Section : 03.06
Site 20903-5640 (White Oak)
Doc. #: 0001
00119

N60921.AR.000007
NSWC WHITE OAK
5090.3a

HYDROGEOLOGICAL INVESTIGATION OF THE GASOLINE SPILL EMANATING FROM AN UNDERGROUND STORAGE TANK SYSTEM AT THE NAVAL SURFACE WARFARE CENTER WHITE OAK, MARYLAND

REWAI Project M88339

Prepared for

Department of Defense, United States Navy
Environmental Division
Naval Surface Warfare Center
White Oak Laboratory
Silver Spring, MD

By

R. E. WRIGHT ASSOCIATES, INC.
125 Airport Drive, Suite 36
Westminster, MD 21157

January 1989

HYDROGEOLOGICAL INVESTIGATION OF THE GASOLINE SPILL EMANATING FROM AN UNDERGROUND STORAGE TANK SYSTEM AT THE NAVAL SURFACE WARFARE CENTER, WHITE OAK, MARYLAND

REWAI Project M88339

Prepared for

Department of Defense, United States Navy
Environmental Division
Naval Surface Warfare Center
White Oak Laboratory
Silver Spring, Maryland

By

R. E. WRIGHT ASSOCIATES, INC.
125 AIRPORT DRIVE, SUITE 36
WESTMINSTER, MARYLAND 21157

January 1989

Respectfully submitted,

Daniel J. Acquaviva
Daniel J. Acquaviva
Staff Hydrogeologist

Michael D. Haufler
Michael D. Haufler
Manager of Technical Services

Reviewed by:

Richard E. Wright / PW
Richard E. Wright, PG
President

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	Preceeding Text
1.0 INTRODUCTION	5
1.1 Scope and Purpose of the Investigation	6
2.0 MONITORING WELL INSTALLATIONS	9
3.0 HYDROGEOLOGICAL SETTING	11
3.1 Site Geology	11
3.2 Site Hydrology	14
4.0 GROUNDWATER CHEMISTRY	19
4.1 Nature of the Potential Groundwater Contaminants	19
4.2 Sampling Results	20
5.0 OVERVIEW OF POTENTIAL REMEDIATION OPTIONS	24
5.1 Physical Containment	24
5.2 Aquifer Restoration	25
6.0 CONCLUSIONS AND RECOMMENDATIONS	27
BIBLIOGRAPHY	31
GLOSSARY OF TERMS	34
LIST OF ABBREVIATIONS	37

LIST OF TABLES

Table 1, Physical Properties of Gasoline Degradation Products	19
Table 2, Chemical Analyses of Monitoring Well Groundwater Samples	21
Table 3, Groundwater Quality Criteria for Gasoline Constituents	23

LIST OF FIGURES

Figure 1, Site Location Map	2
Figure 2, Detailed Plan of the Spill Site	7

Figure 3, Geologic Map of Southern Montgomery County..... 12

Figure 4, Cross-Section A-A'..... 13

Figure 5, Groundwater Contour Map, White Oak, MD Area..... 15

Figure 6, Groundwater Contour Map of Spill Site Area..... 16

Figure 7, Schematic Model of Contaminant Plume Movement... 18

Figure 8, Contour Map of Total BTEX Concentrations in Groundwater Proximal to Spill Site..... 22

Figure 9, Proposed Locations of Additional Groundwater.... Monitoring Wells..... 28

LIST OF APPENDICES

Appendix A, Site Complaint and Pertinent Sections of Code of Maryland Title 26..... Following Text

Appendix B, Schematic Logs of Monitoring Well Lithology and Construction..... Following Text

