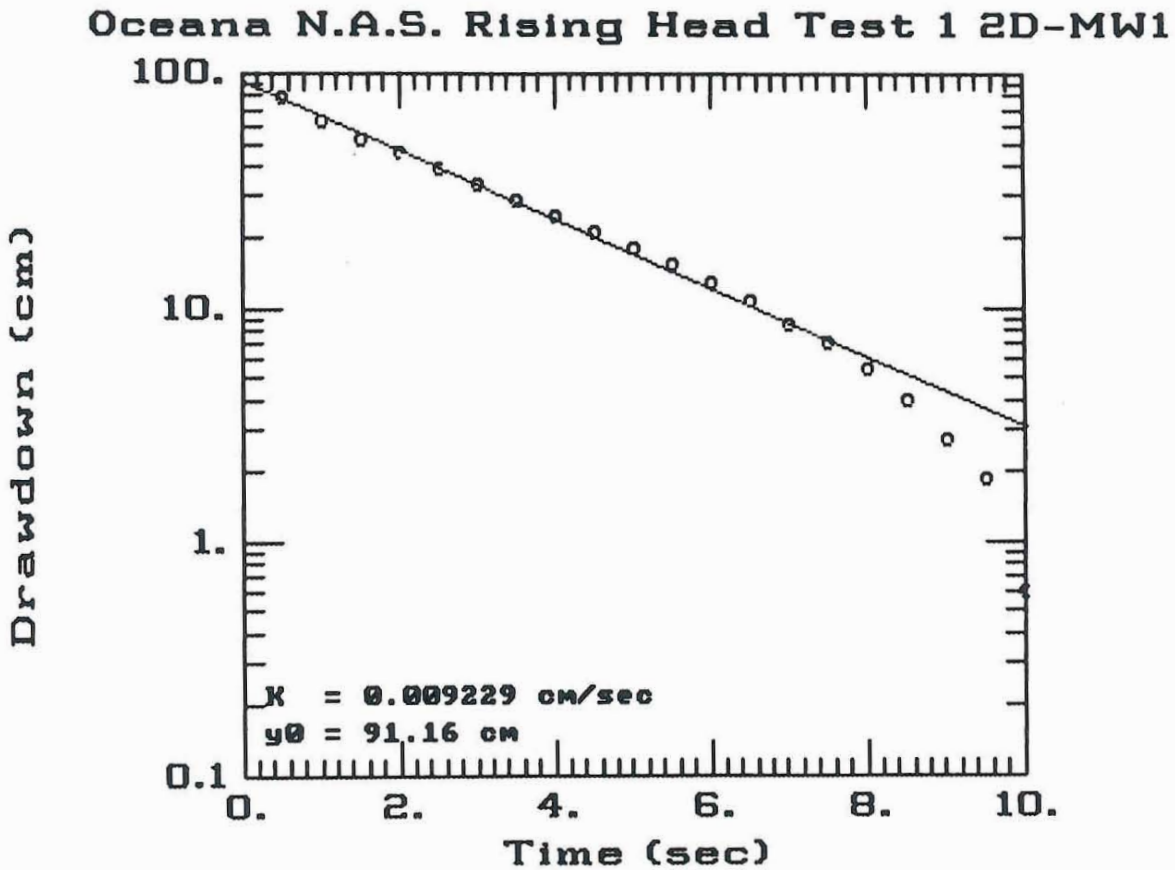
As part of the Phase II RFI field investigation, CH2M HILL personnel performed in-situ hydraulic conductivity tests on three monitoring wells each at Sites 2D, 2E, and 15. The conductivity tests, referred to as slug tests, recorded water level fluctuations caused by removing slugs of water from the monitoring well. A Campbell 21X datalogger equipped with pressure transducers recorded the rising water levels until the water level reached its original static position. Multiple tests were performed at each monitoring well to ensure representative data.

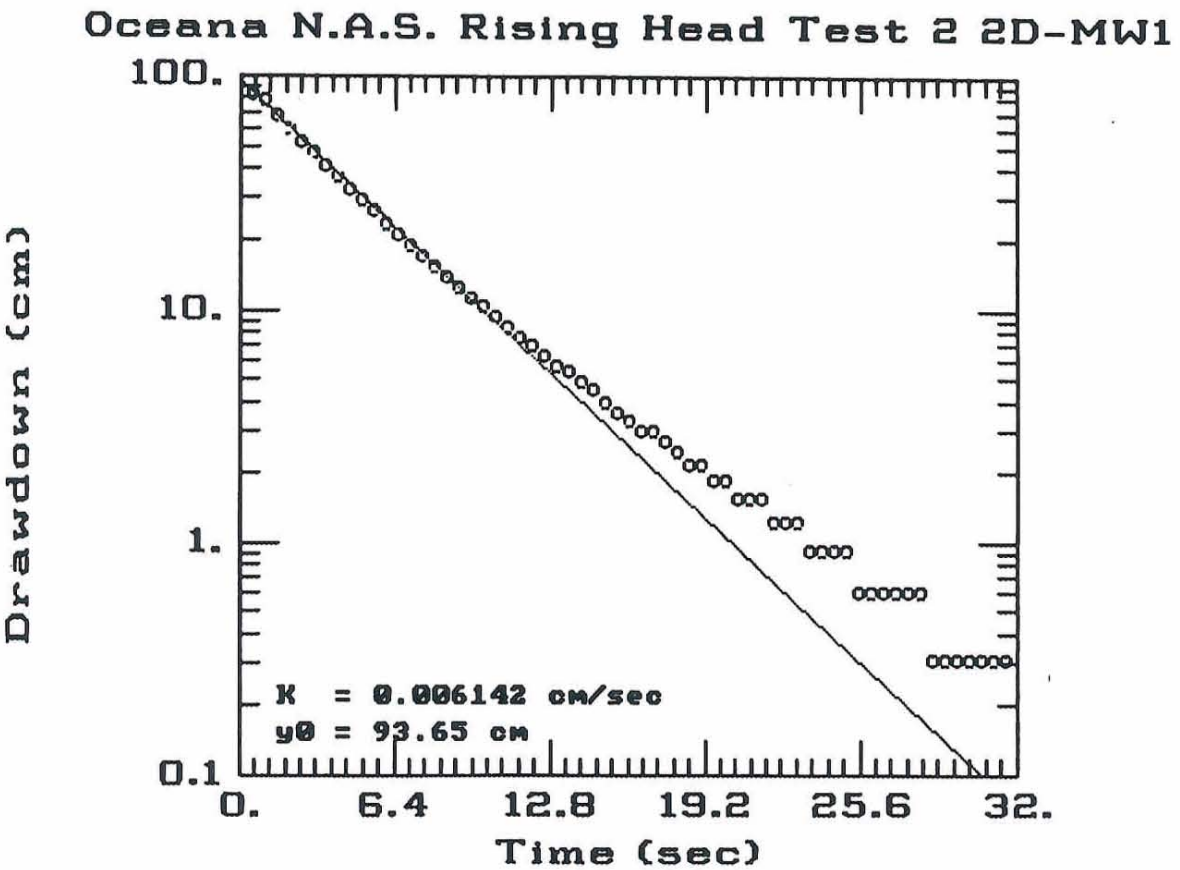
CH2M HILL hydrogeologists analyzed the water-level data using AQTESOLV (Geraghty and Miller, 1989), a computer software package. The data were analyzed using the Bouwer and Rice method (1976) for unconfined aquifers. Table C-1 summarizes the hydraulic conductivities derived for each monitoring well. The graphical results of the in-situ tests follow the table in this appendix.

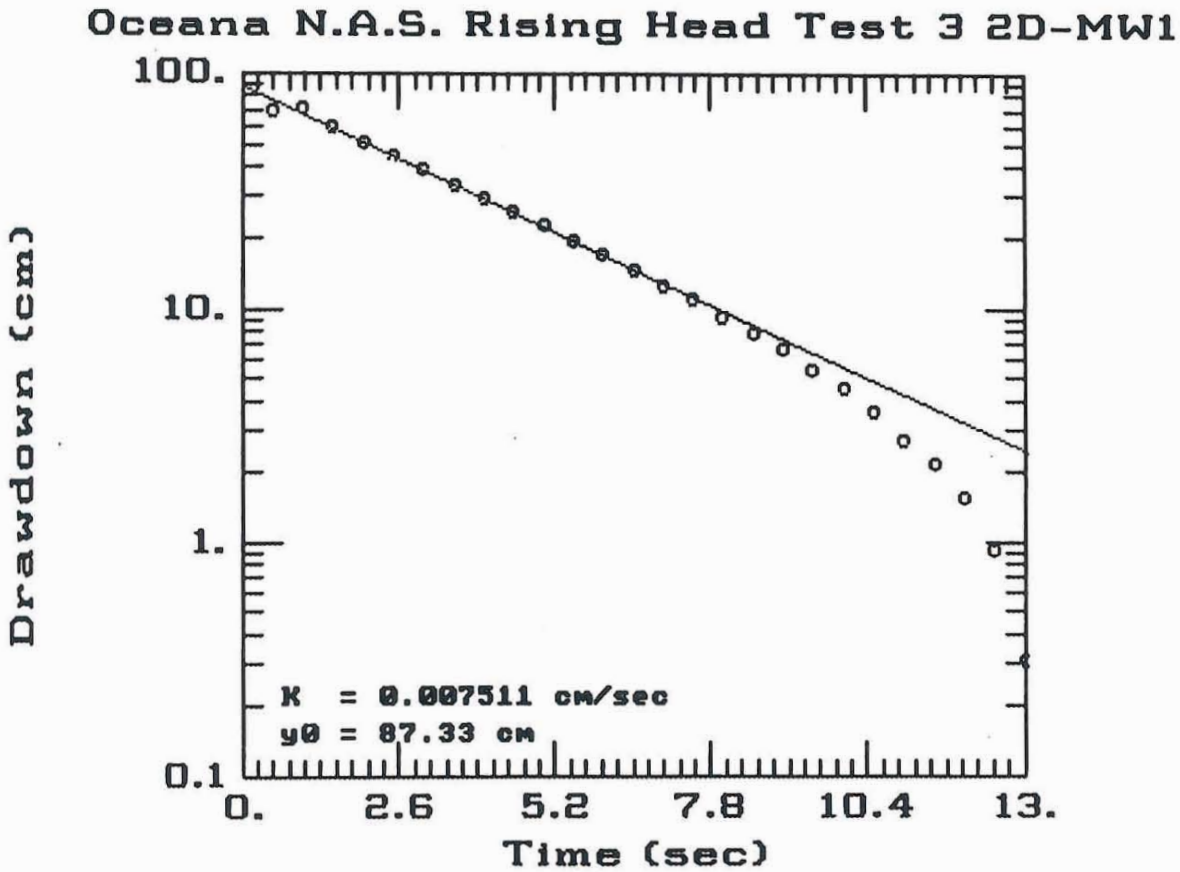
WDCR838/023.WP5

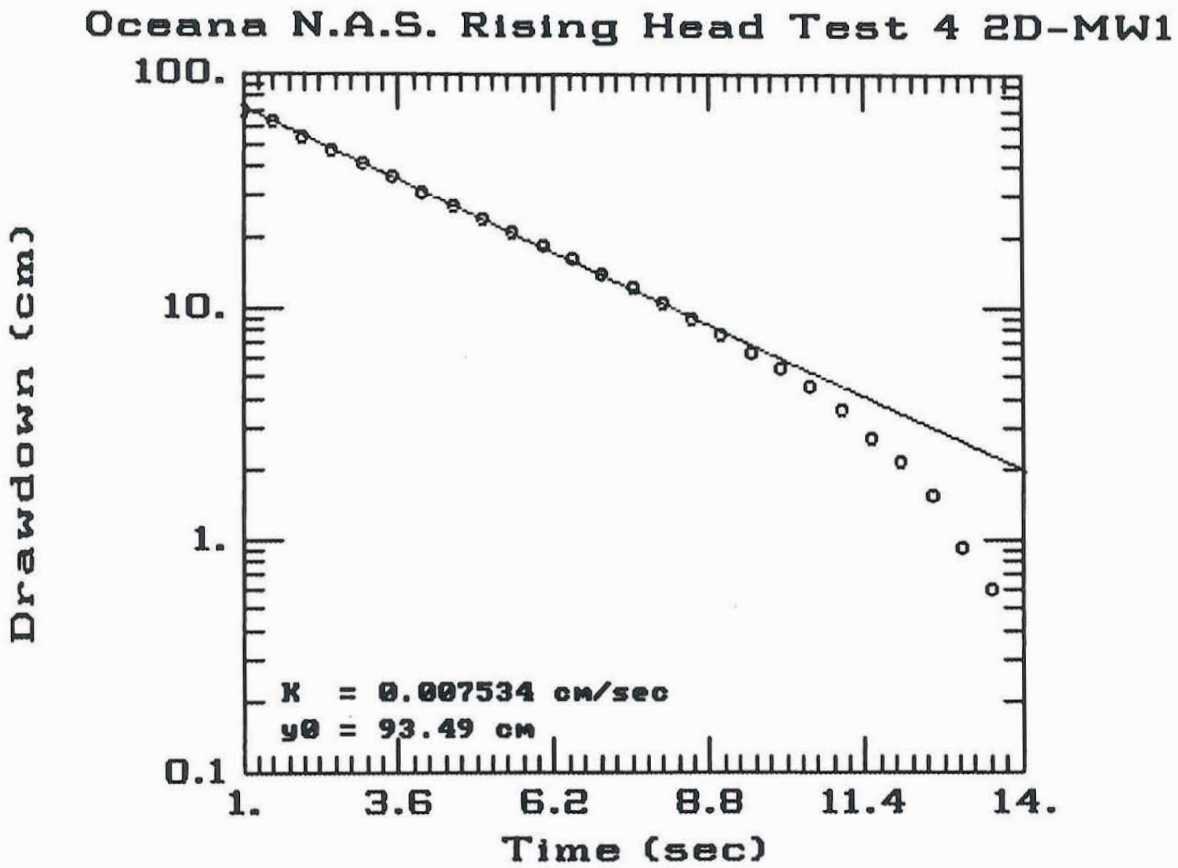
Table C-1
RESULTS OF HYDRAULIC CONDUCTIVITY TESTS
ON SELECT MONITORING WELLS AT SITES 2D, 2E, AND 15
March and April 1994
(All figures in cm/sec)

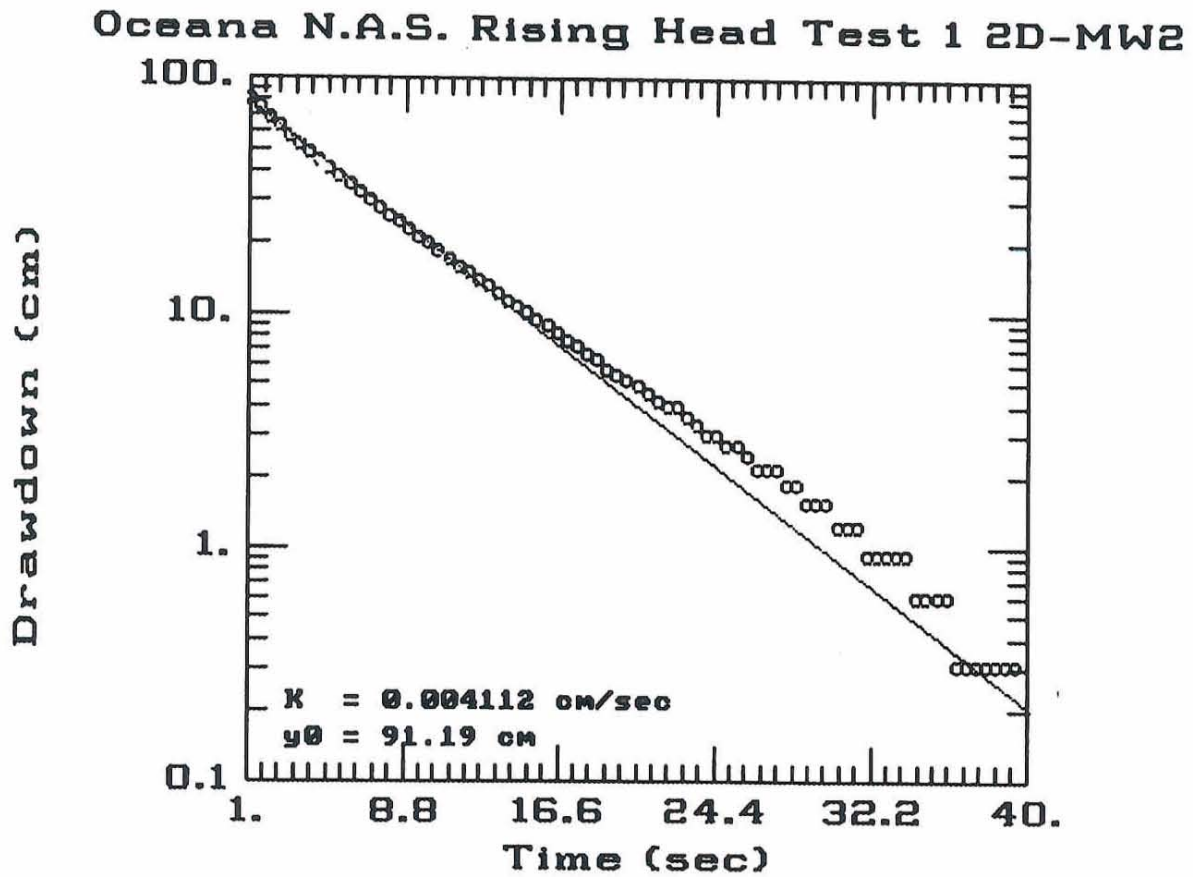
Monitoring Well	Test Results (cm/sec)	Average Hydraulic Conductivity (cm/sec)
2D-MW1	9×10^{-3} 6×10^{-3} 8×10^{-3} 8×10^{-3}	8×10^{-3}
2D-MW2	4×10^{-3} 4×10^{-3} 4×10^{-3}	4×10^{-3}
2D-MW3	3×10^{-3} 3×10^{-3} 3×10^{-3}	3×10^{-3}
2E-MW3	7×10^{-3} 6×10^{-3} 6×10^{-3}	6×10^{-3}
2E-MW7	7×10^{-3} 8×10^{-3} 7×10^{-3}	7×10^{-3}
2E-MW8	6×10^{-3} 5×10^{-3} 5×10^{-3}	5×10^{-3}
15-MW5	5×10^{-3} 5×10^{-3} 5×10^{-3}	5×10^{-3}
15-MW6	2×10^{-2} 1×10^{-2} 1×10^{-2}	1×10^{-2}
15-MW8	4×10^{-3} 5×10^{-3} 5×10^{-3}	5×10^{-3}