Appendix C, Chemical Analyses of Groundwater Samples..... Following Text

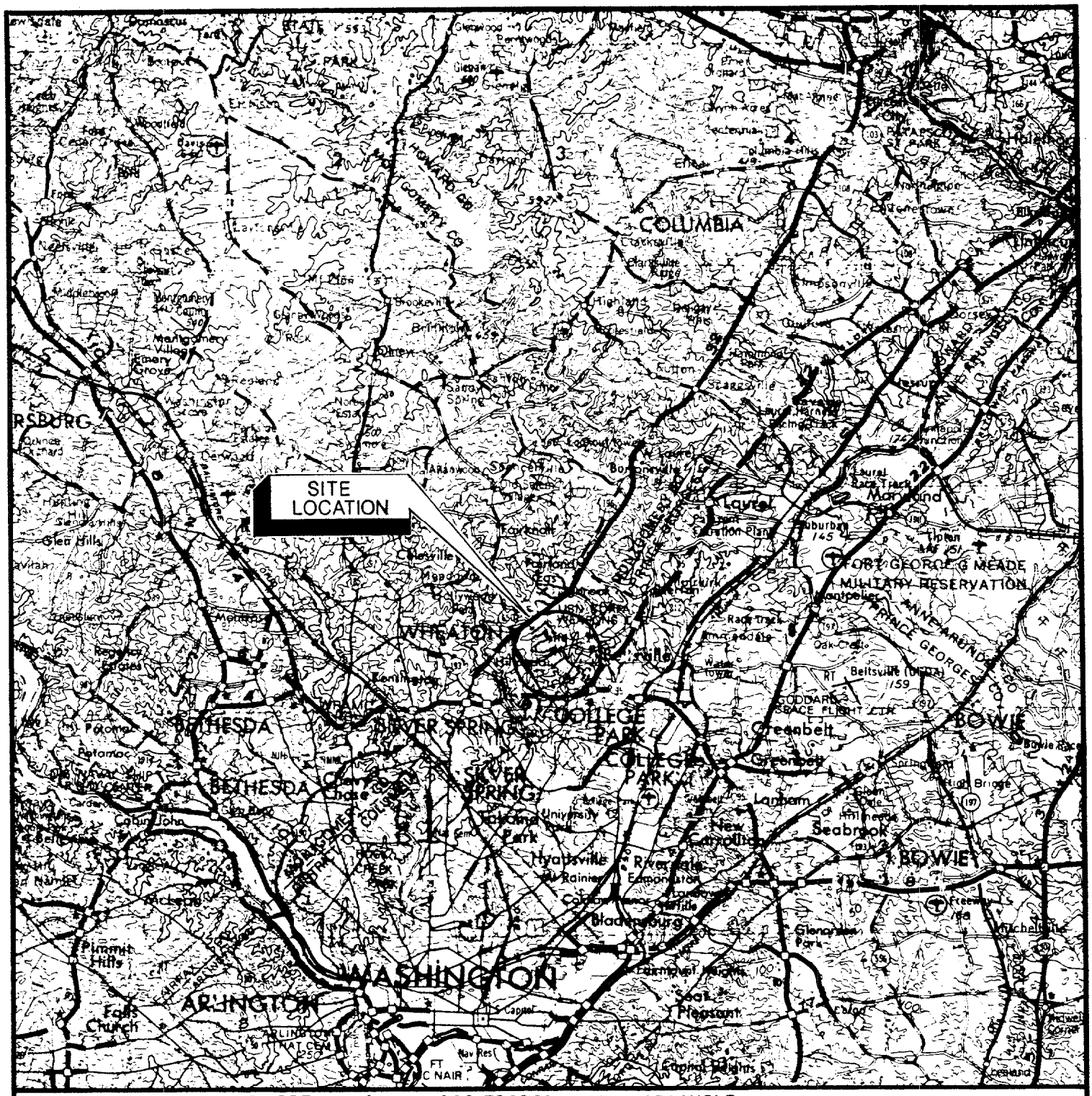
EXECUTIVE SUMMARY

Presented herein is the hydrogeological investigation conducted by R. E. Wright Associates, Inc. (REWAI) at the U.S. Navy Surface Warfare Center in White Oak, Maryland (Figure 1). This work was undertaken in order to address a perceived gasoline spill from an underground storage tank (UST) located at the site.

Leakage from the 5,000 gallon gasoline UST was detected on October 21, 1988, when this tank, along with an adjacent gasoline UST, was removed by the Navy. A corrosion hole in the steel tank and evidence of gasoline leakage were noted at that time. Mr. John J. Smiechowski of the Maryland Department of the Environment (MDE) issued a site complaint to the Navy effective that date (Appendix A). The two UST's were removed and the excavation was backfilled with imported soil fill. The MDE requested that a hydrogeological investigation be instigated to determined possible consequences of the spill.

On November 30, 1988, the U.S. Navy contracted REWAI to perform a hydrogeological investigation. The scope of this investigation included the installation of three groundwater monitoring wells, collection and analysis of groundwater samples from each well, and construction of a plot plan of the site, as well as a final report detailing the work undertaken and the interpretations derived therefrom.

The subsequent groundwater investigation conducted by REWAI commenced on December 19, 1988, and consisted of the installation and sampling of groundwater monitoring wells and the integration of the data obtained from these operations into the local and regional hydrogeological framework.


SITE LOCATION
COLUMBIA
WHEATON
BETHESDA
SILVER SPRING
COLLEGE PARK
BOWIE
WASHINGTON
ARLINGTON
FORT GEORGE G MEADE MILITARY RESERVATION
Laurel
Greenbelt
Seabrook
New Carrollton
Hyattsville
Bladensburg
Falls Church
Pimmit Hills
Glen Hills
Chevy Chase
Takoma Park
Cabin John
Potomac
Montgomery Village
Emory Grove
Sandy Spring
Olney
Brookeville
Burtonsville
Fairland
Cloverly
Colesville
Fairlawn
Lanham
Glenarden
Glenn Dale
Mitchellville
Beltsville
Oak Creek
Maryland
Capitol Heights
Coral Hills
Camp Springs
Clinton
Tuxedo
Kensington
Wheaton
Forest Glen
Silver Spring
Takoma Park
Hyattsville
Riverdale
Edmonston
Bladensburg
Landover Hills
Cottage City
Colmar Manor

Three, 4-inch diameter polyvinyl chloride (PVC) 0.020-inch slotted screen monitoring wells were constructed at the U.S. Navy facility by REWAI and its drilling subcontractor, Hardin-Huber, Inc., between December 19 and 21, 1988. The depths of the three wells ranged between 19.5 and 30.0 feet. The wells were drilled by hollow stem auger method and continuous split spoon samples were collected and analyzed.

The unconsolidated deposits encountered were alluvial sediments consisting of interbedded clays, silts, and sands of the Upper Cretaceous-age Patapsco Formation. Hydraulic conductivities probably vary greatly depending upon lithology. Strong hydrocarbon odors were detected in Monitoring Well 1 (MW-1) which was drilled at the former location of the two UST's. Minor hydrocarbon odors were noted during the drilling of MW-2 and MW-3.

Groundwater samples were collected from each of the three monitoring wells after proper development of the wells was completed. The groundwater samples were analyzed for the gasoline components benzene, toluene, ethylbenzene, and xylene (BTEX) and lead, by Wright Lab Services, Inc. (WLSI), a MDE-certified laboratory (Cert #128). Total BTEX constituents in the groundwater sample from MW-1 were nearly 2,900 parts per billion (ppb) - well above the maximum contaminant level (MCL) of 100 ppb set by the MDE. Total BTEX constituents in groundwater samples obtained from MW-2 and MW-3 were well below the MCL for total BTEX. The lead concentration of 130 ppb from the MW-1 groundwater sample is also above the MCL of 50 ppb for lead.

Water level elevations measured in the three monitoring wells, as well as in a fourth well located nearby, indicate that preferential groundwater flow in the vicinity of the UST gasoline leak is to the northeast toward an unnamed tributary of the Paint Branch tributary of the Anacostia River. Groundwater flow velocities were not calculated, as no permeability tests were conducted on the wells.

(A perched water table was encountered in MW-1. This condition is possibly related to inferred high hydraulic conductivities of the imported sand fill material (which was used to backfill the tank excavation) and adjacent natural sediments relative to the underlying indigenous clayey silts and the cement base pads for the UST's (which were not removed when the tanks were extracted), as well as to the fact that the portion of the access road overlying the site of the removed UST's had not been repaved.) ?

An overview is given of four potential remediation methods. However, before any of these methods can be utilized, a more detailed knowledge of the extent of the contaminant plume must be obtained. For this reason, it is recommended that four additional groundwater monitoring wells be drilled at the site. It is further recommended that MW-1 be grouted and plugged in order to prevent any communication between the perched and natural water tables. MW-1 should then be replaced with two wells, one shallow and one deeper, which should be screened at discrete levels; the shallower well to be screened in the perched water table, and the deeper well to be screened in the natural water table.

1.0 INTRODUCTION

On October 21, 1988, two 5,000 gallon UST's used to hold gasoline and located proximal to Building 100 at the U.S. Navy Surface Warfare Center in White Oak, Maryland, were excavated and removed. This was done as part of the Navy's on-going maintenance and modernization operations at the facility. The steel tanks were believed by Navy employees to be at least 30 years old. One of the UST's had a corrosion hole and evidence of a gasoline leak was present.

The U.S. Navy was officially notified by Mr. John J. Smiechowski of the MDE, effective that date, that it was in violation of Code of Maryland Regulations Title 26, Subtitle 10, Section 1, Subsection 2 (Appendix A). The MDE requested that the U.S. Navy retain a hydrogeologic consultant to conduct a groundwater study of the Building 100 site at the White Oak facility and prepare a remediation proposal. REWAI submitted an investigation proposal (number 88437) on November 21, 1989, and the U.S. Navy thereupon contracted REWAI on November 30, 1988, to act as its consultant for this leakage event (U.S. Navy Contract number N62477-89-M-4801). REWAI retained the services of Hardin-Huber, Inc. (HHI) for drilling, and Wright Lab Services, Inc. (WLSI) for analytical work.

We wish to acknowledge the help and cooperation extended to us by Navy personnel, particularly Mr. George Jones. Primary REWAI investigators have been Mr. Daniel J. Acquaviva, Project Hydrogeologist; Mr. Michael D. Haufler, Manager of Technical Services, and Mr. Carroll R. Dell, Manager of Consulting

Services, with administrative assistance from Mrs. Patricia R. Wise.