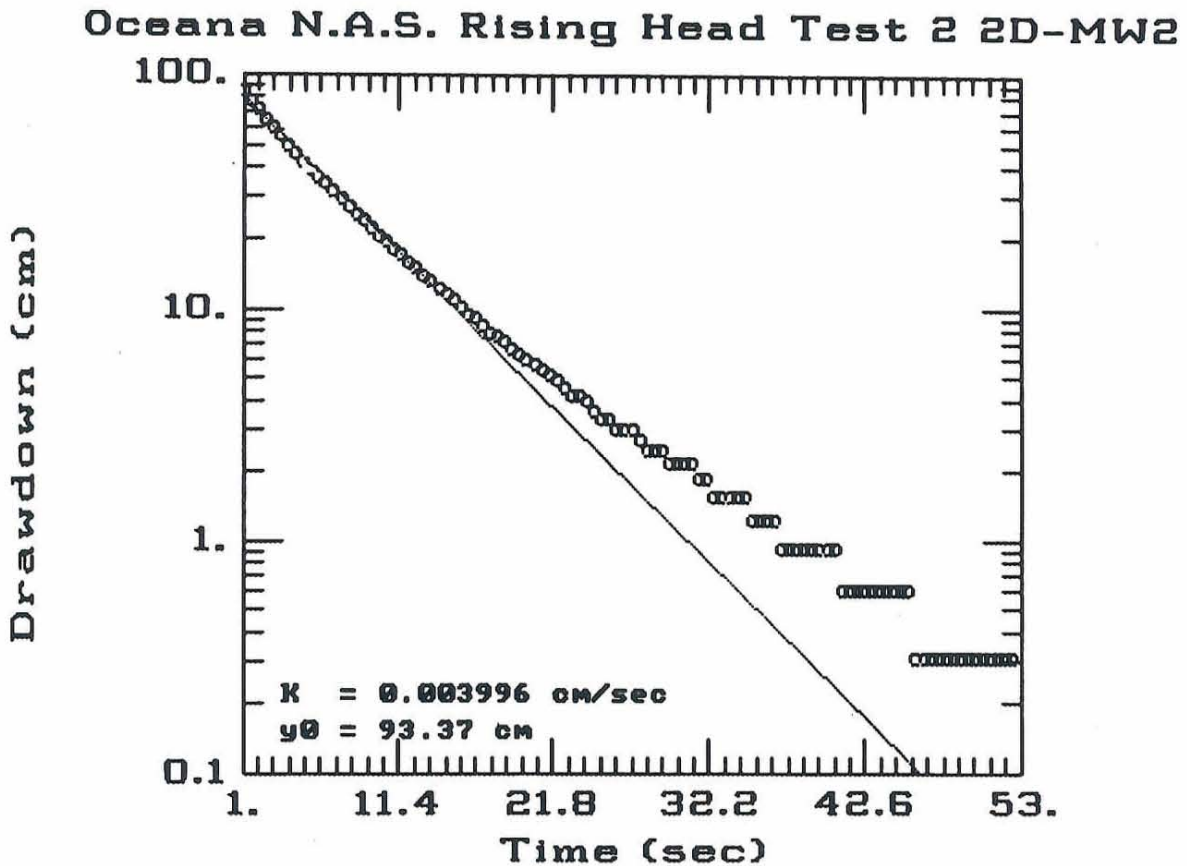

Oceana N.A.S. Rising Head Test 1 2D-MW1
100.
10.
1.
0.1
Drawdown (cm)
K = 0.009229 cm/sec
y0 = 91.16 cm
0.
2.
4.
6.
8.
10.
Time (sec)

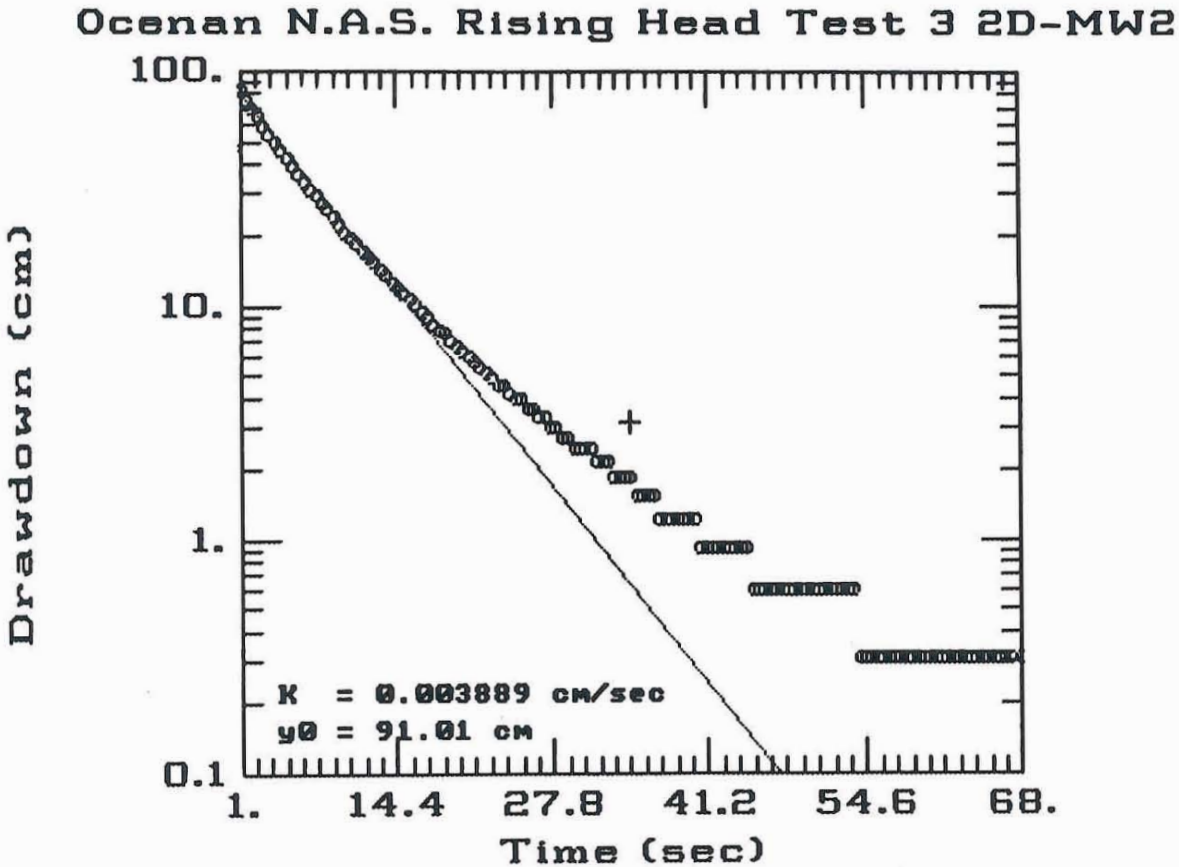

Oceana N.A.S. Rising Head Test 2 2D-MW1
100.
10.
1.
0.1
Drawdown (cm)
K = 0.006142 cm/sec
y0 = 93.65 cm
0.
6.4
12.8
19.2
25.6
32.
Time (sec)

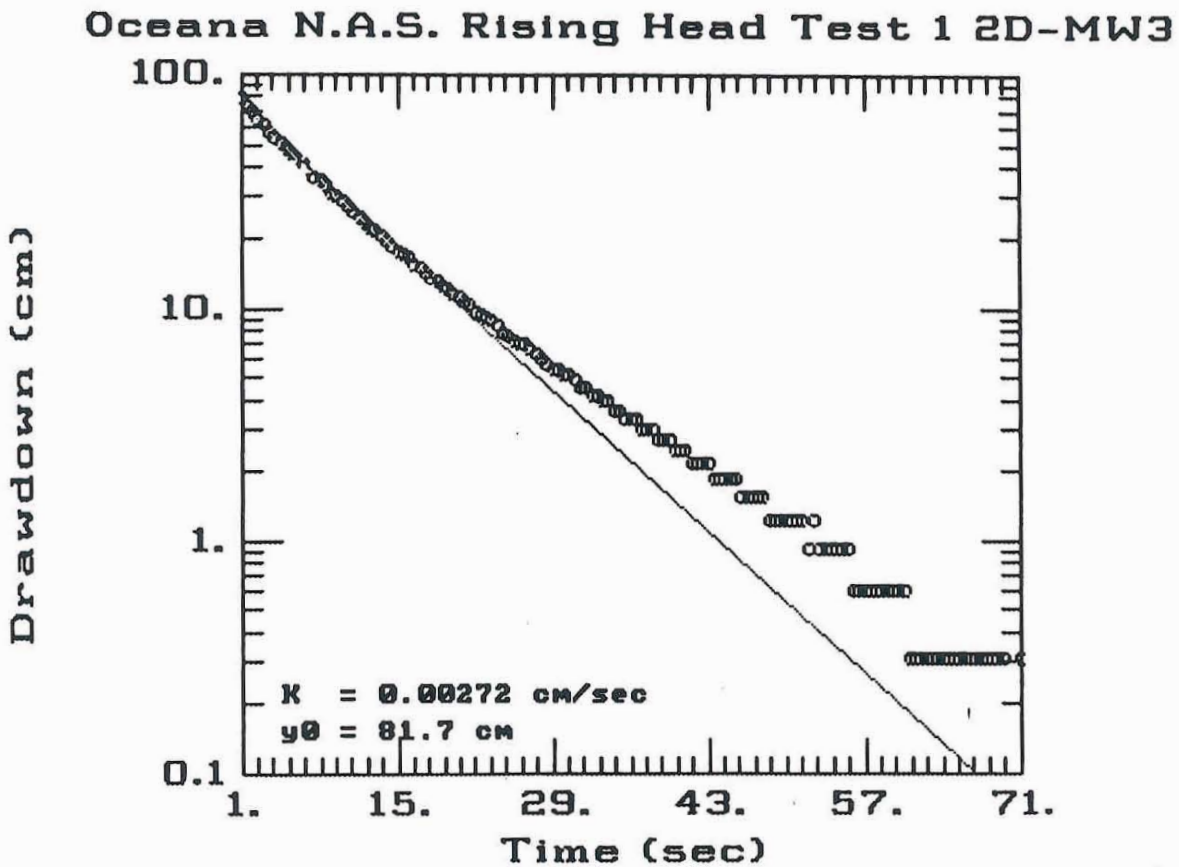

Oceana N.A.S. Rising Head Test 3 2D-MW1
100.
10.
1.
0.1
Drawdown (cm)
K = 0.007511 cm/sec
y0 = 87.33 cm
0.
2.6
5.2
7.8
10.4
13.
Time (sec)

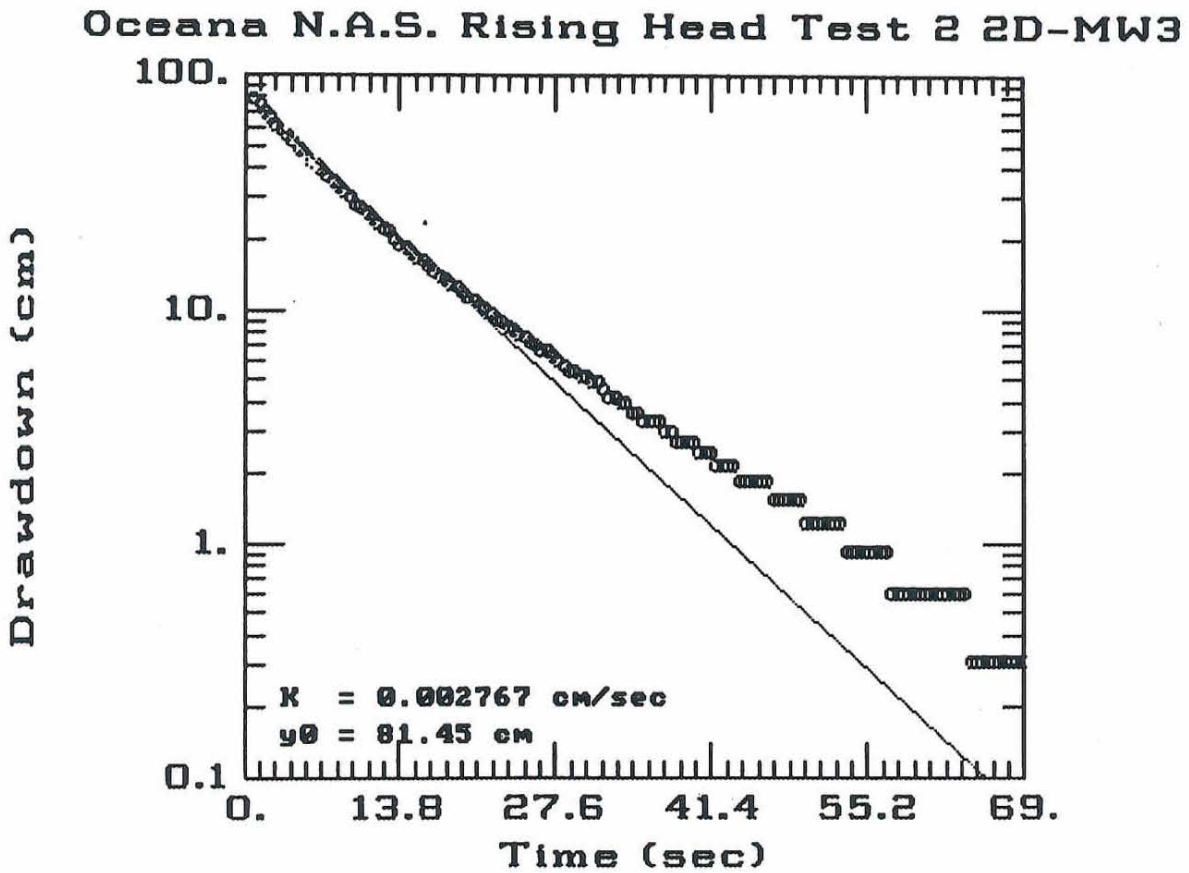

Oceana N.A.S. Rising Head Test 4 2D-MW1
100.
10.
1.
0.1
Drawdown (cm)
K = 0.007534 cm/sec
y0 = 93.49 cm
1.
3.6
6.2
8.8
11.4
14.
Time (sec)

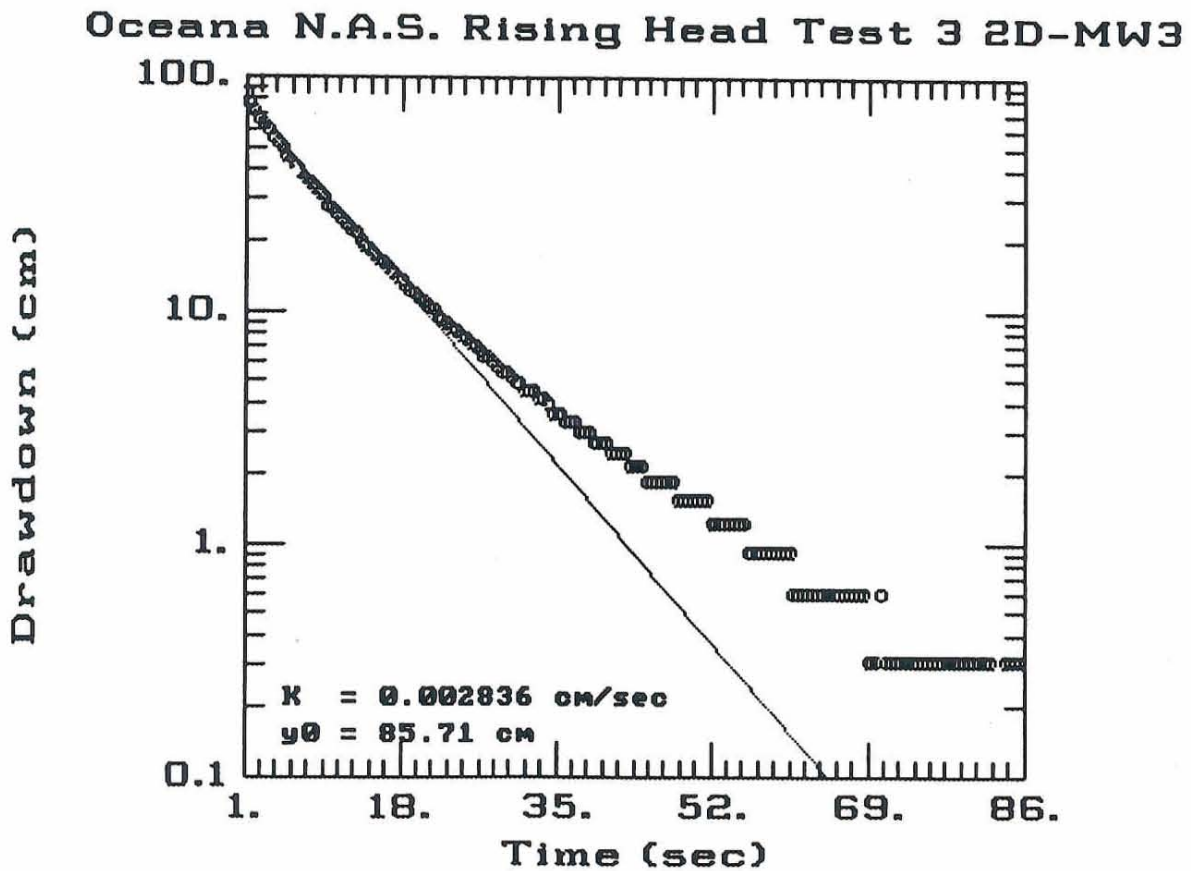

Oceana N.A.S. Rising Head Test 1 2D-MW2
100.
10.
1.
0.1
Drawdown (cm)
K = 0.004112 cm/sec
y0 = 91.19 cm
1.
8.8
16.6
24.4
32.2
40.
Time (sec)