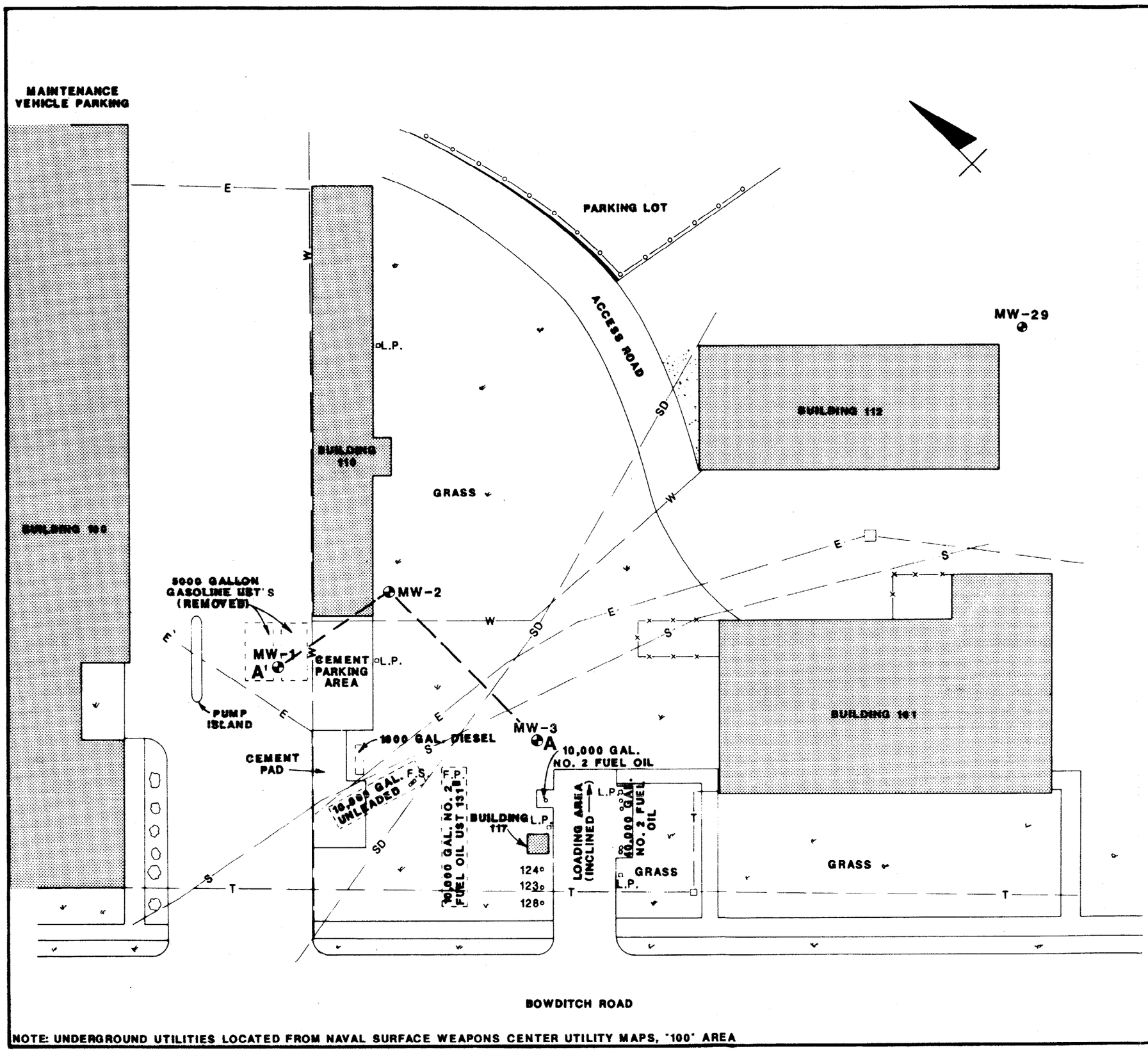
1.1 Scope and Purpose of the Investigation

The purpose of the hydrogeologic investigation undertaken at the U.S. Navy Surface Warfare Center was to determine the extent of groundwater contamination which resulted from gasoline leakage emanating from the UST proximal to Building 100 at the site. After the extent of contamination had been determined, a remediation plan was to be proposed, if necessary.

REWAI recommended a three-monitoring-well array to ascertain the direction of groundwater movement and the extent of the contaminant plume. This recommendation was approved by the MDE.

The three groundwater monitoring wells were drilled by hollow stem auger method, and split spoon samples were collected and analyzed every two feet. After proper development, groundwater samples were obtained from each well and analyzed for BTEX and lead by WLSI.