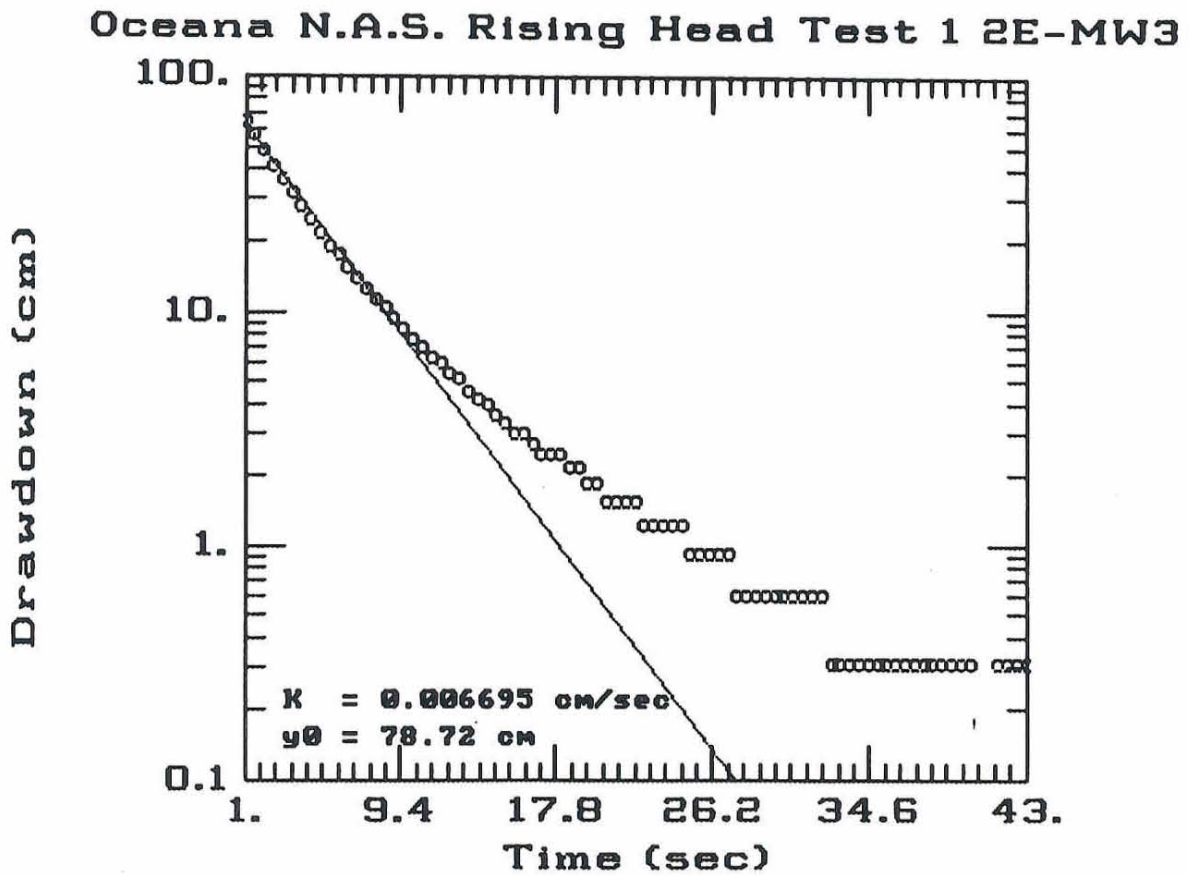

Oceana N.A.S. Rising Head Test 2 2D-MW2
100.
10.
1.
0.1
Drawdown (cm)
K = 0.003996 cm/sec
y0 = 93.37 cm
1.
11.4
21.8
32.2
42.6
53.
Time (sec)

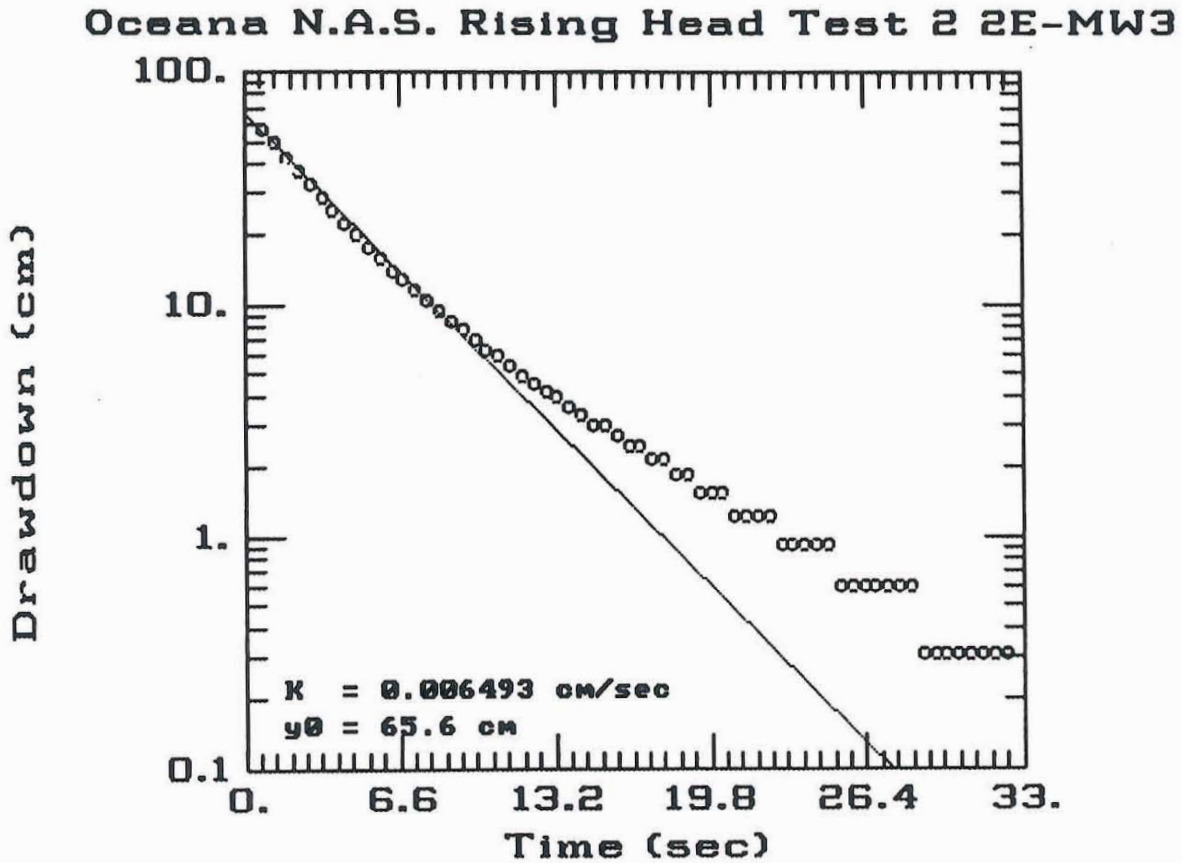

Ocenan N.A.S. Rising Head Test 3 2D-MW2
100.
10.
1.
0.1
Drawdown (cm)
K = 0.003889 cm/sec
y0 = 91.01 cm
1.
14.4
27.8
41.2
54.6
68.
Time (sec)

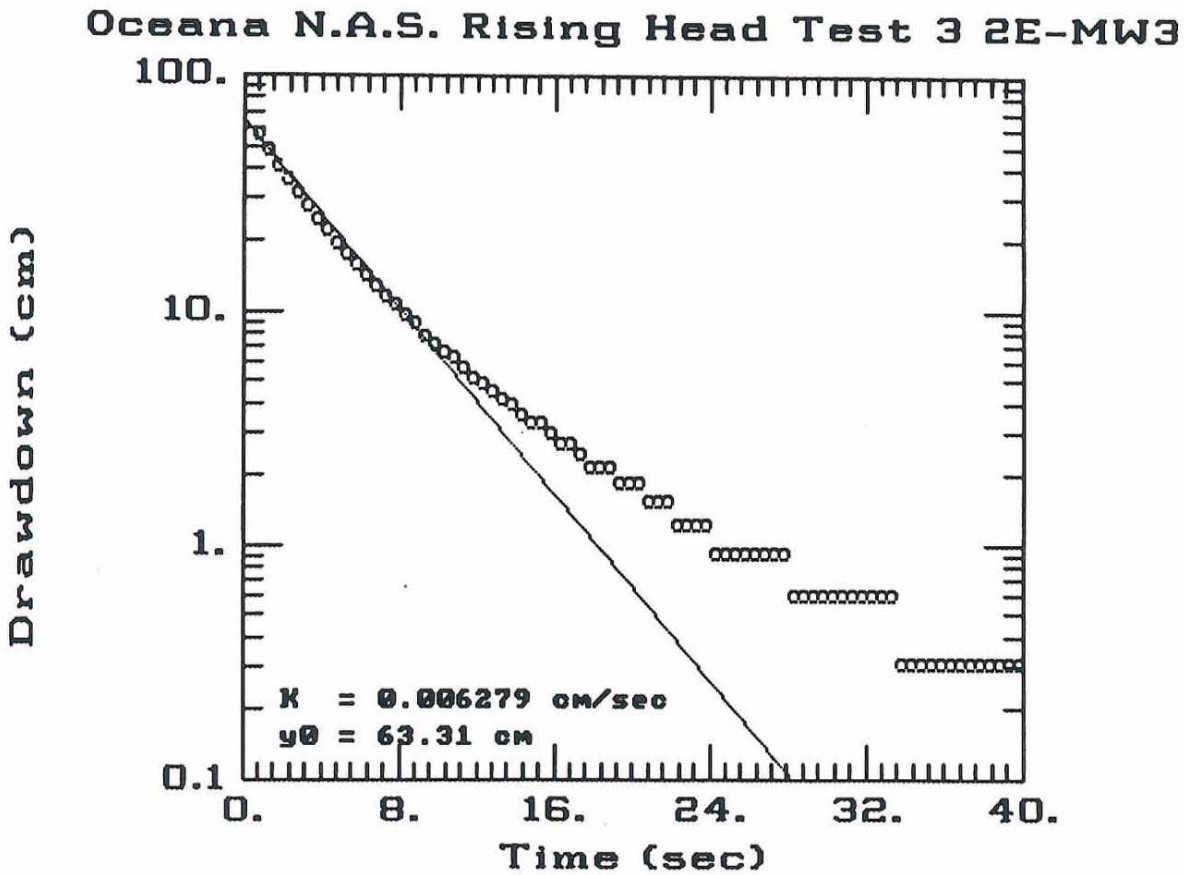

Oceana N.A.S. Rising Head Test 1 2D-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.00272 cm/sec
y0 = 81.7 cm
1.
15.
29.
43.
57.
71.
Time (sec)

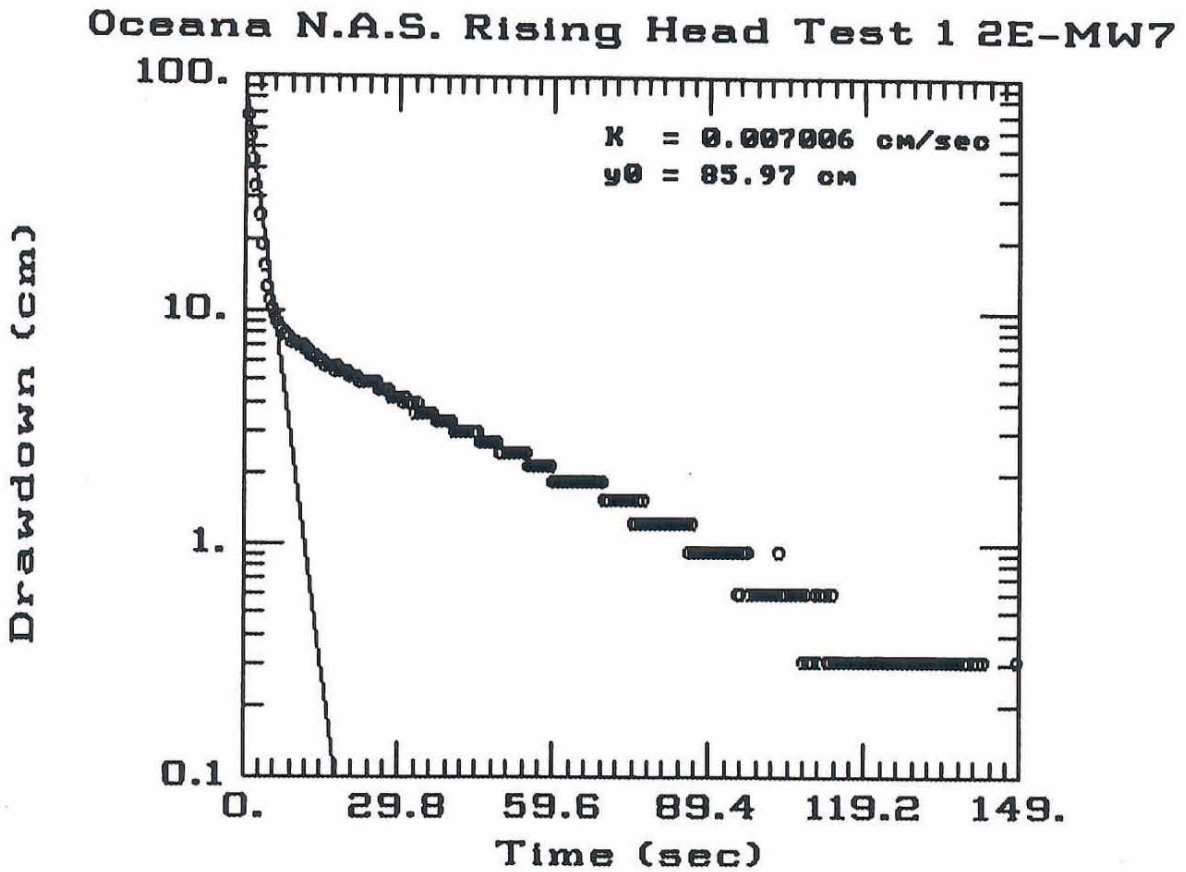

Oceana N.A.S. Rising Head Test 2 2D-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.002767 cm/sec
y0 = 81.45 cm
0.
13.8
27.6
41.4
55.2
69.
Time (sec)

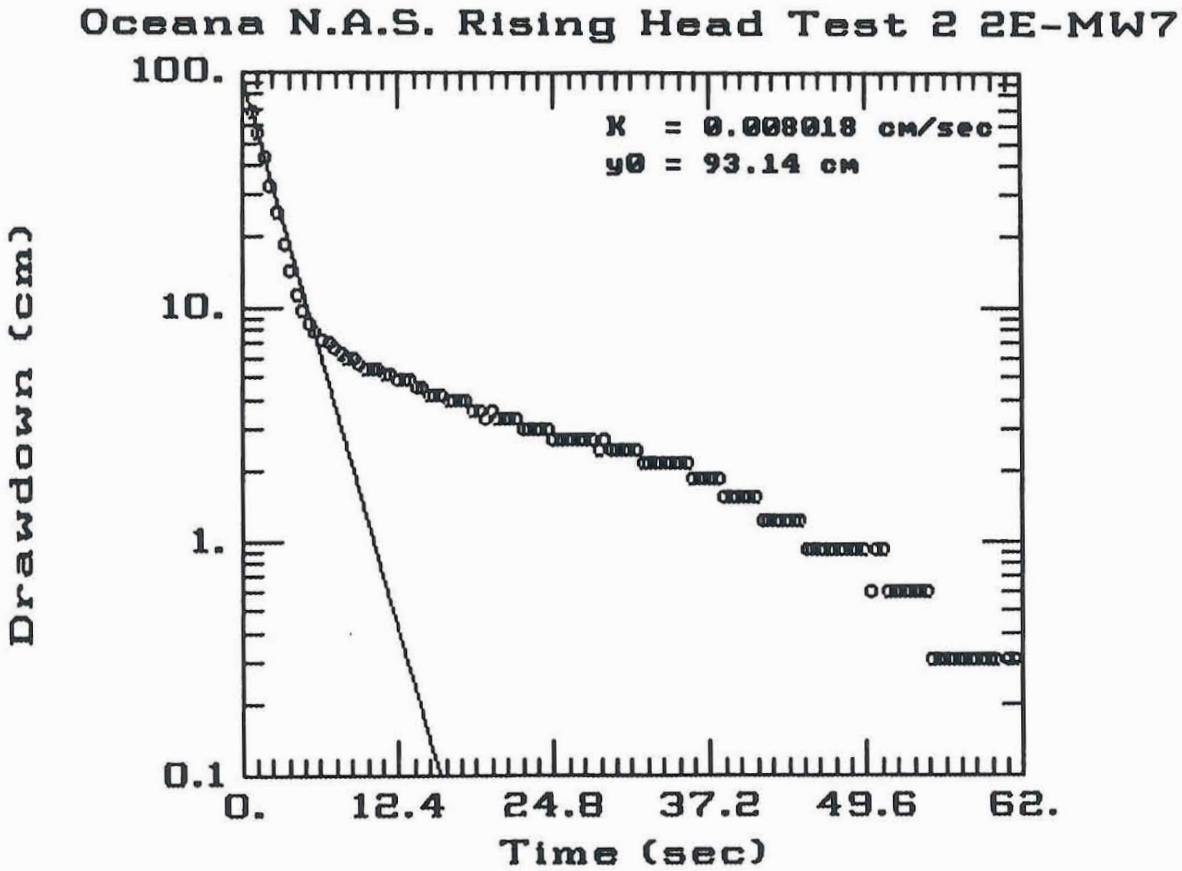

Oceana N.A.S. Rising Head Test 3 2D-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.002836 cm/sec
y0 = 85.71 cm
1.
18.
35.
52.
69.
86.
Time (sec)

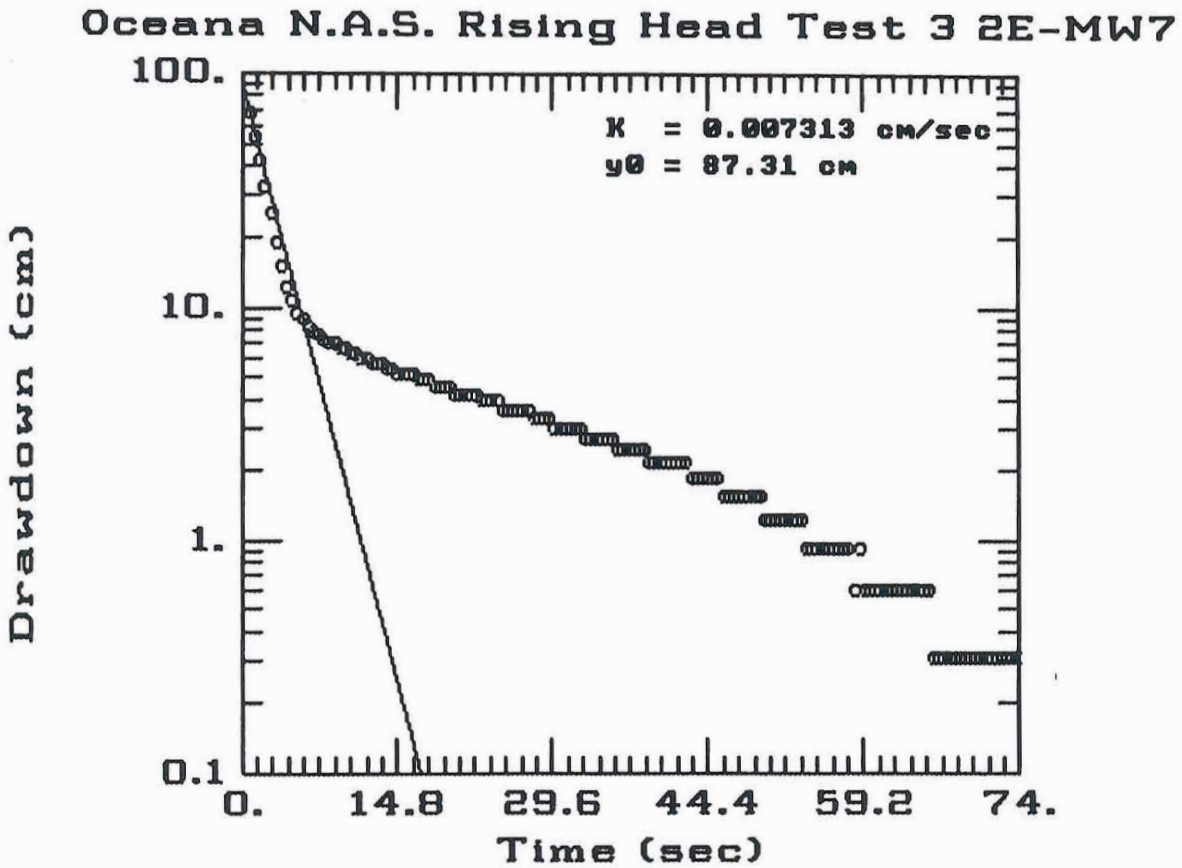

Oceana N.A.S. Rising Head Test 1 2E-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.006695 cm/sec
y0 = 78.72 cm
1.
9.4
17.8
26.2
34.6
43.
Time (sec)

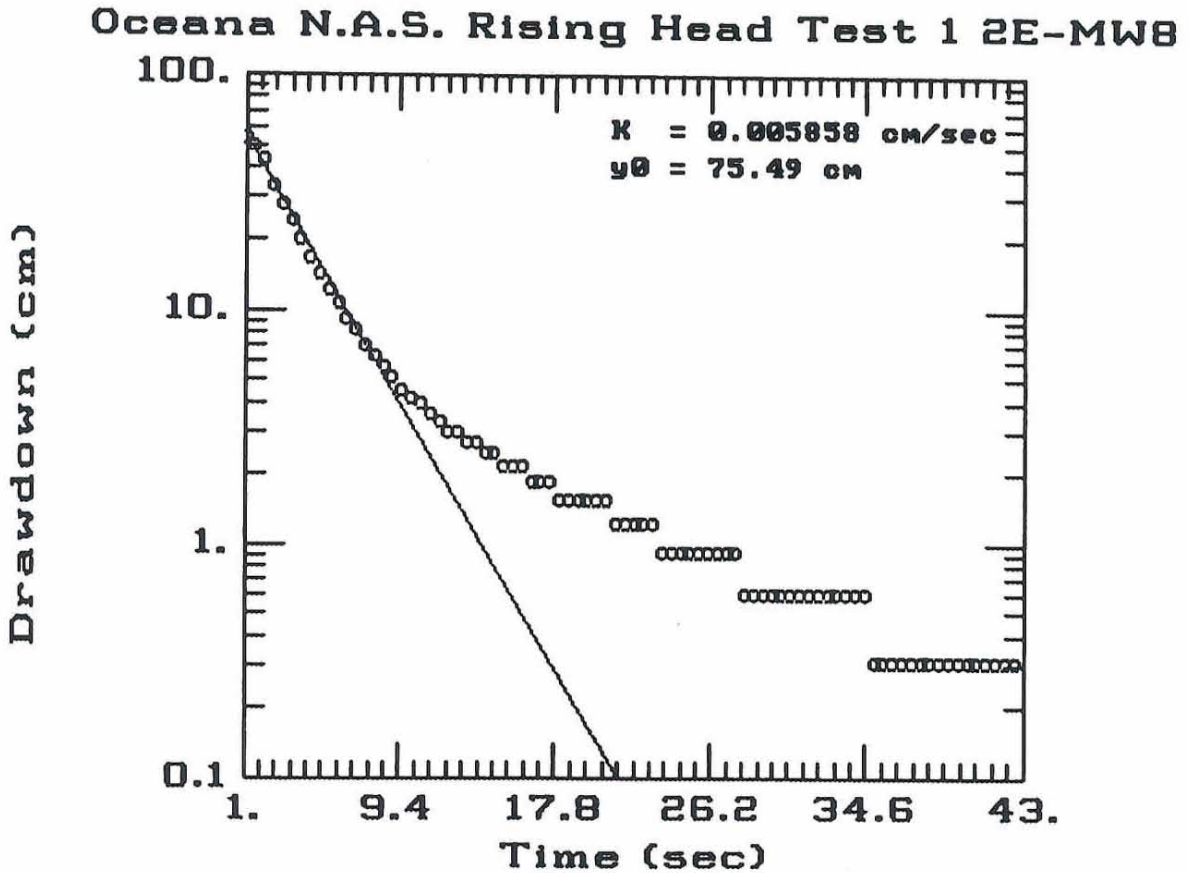

Oceana N.A.S. Rising Head Test 2 2E-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.006493 cm/sec
y0 = 65.6 cm
0.
6.6
13.2
19.8
26.4
33.
Time (sec)

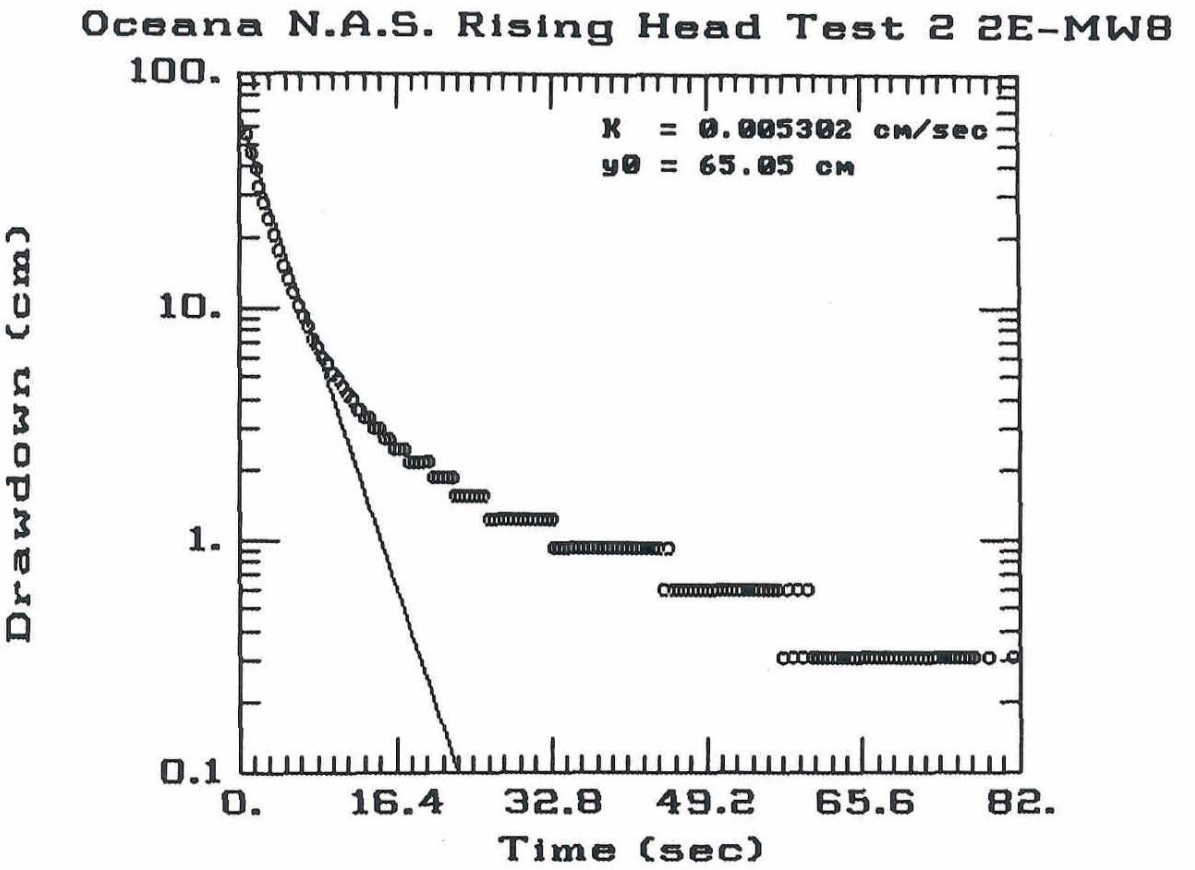

Oceana N.A.S. Rising Head Test 3 2E-MW3
100.
10.
1.
0.1
Drawdown (cm)
K = 0.006279 cm/sec
y0 = 63.31 cm
0.
8.
16.
24.
32.
40.
Time (sec)

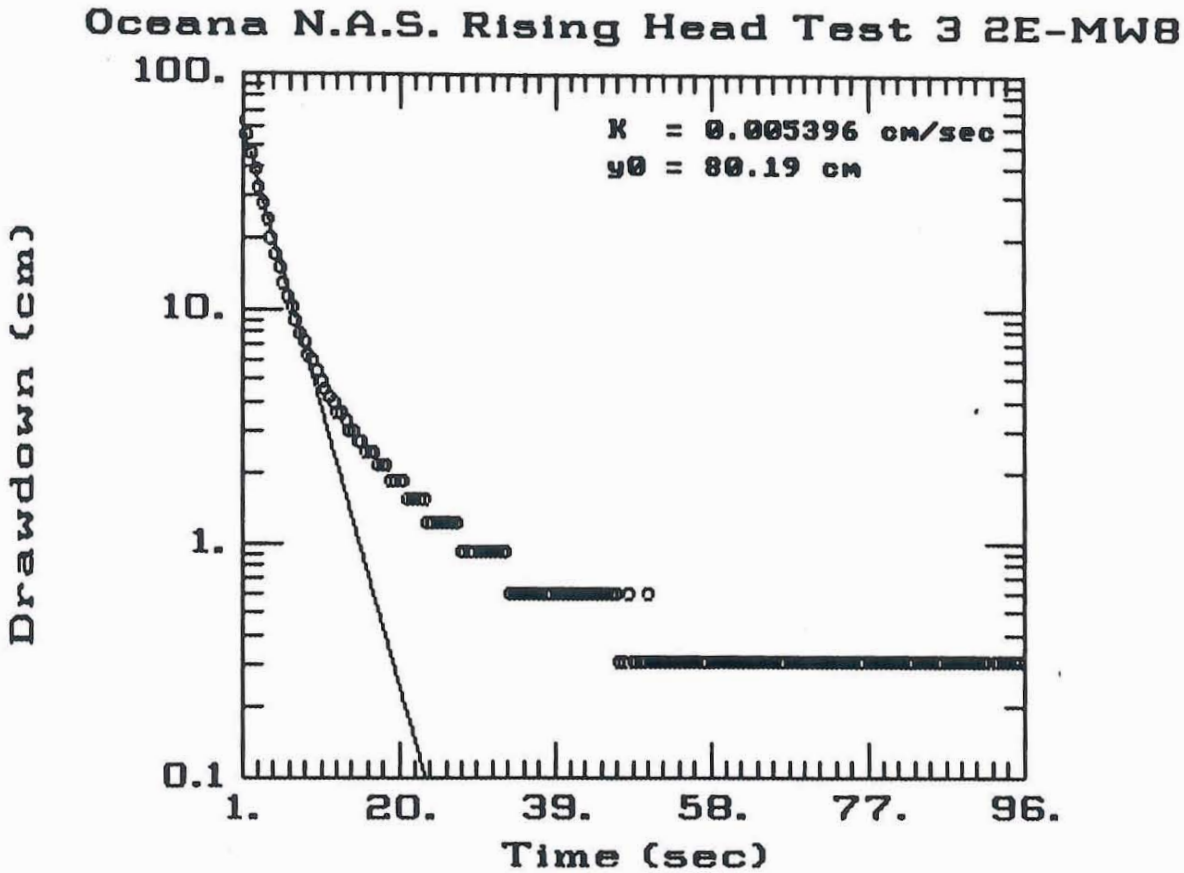

Oceana N.A.S. Rising Head Test 1 2E-MW7
K = 0.007006 cm/sec
y0 = 85.97 cm
Drawdown (cm)
100.
10.
1.
0.1
0.
29.8
59.6
89.4
119.2
149.
Time (sec)

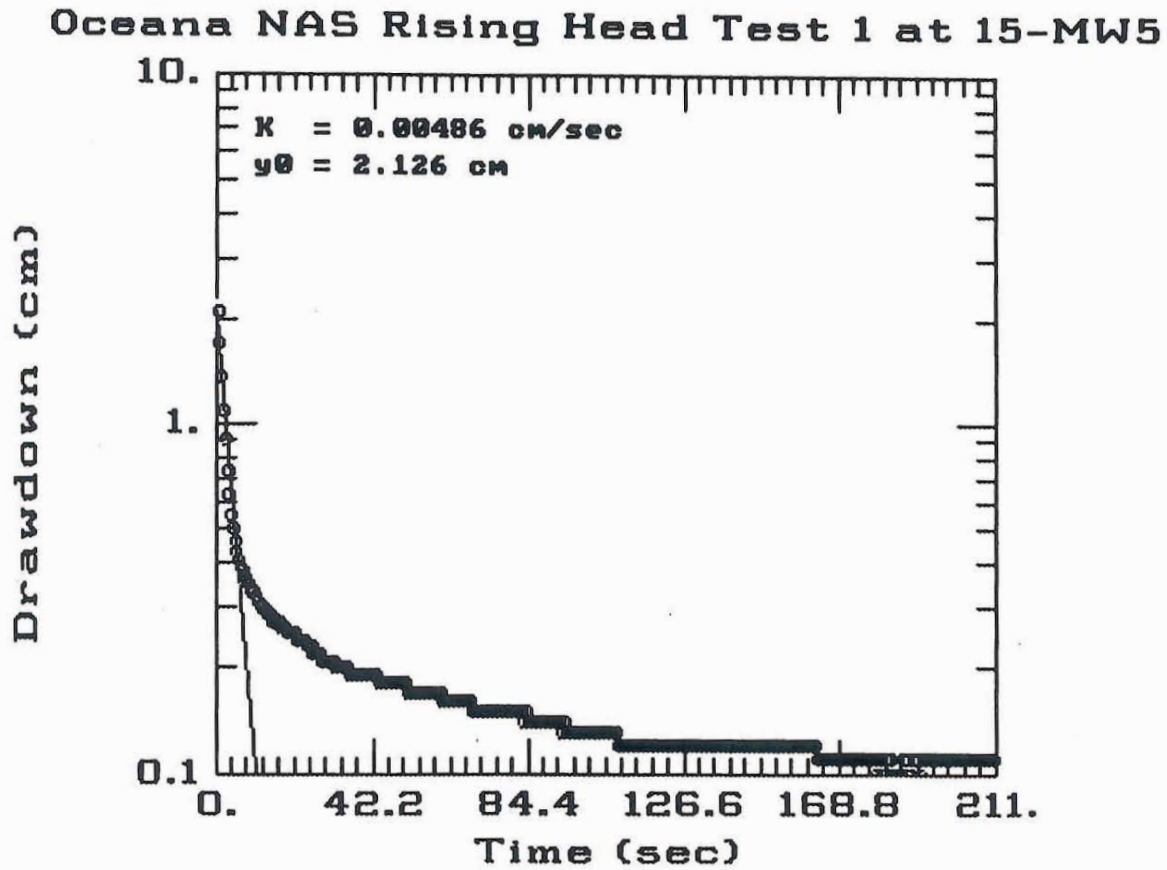

Oceana N.A.S. Rising Head Test 2 2E-MW7
K = 0.008018 cm/sec
y0 = 93.14 cm
Drawdown (cm)
100.
10.
1.
0.1
0.
12.4
24.8
37.2
49.6
62.
Time (sec)

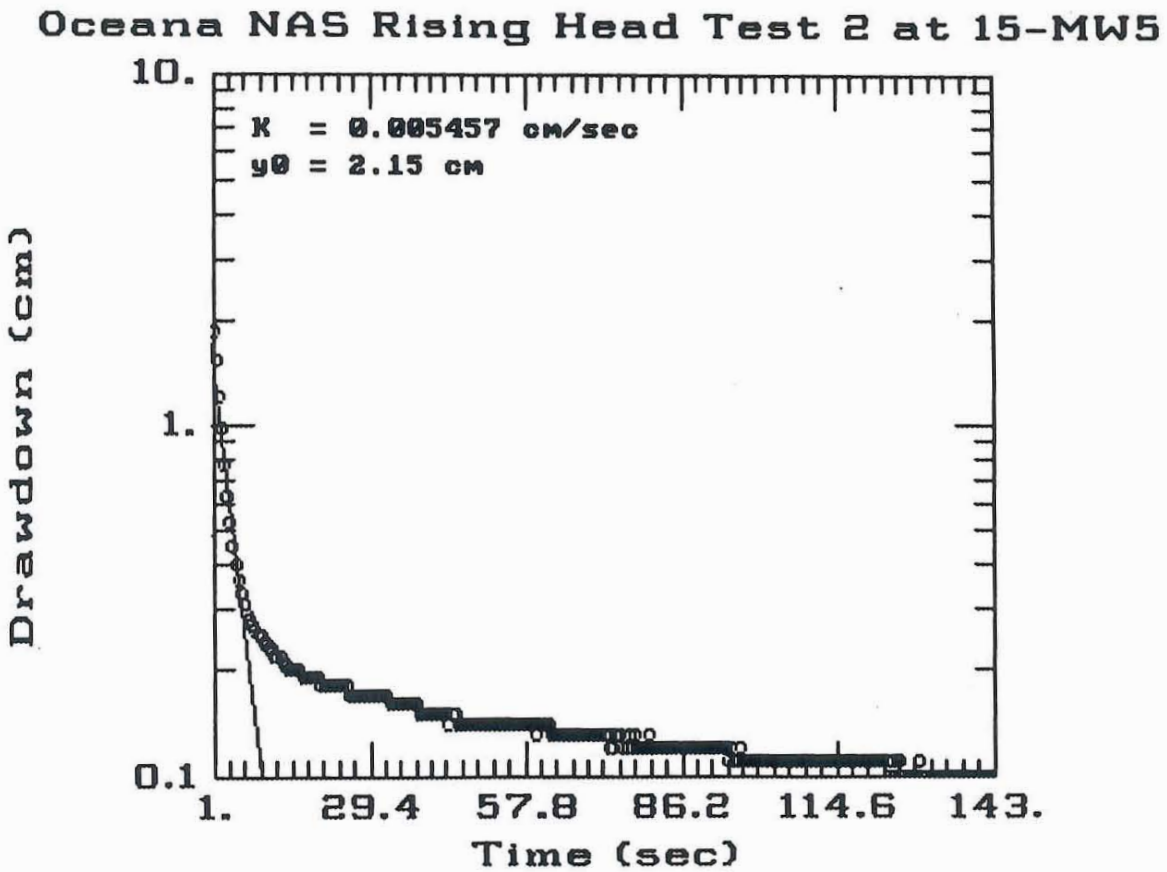

Oceana N.A.S. Rising Head Test 3 2E-MW7
K = 0.007313 cm/sec
y0 = 87.31 cm
Drawdown (cm)
100.
10.
1.
0.1
0.
14.8
29.6
44.4
59.2
74.
Time (sec)