Groundwater elevations were measured by REWAI personnel utilizing electric water tapes. Measuring point elevations of the well sites were determined by leveling. The ground surface elevation of MW-2 was assumed to be +340.00 feet MSL, and this was used as a base station for relative elevations measured while surveying. REWAI personnel also constructed a detailed map (Figure 2) of the site.



NOTE: UNDERGROUND UTILITIES LOCATED FROM NAVAL SURFACE WEAPONS CENTER UTILITY MAPS, "100" AREA

LEGEND

◉	MONITORING WELL
F.P.	FILL PIPE
F.S.	FILL STAND
L.P.	LIGHT POLE
—— W ——	WATER MAIN
—— E ——	ELECTRICAL UTILITY
—— S ——	SEWER MAIN
—— SD ——	STORM AND ACID WASTE DRAIN
—— T ——	TELEPHONE CABLE
—X—X—	CHAIN LINK FENCE
—o—o—	METAL GUARD RAIL
	SHRUBBERY
	GRAVEL AREA
A — — A'	LINE OF CROSS SECTION

20' 0 20'
SCALE IN FEET

FIGURE 2

U.S. NAVY-SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

DETAILED PLAN OF THE SPILL SITE

drawn JST II	approved MDH	drawing no.
checked DJA	date 1/24/89	M88339-004-A

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

The site investigation was designed such that if extensive groundwater contamination had occurred, it could be detected, and remediated. If necessary, further investigation in the form of additional drilling would be facilitated by an existing data base. Conversely, if no contamination problem was determined to exist, investigative cost would be minimized.

2.0 MONITORING WELL INSTALLATIONS

Three eight-inch diameter soil borings were drilled by a hollow stem auger rig. Continuous soil samples were collected by split spoon method and analyzed for color, texture, moisture, and odor. Four-inch diameter PVC 0.020-inch slotted well screens were placed in appropriate sections of the upper bore holes. At a minimum, the screens extended from five feet below to five feet above the groundwater level as measured subsequent to attainment of total depth. Four-inch diameter PVC casing, which was thread-connected to the PVC screens, was brought flush to the ground surface in MW-1 and to a height of approximately two and one-half feet above ground level in MW-2 and MW-3. A sand pack utilizing No. 2 Morie sand was installed in the annulus around the PVC screen in each well, to a height of approximately three feet above the screen top. Approximately two feet of bentonite pellets were placed above the sand packs and sufficiently hydrated before subsequent grouting operations were undertaken. Portland cement grout was placed above the bentonite to the ground surface to secure the casing and the steel drive-over of MW-1 and the six and one-half inch outside diameter (OD) protective steel casings (which extend approximately two and a half feet below ground level) in MW-2 and MW-3. Appendix B presents graphic logs of well construction details and soil lithology.

To develop the wells, static water levels were measured and the amount of three well volumes of water were calculated for each well. The three well volumes of water subsequently removed from each of the wells for development purposes were extracted by bailer and/or submersible pumping method. As development

progressed, electrical conductance measurements of the removed water were recorded. In each case, the conductance of the groundwater had reached relatively constant values before the development process had been completed. These values were as follows:

Monitoring Well	Sustained Electrical Conductance (uohms/cm)
MW-1	1120
MW-2	160
MW-3	104

The higher electrical conductance values of MW-1 indicate greater amounts of total dissolved solids (TDS) are present in the groundwater proximal to this well. (One possible explanation for this occurrence may be road salts used on the access road through which MW-1 was drilled.) ?

3.0 HYDROGEOLOGICAL SETTING

3.1 Site Geology

The soils at the spill site are classified as Glenelg series silt loams (USDA, 1961). These soils are formed from the weathering of the underlying rocks which are described below.

Unconsolidated sediments of the base of the Upper Cretaceous-aged Patapsco Formation underlie the area around the site of the former UST system at the Navy's White Oak facility (Figure 3). The Patapsco Formation (of the Potomac Group) is described on the Geologic Map of Maryland (1968), as being composed of gray, brown, and red varigated silts and clays; lenticular, cross-bedded, argillaceous, subrounded sands, and minor gravels. Formation thickness is from 0 to 400 feet. The Patapsco Formation dips to the southeast and increases from a thin transgressive feather edge in eastern Montgomery County, to between 200 and 300 feet in Prince Georges County (Maryland Geological Survey, 1964) to its greatest measured thickness of 400 feet in Anne Arundel County.

The Patapsco Formation is described as a deltaic deposit formed on an ancient coastal plain that drained eastward (Hack, 1977). However, at the site the Patapsco sediments appear to be more characteristic of an alluvial (or upper delta plain) origin in a more oxidized environment of deposition. Cross-section A-A (Figure 4) shows the interbedded nature of the sands, silts, and clays of the Patapsco Formation at the site.

BASE MAP: FROM BALTIMORE, MD 1° X 2° USGS TOPOGRAPHIC QUADRANGLE.

LEGEND

Ql	Quaternary Alluvium
T	Tertiary Coastal Plain Sediments
Kmo	Cretaceous Monmouth Formation
Km	Cretaceous Magothy Formation
Kp	Cretaceous Potomac Group
Epm	Eastern Piedmont Metasedimentary Rocks
Wpm	Western Piedmont Metasedimentary Rocks
Epp	Eastern Piedmont Plutonic Rocks

4 0 4

SCALE IN MILES

FIGURE 3

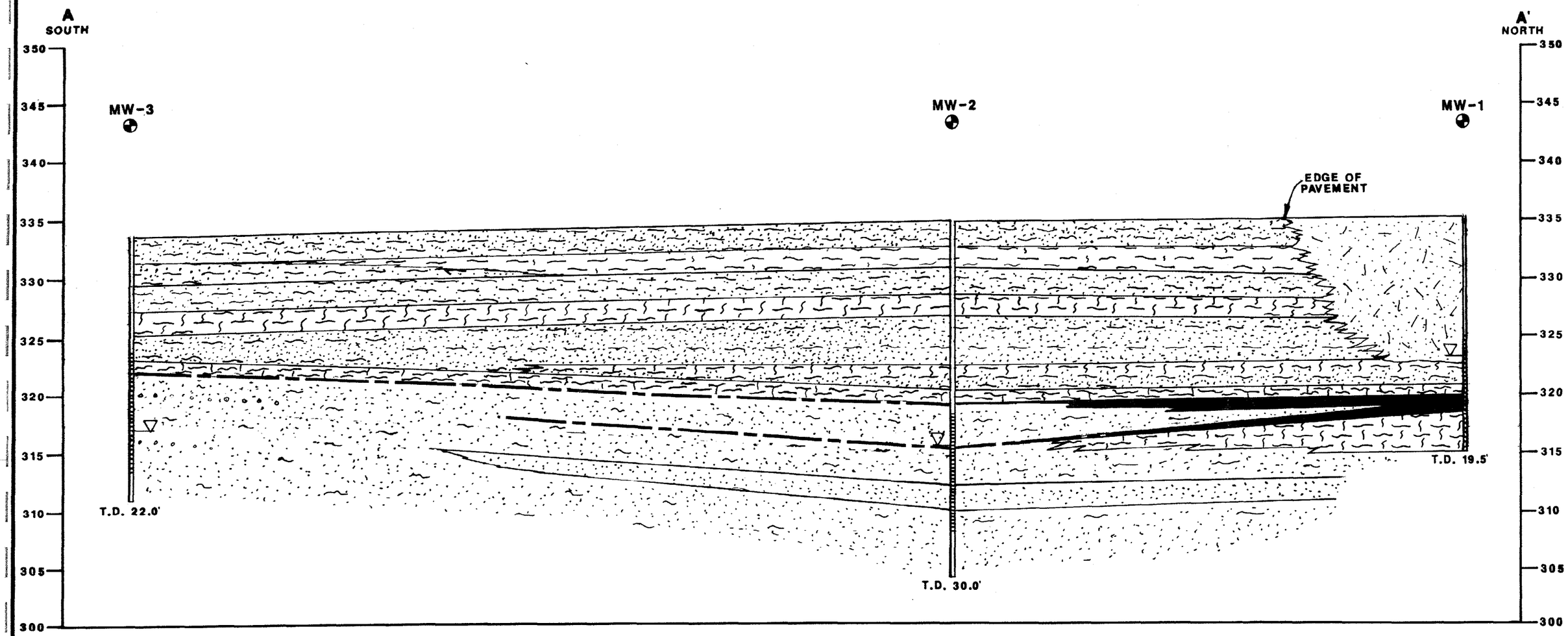
U.S. NAVY SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

GENERALIZED GEOLOGIC MAP OF SOUTHERN MONTGOMERY COUNTY, MD

drawn JST JL	approved MDH	drawing no.	
checked DJA	date 11/25/89	M88339-006-AA	

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

0019 002Y



LEGEND

STATIC WATER LEVEL

SCREENED INTERVAL

CLAY

CLAYEY SILT

SILTY CLAY

SILT

SANDY SILT

SILTY SAND

SAND

SAND AND GRAVEL

ORGANICS/PEAT

FILL

VERTICAL SCALE IN FEET: 0, 2, 4, 6, 8, 10

HORIZONTAL SCALE IN FEET: 0 2 4 6 8 10

FIGURE 4

U.S. NAVY-SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

CROSS SECTION A-A'

drawn JTT	approved MDH	drawing no.
checked DJA	date 1/26/89	M88339-008-A

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

00119C032

The Patapsco overlies the Boulder Gneiss member of the Wissahickon Formation (of the Glenarm Series) of probable lower Paleozoic age. The Boulder Gneiss, an indurated metamorphic rock unit, was not encountered at the site; however, some of the light gray micaceous sands encountered near total depth in MW-2 may be indicative of a close proximity and short transport distance from weathered gneissic material.