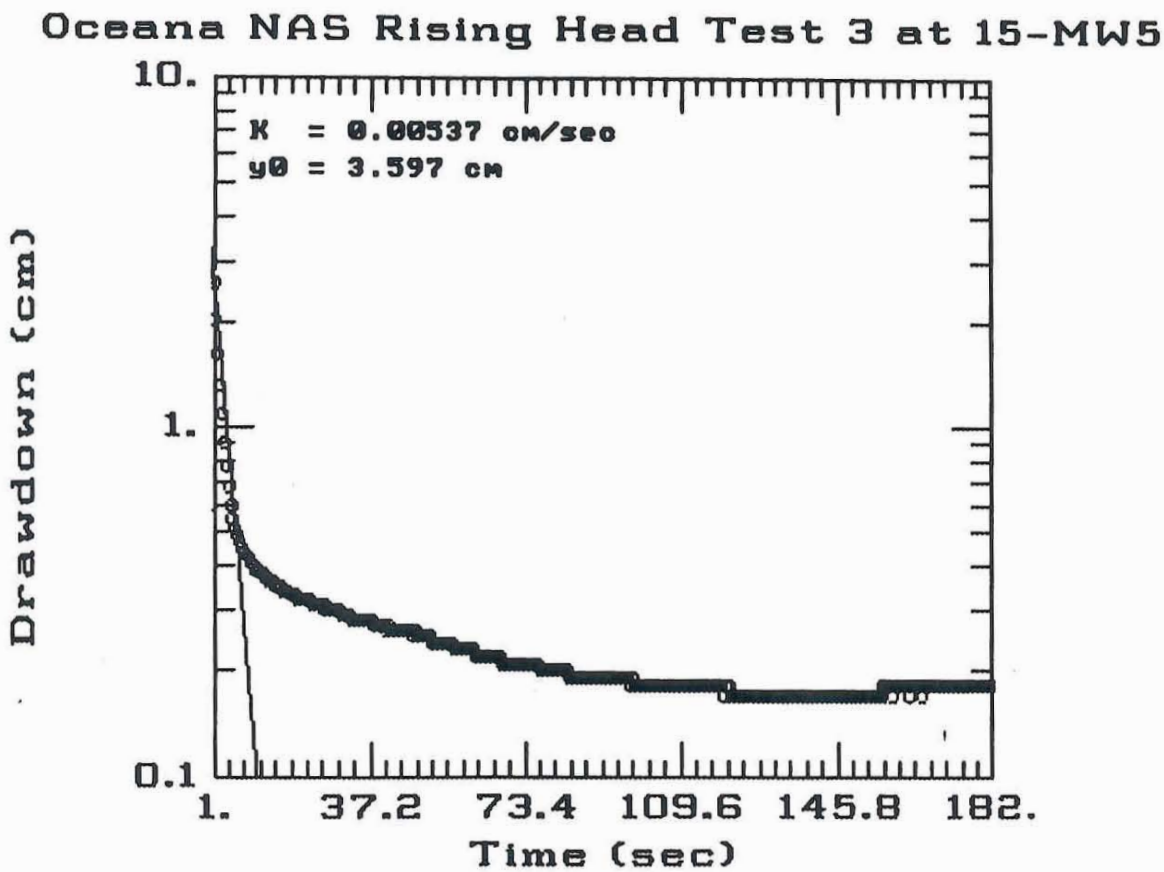

Oceana N.A.S. Rising Head Test 1 2E-MW8
K = 0.005858 cm/sec
y0 = 75.49 cm
Drawdown (cm)
100.
10.
1.
0.1
1.
9.4
17.8
26.2
34.6
43.
Time (sec)

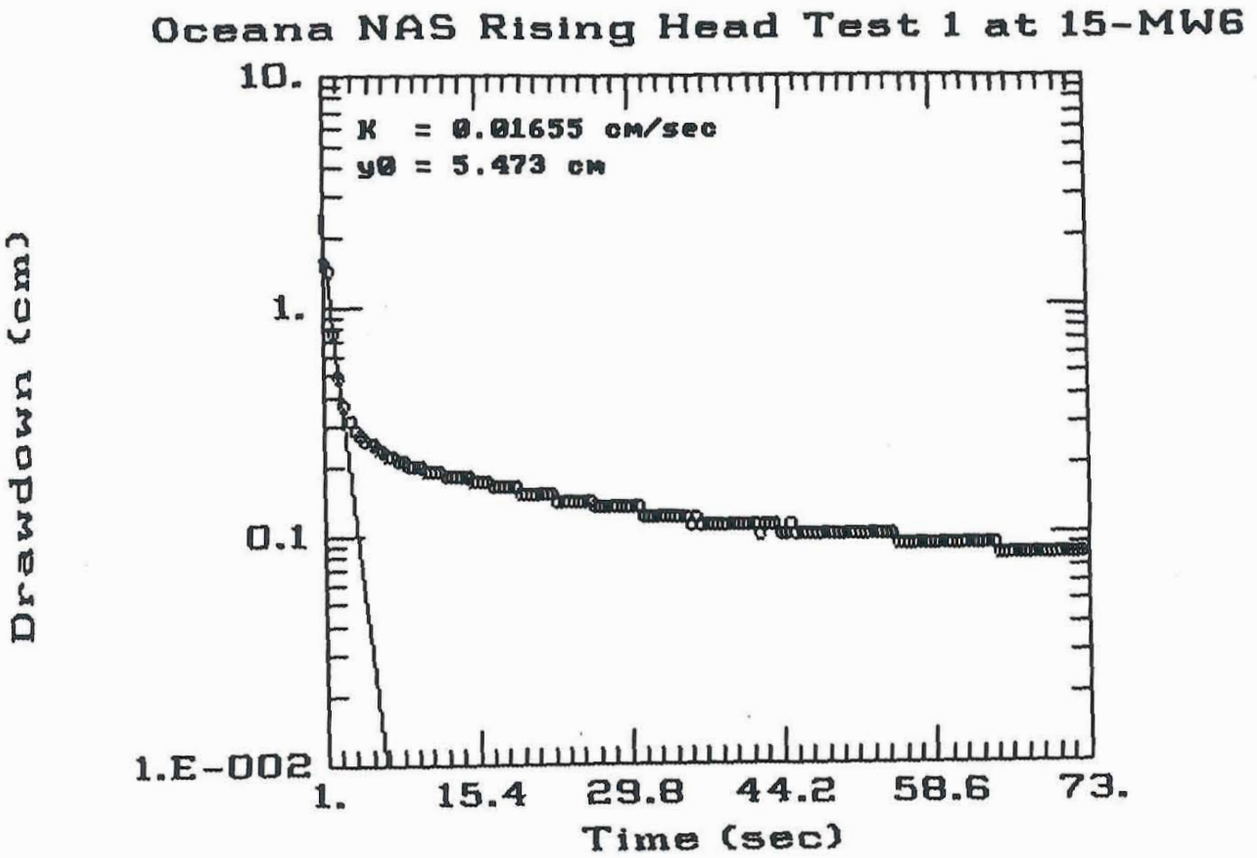

Oceana N.A.S. Rising Head Test 2 2E-MW8
K = 0.005302 cm/sec
y0 = 65.05 cm
100.
10.
1.
0.1
Drawdown (cm)
0.
16.4
32.8
49.2
65.6
82.
Time (sec)

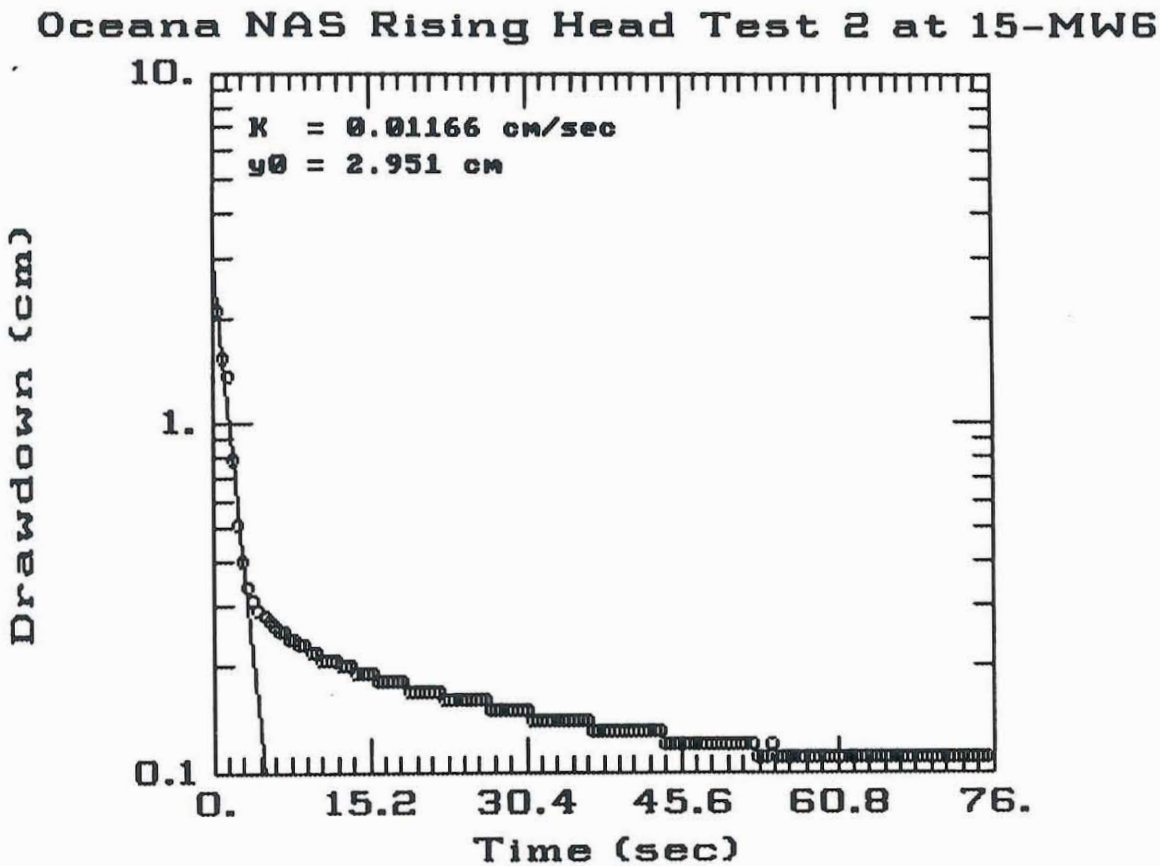

Oceana N.A.S. Rising Head Test 3 2E-MW8
K = 0.005396 cm/sec
y0 = 80.19 cm
100.
10.
1.
0.1
Drawdown (cm)
1.
20.
39.
58.
77.
96.
Time (sec)

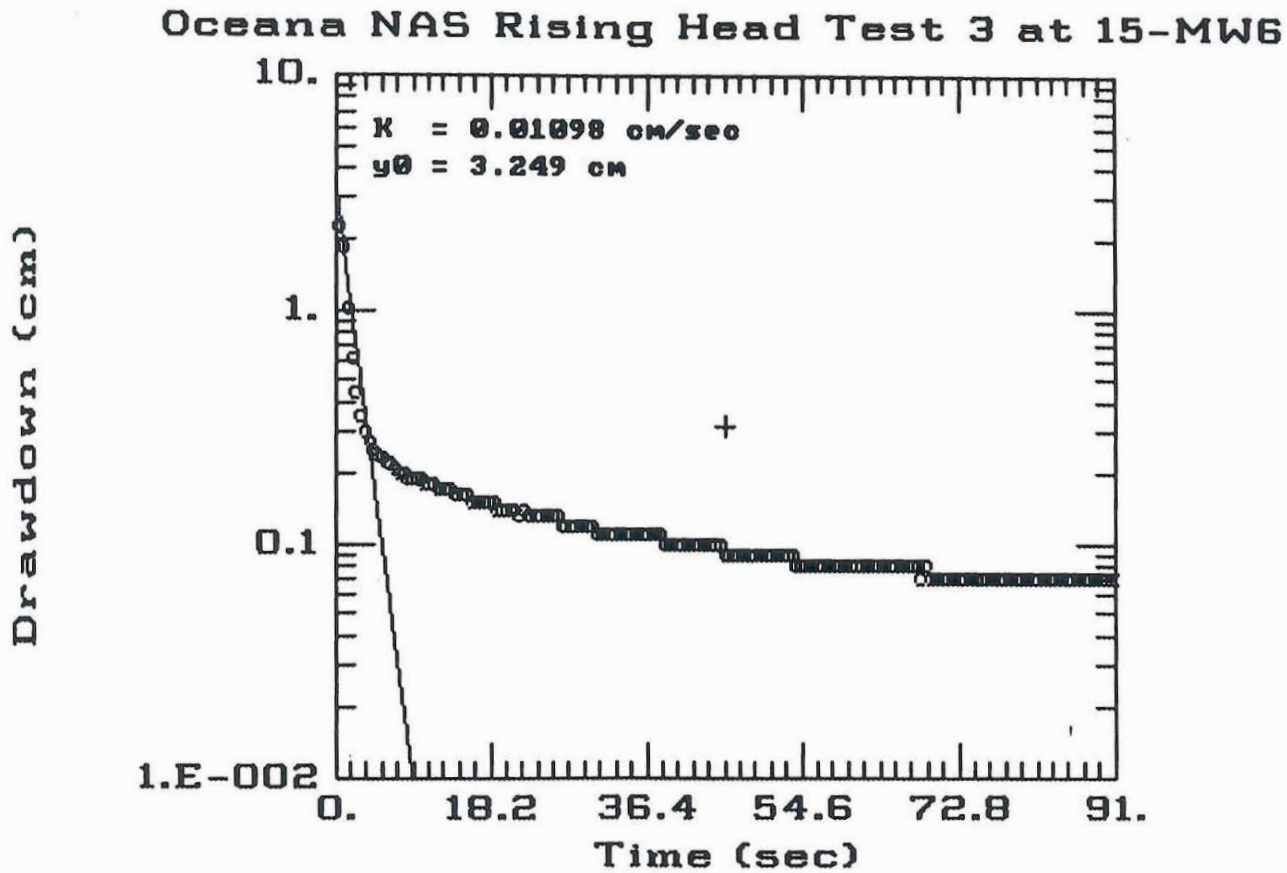

Oceana NAS Rising Head Test 1 at 15-MW5
K = 0.00486 cm/sec
y0 = 2.126 cm
Drawdown (cm)
10.
1.
0.1
0.
42.2
84.4
126.6
168.8
211.
Time (sec)

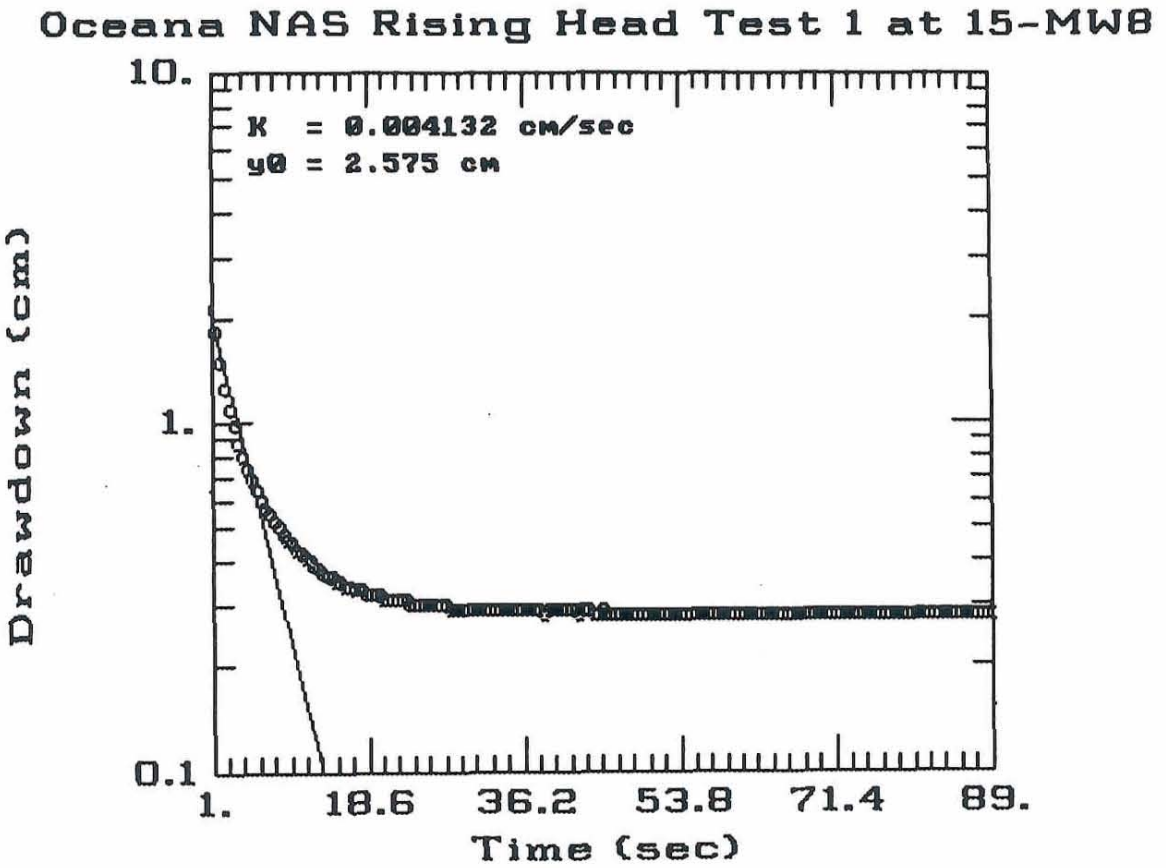

Oceana NAS Rising Head Test 2 at 15-MW5
K = 0.005457 cm/sec
y0 = 2.15 cm
Drawdown (cm)
10.
1.
0.1
1.
29.4
57.8
86.2
114.6
143.
Time (sec)

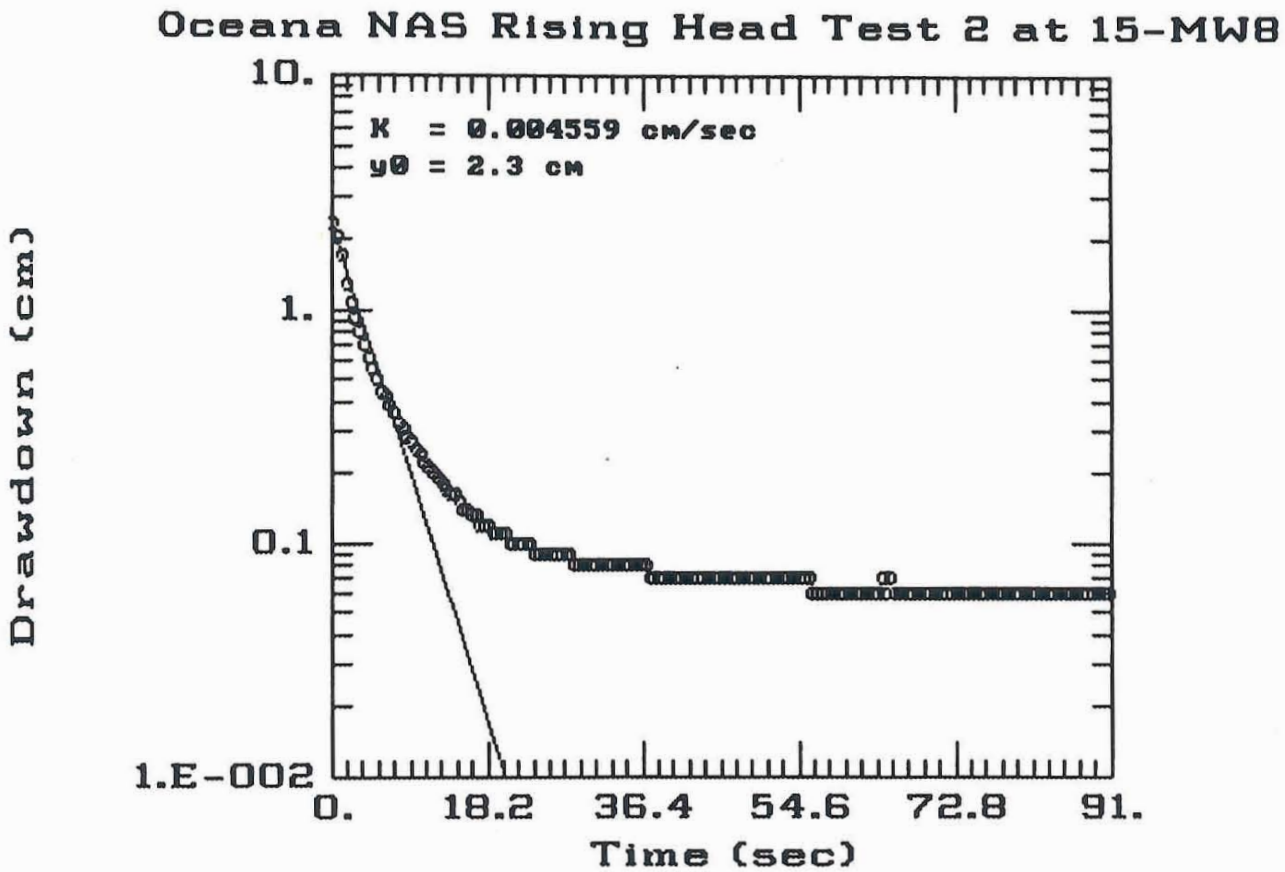

Oceana NAS Rising Head Test 3 at 15-MW5
K = 0.00537 cm/sec
y0 = 3.597 cm
Drawdown (cm)
10.
1.
0.1
1.
37.2
73.4
109.6
145.8
182.
Time (sec)

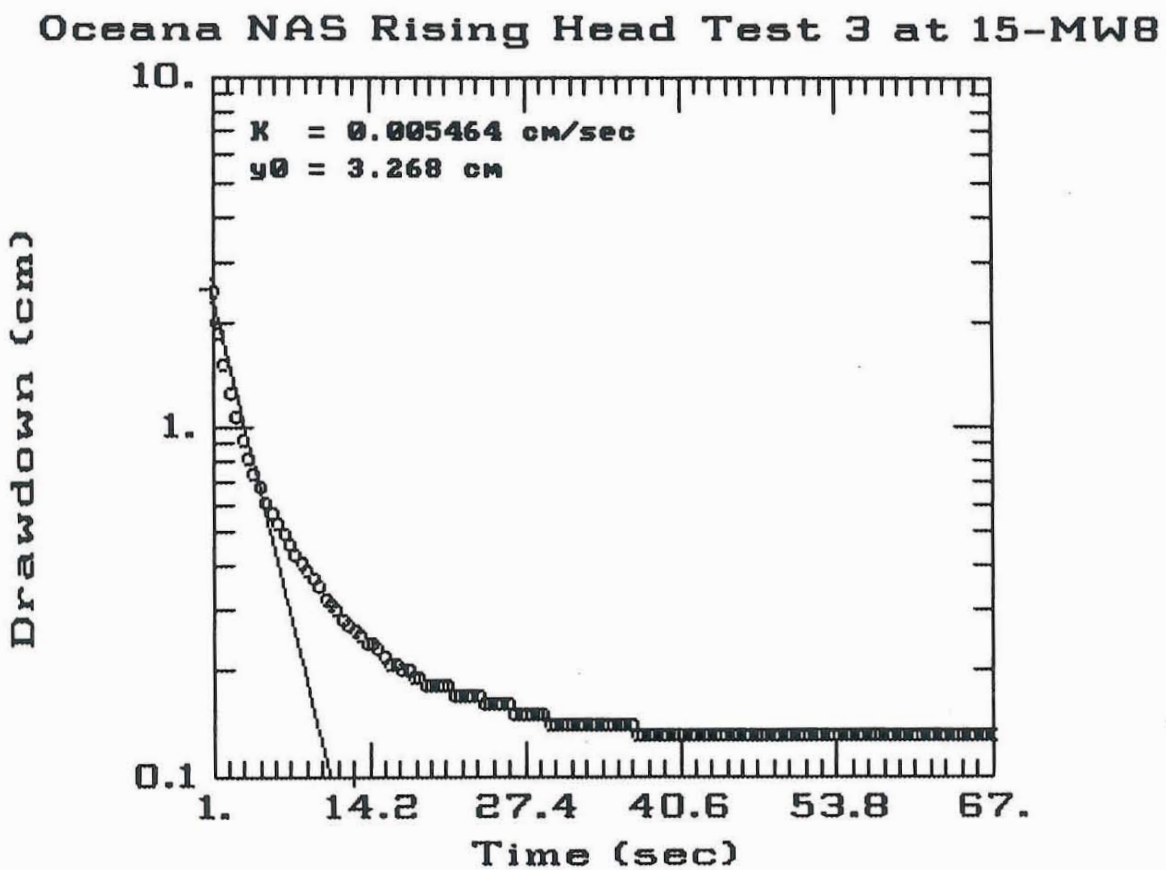

Oceana NAS Rising Head Test 1 at 15-MW6
K = 0.01655 cm/sec
y0 = 5.473 cm
Drawdown (cm)
10.
1.
0.1
1.E-002
1.
15.4
29.8
44.2
58.6
73.
Time (sec)


Oceana NAS Rising Head Test 2 at 15-MW6
K = 0.01166 cm/sec
y0 = 2.951 cm
Drawdown (cm)
10.
1.
0.1
0.
15.2
30.4
45.6
60.8
76.
Time (sec)


Oceana NAS Rising Head Test 3 at 15-MW6
K = 0.01098 cm/sec
y0 = 3.249 cm
10.
1.
0.1
1.E-002
Drawdown (cm)
0.
18.2
36.4
54.6
72.8
91.
Time (sec)


Oceana NAS Rising Head Test 1 at 15-MW8
K = 0.004132 cm/sec
y0 = 2.575 cm
Drawdown (cm)
10.
1.
0.1
1.
18.6
36.2
53.8
71.4
89.
Time (sec)


Oceana NAS Rising Head Test 2 at 15-MW8
K = 0.004559 cm/sec
y0 = 2.3 cm
Drawdown (cm)
10.
1.
0.1
1.E-002
0.
18.2
36.4
54.6
72.8
91.
Time (sec)


Oceana NAS Rising Head Test 3 at 15-MW8
K = 0.005464 cm/sec
y0 = 3.268 cm
Drawdown (cm)
10.
1.
0.1
1.
14.2
27.4
40.6
53.8
67.
Time (sec)

Appendix D
Other Field Activities

Appendix D

Other Field Activities

Surveying and investigation-derived waste (IDW) management were also part of the POL/ CMS/RFI Phase II field investigations. Baldwin and Gregg, Inc., of Norfolk, Virginia, surveyed the new monitoring well locations for vertical control. The elevations of the newly installed monitoring wells were surveyed to an accuracy of +0.01 feet. At Site 1 and Site 15, horizontal coordinates also were recorded at the new monitoring wells due to the lack of context resulting from heavy vegetation at these sites. In addition, permanent benchmarks were installed and surveyed in the drainage ditches at Site 1 and Site 2B, and the Site 2D wetland's elevation also was surveyed. The benchmarks and monitoring well elevations were essential for calculating groundwater flow gradients. The elevation data for all wells at active groundwater sites are presented in Table D-1. The horizontal coordinates of the new monitoring wells at Site 1 and Site 15 are presented in Table D-2.

Management of investigation-derived waste was necessary during the field investigation to prevent exposure to potentially hazardous soil and groundwater brought to the surface during the investigation. The investigation generated a large and varied waste stream comprised of soil cuttings, personal protective equipment (PPE), and purge and development water. An IDW management plan was written to document the procedures for handling each type of waste generated during the investigation. The IDW was managed as follows:

- All PPE and soil cuttings were separated and drummed during drilling. Select drums were sampled for TCLP analyses to determine if they were hazardous.

Table D-1
NAS OCEANA MONITORING WELL ELEVATIONS AND DEPTHS

Well	Ground Elevation (Ft. above MSL)	Survey Point Elevation (Ft. above MSL)	Total Depth of Well[c] (Feet)
1-MW1	15.3	17.13	22
1-MW2	17.0	18.59	19
1-MW3	17.3	19.33	19
1-MW4	16.9	19.90	18.5
1-MW5	16.7	19.08	18.5
1-MW6	15.4	18.18	20.5
1-MW7	17.2	19.23	22.5
1-MW7D	17.3	17.68	57
1-MW8	15.2	18.17	22
1-MW8D	15.4	18.46	55
1-MW9D	15.3	17.75	65
1-MW-10	17.1	19.21	18
2B-MW1	21.8	21.59[a]	19
2B-MW1D	21.73	21.73	55
2B-MW2	18.9	20.34	25
2B-MW3	18.0	19.23	20
2B-MW4	20.9	20.93	19
2B-MW5	21.5	21.49	18
2B-MW5D	21.5	21.53	51
2B-MW6	21.0	21.01	15
2B-MW7	18.7	20.95	14
2B-MW8	18.0	20.02	22.5
2B-MW9	20.5	22.27	20
2B-MW10	22.1	22.07	18
2B-MW11	22.1	22.07	18.1
2B-MW12	18.4	21.29	22.5
2B-MW13	17.9	20.40	21
2B-MW14	17.4	20.41	20
2B-MW15	19.0	21.97	22.5
2B-MW16	21.16	21.16	20
2B-MW17	21.7	21.66	24
2B-MW18	21.0	22.75	24
2B-MW19	18.2	18.22	20
2B-MW20	19.1	19.08	20

Table D-1
NAS OCEANA MONITORING WELL ELEVATIONS AND DEPTHS

Well	Ground Elevation (Ft. above MSL)	Survey Point Elevation (Ft. above MSL)	Total Depth of Well[c] (Feet)
1-MW1	15.3	17.13	22.0
1-MW2	17.0	18.59	19.0
1-MW3	17.3	19.33	19.0
1-MW4	16.9	19.90	18.5
1-MW5	16.7	19.08	18.5
1-MW6	15.4	18.18	20.5
1-MW7	17.2	19.23	22.5
1-MW7D	17.3	17.68	57.0
1-MW8	15.2	18.17	22.0
1-MW8D	15.4	18.46	55.0
1-MW9D	15.3	17.75	65.0
1-MW-10	17.1	19.21	18.0
2B-MW1	21.8	21.59[a]	19.0
2B-MW1D	21.73	21.73	55.0
2B-MW2	18.9	20.34	25.0
2B-MW3	18.0	19.23	20.0
2B-MW4	20.9	20.93	19.0
2B-MW5	21.5	21.49	18.0
2B-MW5D	21.5	21.53	51.0
2B-MW6	21.0	21.01	15.0
2B-MW7	18.7	20.95	14.0
2B-MW8	18.0	20.02	22.5
2B-MW9	20.5	22.27	20.0
2B-MW10	22.1	22.07	18.0
2B-MW11	22.1	22.07	18.1
2B-MW12	18.4	21.29	22.5
2B-MW13	17.9	20.40	21.0
2B-MW14	17.4	20.41	20.0
2B-MW15	19.0	21.97	22.5
2B-MW16	21.16	21.16	20.0
2B-MW17	21.7	21.66	24.0
2B-MW18	21.0	22.75	24.0
2B-MW19	18.2	18.22	20.0
2B-MW20	19.1	19.08	20.0

Table D-1
NAS OCEANA MONITORING WELL ELEVATIONS AND DEPTHS

Well	Ground Elevation (Ft. above MSL)	Survey Point Elevation (Ft. above MSL)	Total Depth of Well[c] (Feet)
2C-MW1	20.5	20.14[b]	20.0
2C-MW1D	20.43	20.43	62.0
2C-MW2	20.5	20.23[b]	20.0
2C-MW3	20.1	21.29	18.0
2C-MW4	18.0	19.56	18.0
2C-MW5	20.4	20.42	16.0
2C-MW6	20.7	23.18	22.0
2C-MW7	20.8	20.81	19.5
2C-MW8	19.0	19.05	18.0
2C-MW9	17.0	19.33	18.0
2C-MW9D	17.1	19.45	57.0
2C-MW10	18.24	18.24	20.0
2C-MW11	18.47	18.47	24.0
2C-MW12	17.84	17.84	24.0
2C-MW13	18.49	18.49	22.0
2C-MW14	19.5	19.47	24.0
2C-MW15	18.2	18.24	24.0
2C-MW16	18.8	18.84	24.0
2C-MW17	18.4	18.35	20.0
2C-MW18	18.2	18.23	19.0
2C-MW19	20.6	20.56	20.0
2C-MW20	19.4	19.42	20.0
2D-MW1	18.9	21.52	17.0
2D-MW2	22.3	22.26	19.0
2D-MW3	22.1	22.10	19.0
2D-MW4	22.4	22.40	20.0
2D-MW5	22.3	22.34	21.0

Table D-1
NAS OCEANA MONITORING WELL ELEVATIONS AND DEPTHS

Well	Ground Elevation (Ft. above MSL)	Survey Point Elevation (Ft. above MSL)	Total Depth of Well[c] (Feet)
2E-MW1	20.3	22.52	19.0
2E-MW2	19.4	19.43	18.5
2E-MW3	18.9	20.83	18.0
2E-MW4	20.7	20.69	22.0
2E-MW5	20.4	20.37	23.0
2E-MW6	20.5	20.51	23.0
2E-MW7	20.9	20.94	18.0
2E-MW8	20.4	20.43	20.0
2E-MW9	20.7	20.74	18.5
2E-MW10	21.4	21.64	20.0
2E-MW11	20.3	20.32	20.0
2E-MW12	20.6	20.60	20.0
2E-MW13	20.3	20.35	20.0
11-MW1	17.1	19.25	18.5
11-MW2	16.6	19.82	20.5
11-MW3	17.33	17.33	20.0
15-MW5	18.4	20.13	18.0
15-MW6	17.9	21.11	20.0
15-MW7	16.6	19.02	18.0
15-MW8	17.8	19.92	18.0
15-MW9	18.3	20.23	20.0
15-MW10	17.8	20.38	20.0
15-MW11	17.3	19.16	20.0
15-MW12	17.6	19.16	20.0
15-MW13	16.1	18.60	20.0
15-MW14	17.7	19.37	20.0
15-MW15	17.3	18.80	20.0
22-MW1	16.0	18.61	20.0
22-MW2	15.6	18.08	28.0
22-MW3	19.2	21.18	23.0
22-MW4	16.6	18.77	23.0

Table D-1
NAS OCEANA MONITORING WELL ELEVATIONS AND DEPTHS

Well	Ground Elevation (Ft. above MSL)	Survey Point Elevation (Ft. above MSL)	Total Depth of Well[c] (Feet)
24-MW1	17.0	17.34	20.0
24-MW2	16.9	18.76	20.0
24-MW3	16.0	16.06	20.0
24-MW4	17.3	17.37	20.0
24-MW5	17.0	17.14	20.0
24-MW6	17.7	17.79	19.0

[a]The survey point is the top of a 6″ protective steel casing, which is below grade and covered by a flush mount.
[b]The survey point is the top of PVC, which is below grade.
[c]The total depth of the well is estimated from the well log and drilling field notes.

WDCR895/010.WP5

Table D-2 COORDINATES OF NEW MONITORING WELLS AT SITES 1 AND 15	
Monitoring Well	**Coordinates**
1-MW10	N189101.0 E 2720169.0
15-MW5	N191571.0 E 2723878.0
15-MW6	N191606.0 E 2724307.0
15-MW7	N191715.0 E 2724385.0
15-MW8	N191915.0 E 2724263.0
15-MW9	N191747.0 E 2724180.0
15-MW10	N192147.0 E 2724149.0
15-MW11	N191832.0 E2724615.0
15-MW12	N192017.0 E2724581.0
15-MW13	N192290.0 E2723995.0
15-MW14	N192023.0 E2723796.0
15-MW15	N191367.0 E2723880.0

- The groundwater generated during well development and purging of the Site 2C, Site 2E, and Site 15 monitoring wells was contained in a tanker truck to avoid potential risk to human health and the environment. TCLP analyses of the groundwater indicated that the water was not hazardous and it was subsequently treated and disposed off the station at an industrial wastewater treatment plant.

C&M Waste Oil Distributors of Chesapeake, Virginia, provided a decontaminated tanker truck for containment of the groundwater. Refer to the IDW Management Plan (CH2M HILL, 1994) for additional details.

WDCR838/024.WP5

Appendix E
Data Validation Report

Appendix E

Data Validation Report

Introduction

Data validation is the technical review of a data package using criteria established in the Data Quality Objectives of the Quality Assurance Project Plan. Data validation for the analytical sampling at Oceana Naval Air Station (NAS) was done by Heartland Environmental Services, Inc., St. Peters, Missouri.

Validation Criteria

Samples that were analyzed using SW846 methods were reviewed and validated by Heartland personnel using the *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program, NEESA 20.2-047B (June 1988 revision),* the *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis (June 1991)*, the *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis (July 1988),* and method specific SW-846 requirements.

The data were screened to determine the usability of the results along with the contractual compliance relative to the analytical requirements and deliverables. The screening assumes that the analytical results are correct as reported and merely provides as interpretation of the reported quality control results.

A minimum of 10 percent of all laboratory calculations were verified and all instrument output, such as spectra and chromatogram were reviewed. Data is reviewed to determine if holding times, calibrations, matrix spikes, matrix spike duplicates, duplicates, laboratory control samples, serial dilutions, tunes, surrogate recoveries, and internal standards are

within established quality control criteria and to determine if method and field blanks have any contamination. Quality control criteria are established to show the accuracy and precision of the analyses.

Below is a summary of Heartland's findings organized by type of analysis. Sample results and specific qualifiers are presented on tables found in the body of this report and in data tables of the CMS and POL reports.

Volatiles

The holding times, tunes, matrix spikes, and matrix spike duplicates were all within specified criteria. Acetone, 2-hexanone, and 2-butanone were out of specification in some calibrations and dichlorodifluoromethane was out of specification in one calibration. An internal standard was out of specification for one sample and surrogate recoveries were out for two samples.

Acetone and methylene chloride were found in method, trip, and equipment blanks. Chloromethane and 2-butanone were found in different equipment blanks on one occasion each. Acetone and methylene chloride are used as extraction solvents; hence, they are common laboratory contaminants. When detected in a sample, the concentration reported is the actual concentration in the sample, i.e., correction for contamination also evidenced in method blank was not made. Therefore all the acetone and methylene chloride results qualified as such can be attributed to laboratory contamination.

Semivolatiles

No samples were qualified based on holding times, tunes, initial calibrations, internal standards, field blanks, surrogate recoveries, matrix spikes, or matrix spike duplicates. Di-n-butylphthalate contamination was found in a method blank. Continuing calibrations were out of specified criteria for six compounds (4,6-dinitro-2-methylphenol;

2,4-dinitrophenol; benzoic acid; 1,3,5-Trinitrobenzene; 4-Nitroquinoline-1-oxide; and hexachlorophene).

Organochlorine Pesticides and PCBs

All holding times, calibrations, blanks, surrogate recoveries, matrix spikes, matrix spike duplicates, and gas chromatograph (GC) performance were within specified criteria.

Organophosphorus Pesticides

Holding times, GC performance, calibrations, blanks, surrogate recoveries, matrix spikes, and matrix spike duplicates were all within specification.

Chlorinated Herbicides

Holding times, GC performance, calibrations, blanks, matrix spikes, and matrix spike duplicates were all within criteria. Surrogate recovery for one sample was outside criteria.

Kepone

Holding times, GC performance, calibrations, blanks, surrogate recoveries, matrix spikes, and matrix spike duplicates were all within criteria.

Polynuclear Aromatic Hydrocarbons (PNAs)

No qualifiers were applied for GC performance, continuing calibrations, blanks, matrix spikes, or matrix spike duplicates. Two initial calibrations were out of specification for benzo(a)anthracene and chrysene. One initial calibration was out for benzo(k)fluoranthene. Extraction holding times were exceeded for seven samples. Surrogate recoveries were outside specified criteria for two samples.

Total Petroleum Hydrocarbons (TPH)

Holding times, calibrations, blanks, matrix spikes, and laboratory control samples (LCS) were within specified criteria for all samples except those collected in October 1994. The LCS for TPH during the October event was below the lower control limits. Two duplicates were outside criteria.

Total Organic Carbon (TOC)

All holding times, calibrations, blanks, matrix spikes, duplicates, and LCSs were within criteria.

Sulfide

All holding times, calibrations, blanks, matrix spikes, duplicates, and LCSs were within criteria.

Metals and Cyanide

Holding times, calibrations, interference checks, LCSs, and serial dilutions were within criteria. Arsenic, aluminum, barium, beryllium, chromium, copper, cobalt, lead, sodium, thallium and zinc, were out of specified criteria in some method blanks. Matrix spikes were out of criteria for arsenic, mercury, copper, antimony, selenium, silver, thallium, and zinc. Serial dilutions where outside the control limits for aluminum, calcium, iron, magnesium, manganese, and sodium. Duplicates for aluminum, chromium, copper, iron, lead, manganese, mercury, and zinc were out of specified criteria. Furnace post digestion spikes were out of criteria for three samples.

Overall Assessment

All the data were reviewed against the data quality objectives defined earlier in the Quality Assurance Plan. Using NEESA level C deliverables, it is difficult to assess the accuracy, precision, and completeness because the required raw data are not available as they are with higher levels of QC. In some cases, the field duplicate results did not match well. Overall, the data met the expected data quality objectives and can be considered acceptable as qualified and can be used in the decision-making process.

WDCR835/011.WP5

Appendix F
Memorandum On Background Metals Sampling

MEMORANDUM CH2M HILL

TO: Bob Stroud/EPA Region III

COPIES: Erica Dameron/DEQ
Will Bullard/NAS Oceana
Doug Dronfield/CH2M HILL
Stephen Romanow/CH2M HILL
Chris Bozzini/CH2M HILL

FROM: Steven Brown/CH2M HILL
Jim Harris/LANTDIV

DATE: April 21, 1994

SUBJECT: Results of Background Metals Sampling at Oceana

PROJECT: MAE20368.M0.11

One of the issues remaining after the first phase of the RFI at Oceana was whether metals concentrations in soils were a problem. Specifically, the concentrations of beryllium and arsenic at several sites were above risk-based screening concentrations (RBCs) published by EPA Region III. This was the focus of several comments by the DEQ. The DEQ mentioned burning of fuel oil or coal as a possible source of the high beryllium. Our contention was that the metals concentrations were not the result of any station activities but were naturally above RBCs. Our proposal to resolve this issue was to sample soils for metals at two locations distant from any RCRA sites or other activities that could cause contamination to determine background concentrations of metals in soils.

The results of the background soil sampling are now available. The results are consistent with past results at the RFI sites, that is, the concentrations of beryllium and arsenic were above RBCs at one or both of the locations. The locations of the samples are shown in Figure 1 and the results are tabulated in Table 1. Both samples were collected near the main gate entrance off of Oceana Boulevard. Sample BG-SOIL1 was collected northwest of the large white announcement sign just west of the guard station. BG-SOIL1 was collected at the edge of the woods at a depth of 2 to 3 feet from a silty clay zone. BG-SOIL2 was collected adjacent to the flag pole and blue-and-gold Oceana entrance sign just east of the guard station and the parking lot for the main gate pass office. It was collected from a clayey silt zone at a depth of 0.5 to 1 foot. Both samples were similar lithologically to the majority of the soils samples collected during the RFI and both were in areas of minimal human activity.

The analytical data are compared in Table 1 to the average concentration in the eastern United States (Shacklette and Boerngen, 1984) and to proposed RCRA action levels (*Federal Register*, July 27, 1990), the same criteria used in the Phase I report. Beryllium,

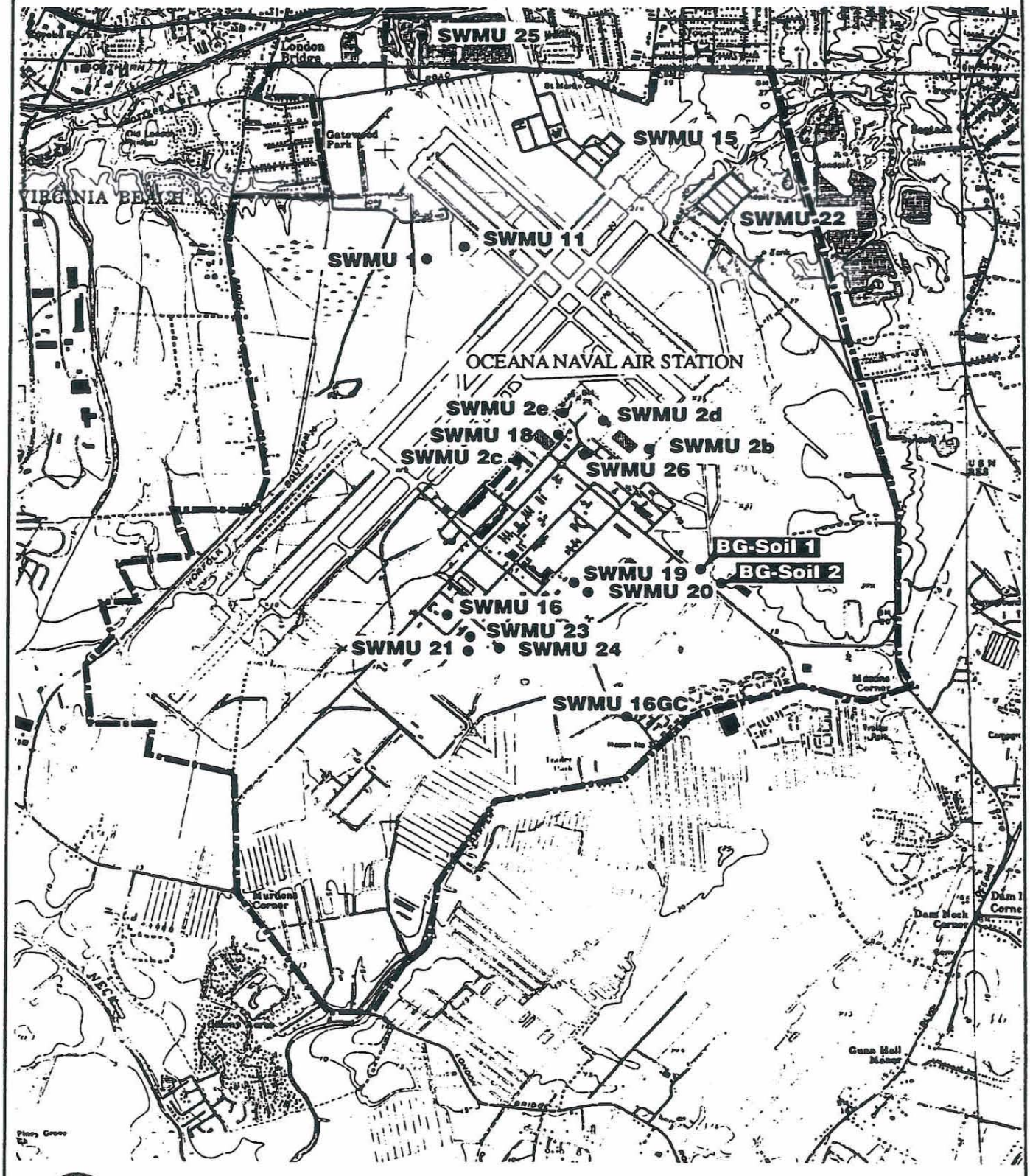
chromium, and lead were present above mean concentrations for the eastern United States. The concentration of arsenic was 0.62 ppm in BG-SOIL1 and 2.1 ppm in BG-SOIL2. The RBCs listed (EPA, first quarter 1994) for residential and industrial soils, were 0.37 ppm and 1.6 ppm for arsenic (as a carcinogen), 0.15 and 0.67 ppm for beryllium, 78,000 and 1,000,000 ppm for trivalent chromium and 390 and 5100 for hexavalent chromium. There is no RBC for lead.

It is apparent from the comparison of RBCs to the data that only beryllium and arsenic are above RBCs in the background soils. This was also true in the soil sampling during the RFI Phase I. Reference to Appendix A of the report shows that maximum concentrations in soils ranged from 1.2 to 22 ppm for arsenic and 0.24 to 1.2 for beryllium. The high concentration in both cases were from sites that have been removed from the RFI after consideration of overall concentrations, pathways, and site history. The concentrations at sites that are still active are 2.2 to 3.5 for arsenic and 0.29 to 0.63 ppm for beryllium.

Because the background soils were collected from clean background areas, are consistent with past concentrations, yet are above RBCs, we conclude that soils at Oceana are naturally above RBCs and, therefore, arsenic and beryllium concentrations above RBCs during the Phase I RFI do not indicate site contamination.

WDCC5/052.WP5

MAE20368.MO.11/D1/01.lpb.4/94



NOT TO SCALE

Figure 1
LOCATIONS OF BACKGROUND SOIL SAMPLES
RCRA Facility Investigation–Naval Air Station, Oceana

Table 1
INORGANIC COMPOUNDS IN BACKGROUND SOILS AT NAS, OCEANA
February 1994
(All data in mg/kg, ppm)

Analyte	BG-SOIL1	BG-SOIL2	Eastern United States Mean #	Proposed RCRA Action Levels &
Aluminum	28,700	16,500	33,000	ND
Antimony	< 2.9 n,uj	<2.7 n,uj	0.52	30
Arsenic	0.62 b	2.1 b	4.8	80
Barium	112	74.0	290	4,000
Beryllium	0.67 b	0.69 b	0.55	0.2
Cadmium	<0.81	<0.76	ND	40
Calcium	318 b	846 b	3,400	ND
Chromium	45.6	24.0	33	400
Cobalt	3.0 b	4.4 b	5.9	ND
Copper	12.1 c	10.6 c	13	ND
Iron	10,200	8,730	14,000	ND
Lead	12.5* j	26.9* j	14	ND
Magnesium	901 b	1,180 b	2,100	ND
Manganese	12.6	28.2	260	ND
Mercury	<0.04	0.05 b	0.081	20
Nickel	9.3 b	10.5	11.0	2,000
Potassium	448 b	726 b	12,000	ND
Selenium	0.68 b	<0.37	0.30	0.86
Silver	<0.67	<0.62	ND	200
Sodium	163 b	126 b	2,500	ND
Thallium	<0.34	0.43 b	ND	ND
Vanadium	35.3	26.3	43	ND
Zinc	17.5	28.4	40	ND

Notes:
< The constituent was not detected at the instrument detection limit (IDL).
b The reported value was less than the Contract Required Detection Limit (CRDL), but greater than or equal to the IDL.
* Indicates duplicate analysis not within control limits.
n Indicates poor prespike recovery.
uj The quantitation limit is estimated
j The reported value is estimated.
c The analyte was found in the associated laboratory or field blank as well as the sample.
ND - No data.
- Shacklette and Boerngen, 1984.
& - Federal Register, July 27, 1990.

(804) 322-4776

5090
1822:JFH:srw

MAY 10 1994

U.S. Environmental Protection Agency
Attn: Mr. Robert Stroud
Mail Code: 3HW61
Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

Re: Results of Background Metals Sampling at Oceana

Dear Mr. Stroud:

One of the issues remaining after the first phase of the RFI at Oceana was whether metals concentrations in soils were a problem. Specifically, the concentrations of beryllium and arsenic at several sites were above Risk-Based Screening Concentrations (RBCs) published by EPA Region III. This was the focus of several comments by the Virginia Department of Environmental Quality (VDEQ). The VDEQ mentioned burning of fuel oil or coal as a possible source of the high beryllium. Our contention was that the metals concentrations were not the result of any station activities but were naturally above RBCs. Our proposal to resolve this issue was to sample soils for metals at two locations distant from any RCRA sites or other activities that could cause contamination to determine background concentrations of metals in soils. This was agreed to by the regulatory agencies in the October 1993 TRC meeting held at NAS Oceana.

The results of the background soil sampling are now available. The results are consistent with past results at the RFI sites, that is, the concentrations of beryllium and arsenic were above RBCs at one or both of the locations. The locations of the samples are shown in Figure 1 and the results are tabulated in Table 1. These are provided as enclosures. Both samples were collected near the main gate entrance off of Oceana Boulevard. Sample BG-SOIL1 was collected northwest of the large white announcement sign just west of the guard station at the edge of the woods at a depth of 2 to 3 feet from a silty clay zone. BG-SOIL2 was collected adjacent to the flag pole and blue-and-gold Oceana entrance sign just east of the guard station and the parking lot for the main gate pass office. It was collected from a clayey silt zone at a depth of 0.5 to 1 foot. Both samples were similar lithologically to the majority of the soils samples collected during the RFI and both were in areas of minimal human activity.

Re: Results of Background Metals Sampling at Oceana

The analytical data are compared in Table 1 to the average concentration in the eastern United States (Shacklette and Boerngen, 1984) and to proposed RCRA action levels (*Federal Register*, July 27, 1990), the same criteria used in the Phase I report. Beryllium, chromium, and lead were present above mean concentrations for the eastern United States. The concentration of arsenic was 0.62 ppm in BG-SOIL1 and 2.1 ppm in BG-SOIL2. The RBCs listed (EPA, first quarter 1994) for residential and industrial soils were respectively, 0.37 ppm and 1.6 ppm for arsenic (as a carcinogen), 0.15 ppm and 0.67 ppm for beryllium, 78,000 ppm and 1,000,000 ppm for trivalent chromium and 390 ppm and 5100 ppm for hexavalent chromium. There is no RBC for lead.

It is apparent from the comparison of RBCs to the data that only beryllium and arsenic are above RBCs in the background soils. This was also true in the soil sampling during the RFI Phase I. Appendix A of the report shows that maximum concentrations in soils ranged from 1.2 ppm to 22 ppm for arsenic and 0.24 ppm to 1.2 ppm for beryllium. The high concentration in both cases were from sites that have been removed from the RFI after consideration of overall concentrations, pathways, and site history. The concentrations at sites that are still active are 2.2 ppm to 3.5 ppm for arsenic and 0.29 ppm to 0.63 ppm for beryllium.

Because the background soils were collected from clean background areas, are consistent with past concentrations, yet are above RBCs, we conclude that soils at Oceana are naturally above RBCs and, therefore, arsenic and beryllium concentrations above RBCs during the Phase I RFI do not indicate site contamination with respect to metals.

Sincerely,

N. M. JOHNSON, P.E.
Head
Installation Restoration Section
(North)
Environmental Programs Branch
Environmental Quality Division
By direction of the Commander

Enclosures

Copy to: (w/encls)
NAS Oceana (Mr. W. Bullard)
VDEQ (Ms. E. Dameron)
Blind copy to:
1822 JFH, 18S, metalbk.jfh

Appendix G
Memorandum on the Results of the Records Search at Site 2E

MEMORANDUM CH2M HILL

TO: Jim Harris/LANTDIV

COPIES: Will Bullard/Oceana Base Civil Engineering (BCE)
Darren Braccia/CH2M HILL
John Ballinger/Oceana BCE Environmental

FROM: Steven Brown/CH2M HILL

DATE: August 19, 1994

SUBJECT: Results of Records Search at Site 2E

PROJECT: MAE20368.M0.MI

This memorandum summarizes the results of efforts to determine the source of free product fuel at RCRA Site 2E near Hangar 23 and Line Shack 109. The purpose of the 2E records search was to identify the source of free product so that additional sampling planned for September 1994 could be as focused as possible. The search effort involved several activities, including interviews with long-term employees, a review of utility and construction maps on file at Base Civil Engineering, a brainstorming meeting with several current Oceana employees, a round of measurement of water level and free product thickness conducted by Oceana personnel, an onsite review of manholes up and down the service lines from the contaminated manholes at Site 2E, and a review of some historical air photos.

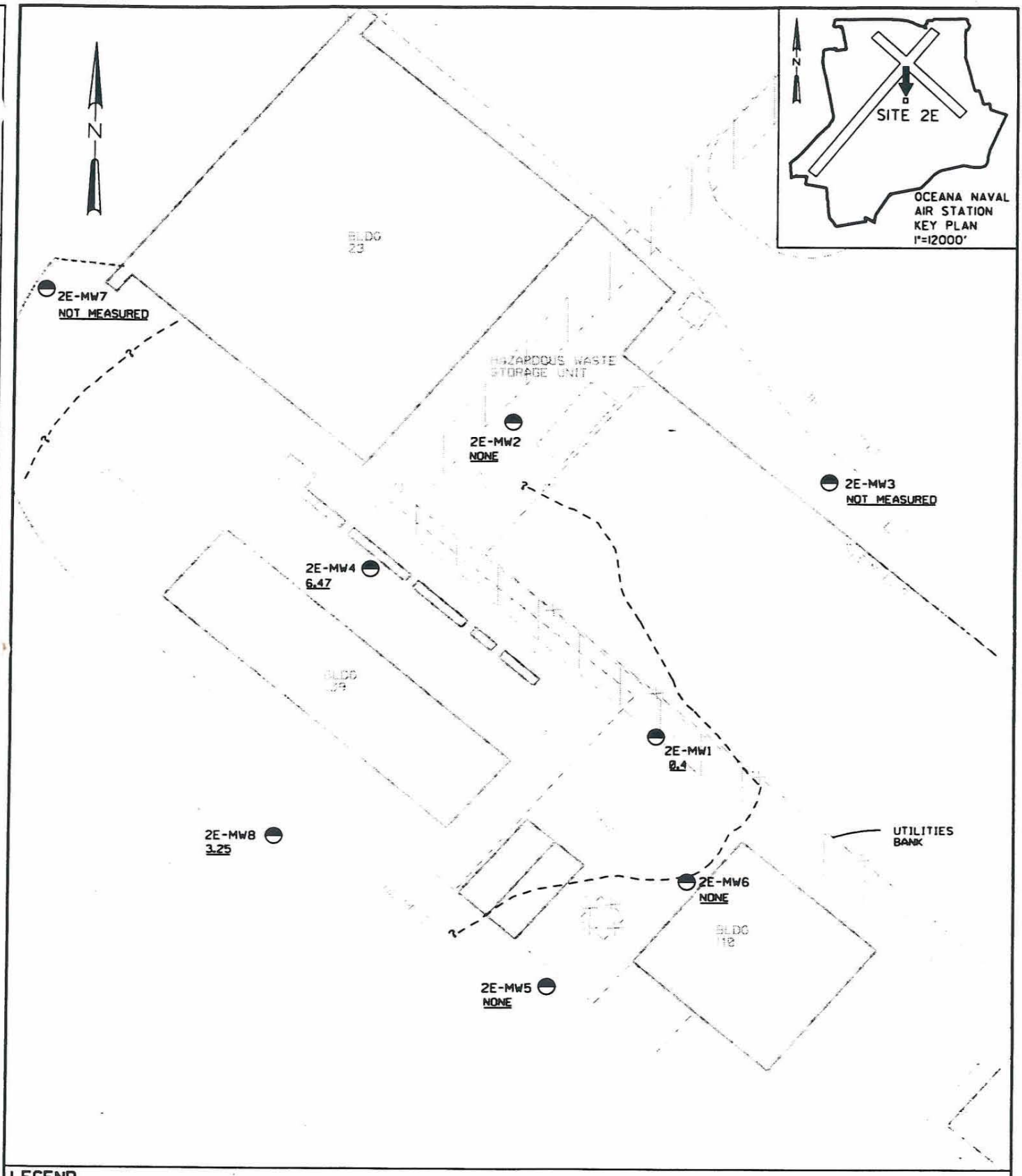
The current status of the free product at Site 2E is illustrated in Figure 1. The thickness of free product in well 2E-MW8 has increased considerably, from 0.25 feet in March 1994 to 3.25 feet on August 10, 1994. The fuel thickness in well 2E-MW4 increased from 3.25 to 6.47 feet over the same period. John Ballinger, Mike Ryan, and Pat Ryan of Oceana smelled the fuel from well 2E-MW4 and concurred that it smelled like JP-5 rather than diesel. During groundwater sampling in March 1994, two types of free product were observed in well 2E-MW4. There was a black, viscous POL material at the bottom of the free product zone and a more translucent fuel at the top. This suggests that there may be more than one source of free product in this area or that the older material has weathered and become more viscous with age.

A review of the potential causes of the fuel contamination at Site 2E has lead to the following possible causes.

1. Overflows of the day tank and known releases from the fuel lines connecting the day tank to the MATWING fuel pits, with subsequent migration to Site 2E down the utility banks that connect these two areas.

2. Potential leaks from two small UST's near the control tower building.

3. Potential leaks from jet wing tanks stored on wooden racks at a location between Line Shacks 106 and 109.



LEGEND

- SHALLOW MONITORING WELL
- 3.25 FREE PRODUCT THICKNESS IN FEET
- — ? APPROXIMATE EXTENT OF FREE PHASE PETROLEUM > 0.01 FEET

0 25 50 75
SCALE IN FEET

Figure 1

FREE PRODUCT THICKNESS
AT SITE 2E ON
AUGUST 10 & 11, 1994

CH2MHILL

0368m2e6.dgn
18-AUG-1994

ONAS0368BT.DGN

4. Leaks from the above-ground heating oil tank at the center of the northeast side of Line Shack 109.

5. Disposal of waste oil and fuels directly down the manhole at the corner of Hangar 23 and general waste disposal into the grassy area outside Line Shack 109

6. Runoff from areas where aircraft are parked or serviced.

7. Potential leaks and direct disposal of stripped fluids from fuel tanker trucks potentially parked in the area later covered by Hangar 23.

Each of these potential sources will be discussed in sequence, followed by conclusions about the probable source or sources and their implications for future sampling.

Day Tank Activities and MATWING Fuel Line. There are several types of known fuel releases from the day tank. Senior Chief Sundin of the fuels division said that the bottom of the day tank is stripped daily to remove condensate water that could accumulate there. This fuel was formerly dumped directly into a french well (wet well) north of the day tank. Mr. Bill Duff of the fuels division said that the practice of discharging stripped fuel down the well ended in the late 1960s or early 1970s. Substantial overflows of the day tank or leaks from adjacent piping also have occurred. Mr. Larry Kight of the Oceana BCE Planning department, an employee since 1964, recalled a release during the early 1970s during which fuel was 4 to 8 inches deep on the ground surface northwest of the day tank. He said that a separate release occurred in the late 1980s when a 1/4-inch diameter hole developed in the fuel line west of the filter house. The problem was discovered when fuel flowed up through the floor of the filter house. During excavations to repair the problem, a substantial amount of fuel was found in the soil near the filter house. Mr. Pat Ryan of BCE also reported that substantial leaks also had occurred in the old fuel line leading to the day tank from the fuel farm southwest of the runways.

Terry Switzer of BCE reported that the old fuel line that lead from the day tank to the MATWING fuel pits also had a history of leaks. This old line has been replaced with a new line over the last 3 or 4 years. I did not read any reports related to this problem and am not sure that any environmental sampling was done in this area.

The migration pathway of fuel releases at the day tank or from fuel lines is a key consideration. Baker Environmental completed a study of the fuel problem at the day tank in March 1994. Review of the figures in this report showed a broad free product area north, northwest, and southeast of the day tank. The report also clearly shows:

- Groundwater flows to the northwest in this area.

- There are a series of wells that do not contain fuels at locations outward from the free product area.
- Monitoring wells around the entire free product area.
- A minimal number of wells on the south and southeast side of the free product.

The low number of wells on this south/southeast side suggests that free product could have escaped and migrated to Site 2E and been undetected by the monitoring well network; however, this does not appear likely considering the overall size and shape of the free product plume. This result appears to rule out the possibility that fuel releases from the day tank area flowed directly across the taxiway to Site 2E.

Another key possibility is that fuel originating either from the day tank or from releases along the old line leading to the MATWING fuel pits was able to migrate along the utility banks that connect this area with Site 2E. The general layout of utilities connecting these two areas is shown in Figure 2. Chief Chaney of the fuels division reported that one of the manholes near the control tower had to be ventilated of fuel vapors each time it was serviced or used. As part of this work, we removed all of the manholes for the electrical and telephone lines and inspected the inside of the compartments for fuels. None of the manholes showed evidence of fuels either north or south of Site 2E; however, the two manholes at the south corner of Hangar 23 were found to contain fuels as before. It is possible that fuels could flow along the sand or gravel that was laid as a construction base beneath the utility banks yet not be present in the manhole compartments. Mr. Mike Ryan said that sand, not gravel, is used as a construction base for utility banks at the station; however, these utility banks were apparently constructed in the early 1960s before Mr. Ryan started working at Oceana. Nonetheless, the weight of evidence does not suggest that fuel has flowed along the utility bank to contaminate Site 2E.

Potential Leaks From Two Small UST's near the Control Tower. John Ballinger of BCE Environmental reviewed the records of UST's near and north of Site 2E. He found records and evidence of a 1,000-gallon tank at the northeast corner of Building 100 and of a 550-gallon tank next to a small utility building southeast of Building 100. Because of the size of these tanks and the observation that fuel does not appear to have flowed down the utility lines, these two UST's do not appear to be a source of the fuels at Site 2E.

Potential Leaks from Wing Tanks Stored Near Line Shack 106. Terry Switzer and Carl Hebert of BCE showed me air photos of the Line Shack 109 area before the construction of Hangar 23 and Line Shack 110. The photo shows several wing tanks stored on racks at the current location of Line Shack 110. Mr. James Holsey, an Oceana employee since 1955, told me he recalls wing tanks being stored in this area. Mr. Kight also confirmed that wing tanks

were washed and stored in the Hangar 23 area. Although the air photo showed wing tanks southeast of where the fuel was found, it is possible that the tanks were stored over a broader area or that waste fuels from servicing the tanks were disposed onto the grassy area.

Above-ground Heating-Oil Tank Alongside Line Shack 109. A 275-gallon heating oil tank has been present along the northeast side of Line Shack 109 since it was constructed (in 1962?). Piping from the above-ground tank is illustrated to be routed below grade in 1962 as-built drawings. It is likely that some spills have occurred from this tank. These spills are not the likely cause of the probable JP-5 in the adjacent well 2E-MW4 but may be the source of the viscous black POL observed during sampling in March 1994.

Disposal of Waste Oil and Fuel Down Manhole and Onto Grassy Area Near Line Shack 109. It is not clear how long the reported practice of funneling waste oil down the manholes between Hangar 23 and Line Shack 109 continued. Waste-oil funneling was reported in the IAS report written in 1984. Mr. Larry Kight said he remembered fuel flowing into these two manholes in the early 1980s and remembered the rumor that servicemen had dumped waste oil into the manholes. The observations of CH2M HILL personnel during sampling in February and March 1994 and conversations with current enlisted men working at the line shack suggest that some waste handling practices at Line Shack 109 continue to be substandard. Practices were particularly loose in earlier years. It is likely that waste oils and fuels were dumped to some degree in the grassy area northeast of the line shack. Fuels are drained every day from pencil drains in the aircraft in Hangar 23, according to Senior Chief Sundin of the fuels division, but he does not know where the waste fuels are disposed. Officer Robertson, the FITWING and Search and Rescue (SAR) hazardous waste representative may know more about these practices but he did not attend the meeting.

Runoff From Aircraft Areas. A fuel sheen was seen on runoff water flowing into the grassy area from aircraft parking areas northwest of Line Shack 109 during a February 1994 sampling event. Even though the volume of fuels that infiltrated into the grassy area from the aircraft areas may not be significant, runoff clearly flows to the low grassy area near Line Shack 109 from a broad area.

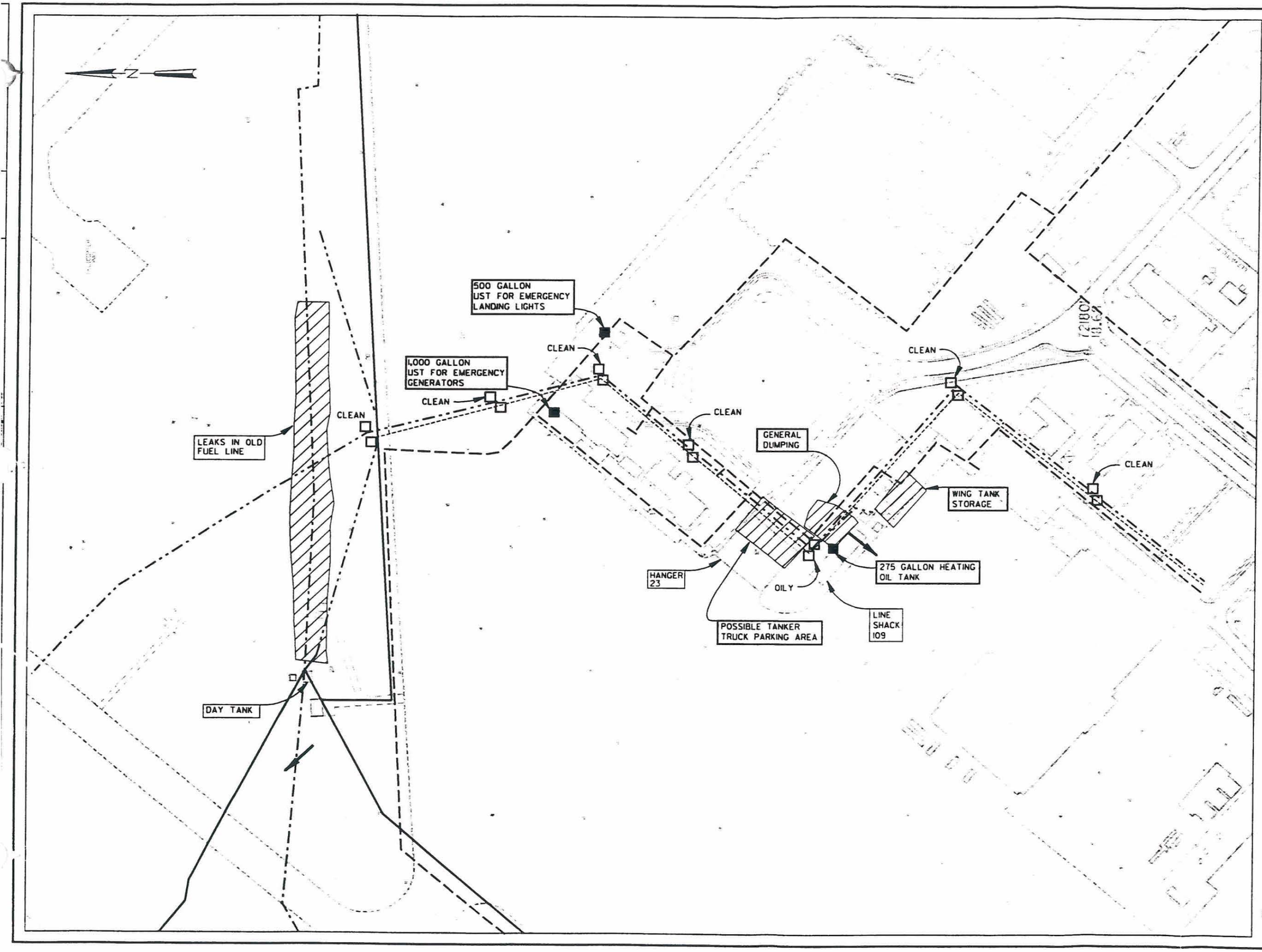
Tanker Trucks Parked Near Hangar 23. Mr. Thomas McGowan of the fuels division, reported that he had been told that refueling tankers used to park in the area now covered by part of the southeastern half of Hangar 23 some time before his arrival at Oceana in 1973. These tankers were probably stripped often to eliminated condensate water. Stripping is currently performed on the tankers according to Senior Chief Sundin, and this activity was also presumably a standard procedure prior to 1973. These waste fuels may have been disposed of on the ground. Mr. Kight and Mr. Holsey of BCE said that he did not recall a time when tankers were parked near Hangar 23 despite working at the station since 1963 and 1955 respectively. Mr. Kight did report that it was a common practice to dispose of waste fuels on the ground in the 1960s. I presume this practice was also common in earlier years.

Mr. Kight worked in 1958 and 1959 as a driver for a private contractor that operated these refueling tankers and said they did not park tankers near Hangar 23 at that time. Mr. Boone, an employee at Oceana since the 1940s, and Mr. Wally Waldrop and Mr. Roger Reed, two other long-term employees, may remember more about the use of tankers in this area but were not available at the time of the records search.

Conclusions

The source of the fuels at Site 2E remains uncertain There may be several sources, but the likelihood is that one or two major sources caused the problem. I judge that the wing tanks and refueling tankers along with routine disposal of waste oils and fuels onto the ground near Line Shack 109 are the primary causes of the fuel contamination. There also may have been a contribution from the heating oil tank to cause the two-phase POL contamination in well 2E-MW4. The day tank and the leaking fuel line leading to the MATWING fuel pits, with subsequent migration down the utility banks do not appear to be a major source.

Sampling should be geared primarily towards the area southwest and downgradient of Line Shack 109. Some samples should be collected north of Hangar 23 to confirm that fuel is not flowing from the day tank and inside the hangar to check on the possibility that the southeastern half was used for parking and stripping out waste fuel from fuel tankers in the 1960s. One to three samples should be collected from the edge of the concrete utility bank northeast of Site 2E to determine if the base of the bank is contaminated with fuels. The POL fingerprinting sample from well 2E-MW4 should be run against a JP-5 standard supplied by Oceana to confirm the identity of the primary POL at the site. A second POL fingerprinting sample of the k viscous material may be warranted.



NOTE THAT UTILITY ALIGNMENTS ARE NOT EXACT. THEY ARE INTENDED TO SHOW POTENTIAL PATHWAYS

Figure 2
APPROXIMATE UTILITY ALIGNMENTS AND POTENTIAL SOURCE AREAS AT SITE 2E OCEANA NAS

CH2MHILL

0368u2el.dgn 18-AUG-1994