A thickness of overburden map of Montgomery County (Froelich, 1975) shows an average of 80 feet of combined soil, Coastal Plain sediments, and saprolite overlying the Boulder Gneiss at the Navy facility. Of this, saprolite forms the thickest and most extensive unit of overburden.

3.2 Site Hydrology

Groundwater at the site is present at shallow depths under unconfined conditions in the unconsolidated Coastal Plain sediments of the Patapsco Formation. The regional gradient of the water table is to the east (Figure 5); locally gradients to the north or south may be present.

Proximal to the former UST system, groundwater was encountered at +322.43 feet relative to mean sea level (MSL) in MW-2, and at +322.97 feet MSL in MW-3. An existing groundwater monitoring well, MW-29, located near Building 112 had a static water level of +317.30 feet MSL. A groundwater contour map (Figure 6) was constructed based upon data from these three wells.

BASE MAP: FROM BELTSVILLE, MD 7 1/2 MINUTE USGS TOPOGRAPHIC QUADRANGLE.

2000' 0 2000'

SCALE IN FEET

LEGEND

—150— GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

240 WELL WITH GROUNDWATER ELEVATION (MSL)

NOTE: GROUNDWATER ELEVATIONS FROM MARYLAND DEPARTMENT OF NATURAL RESOURCES' RECORDS OF WELLS

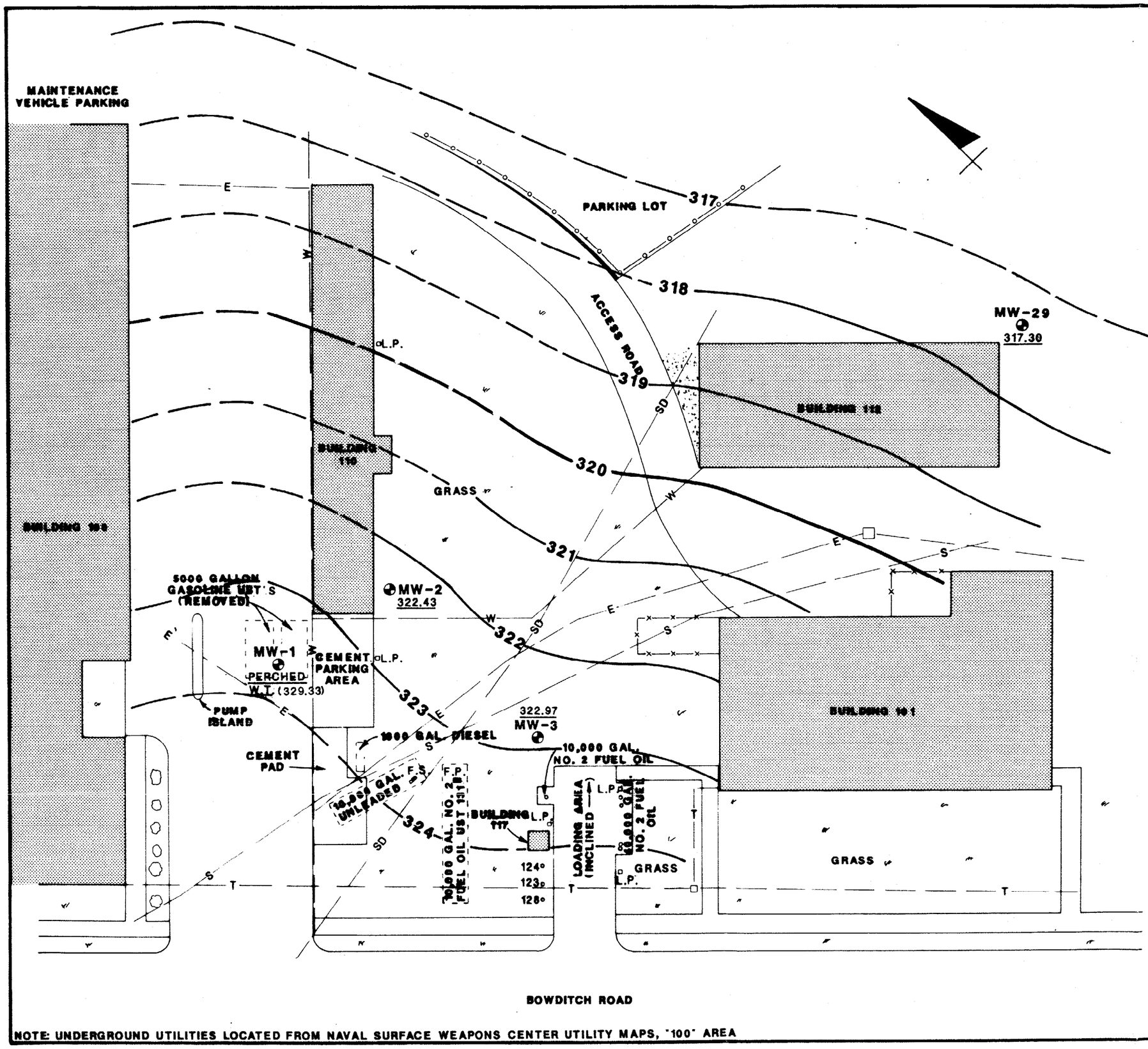
FIGURE 5

U.S. NAVY SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

REGIONAL GROUNDWATER CONTOUR MAP
WHITE OAK, MD AREA

drawn	VST II	approved	MOH	drawing no.
checked	DJA	date	1/27/89	M88339-009-AA

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.



NOTE: UNDERGROUND UTILITIES LOCATED FROM NAVAL SURFACE WEAPONS CENTER UTILITY MAPS, "100" AREA

LEGEND

320.84	GROUNDWATER MONITORING WELL, WITH GROUNDWATER ELEVATION RELATIVE TO MSL
325	GROUNDWATER CONTOUR (DASHED WHERE INFERRED)
F.P.	FILL PIPE
F.S.	FILL STAND
L.P.	LIGHT POLE
W	WATER MAIN
E	ELECTRICAL UTILITY
S	SEWER MAIN
SD	STORM DRAIN AND ACID WASTE
T	TELEPHONE CABLE
X	CHAIN LINK FENCE
o	METAL GUARD RAIL
	SHRUBBERY
	GRAVEL AREA

20' 0 20'
SCALE IN FEET

FIGURE 6

U.S. NAVY-SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

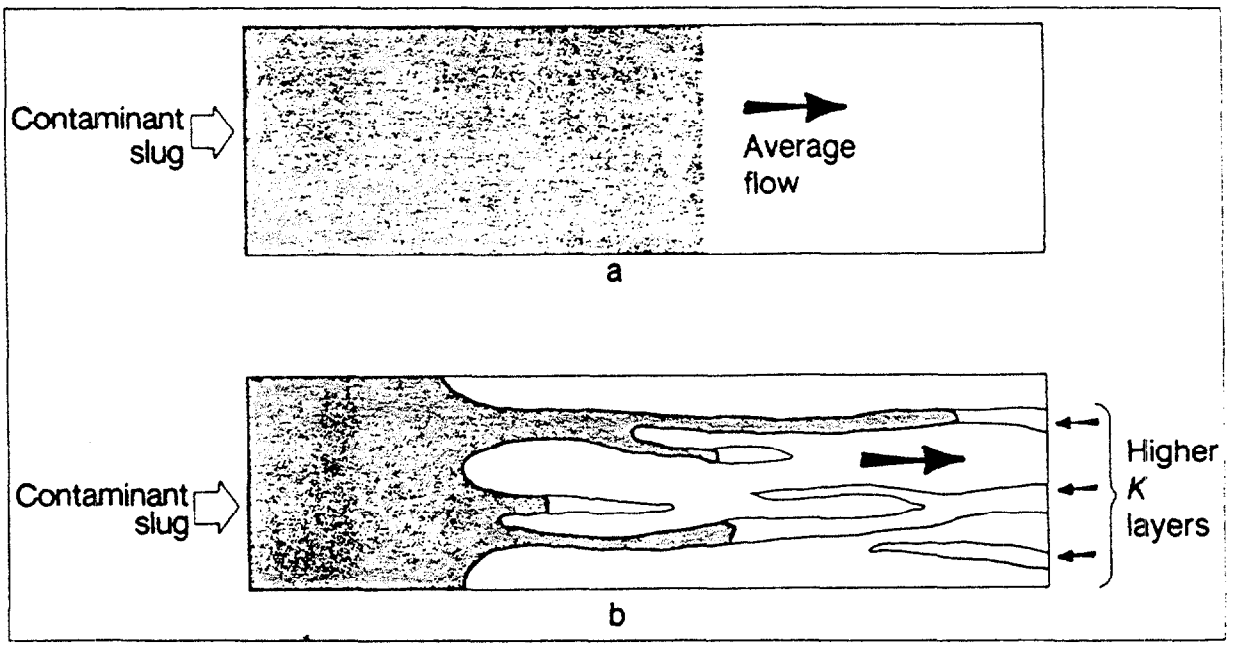
GROUNDWATER CONTOUR MAP OF SPILL SITE AREA

drawn JST II	approved MOH	drawing no.
checked DJA	date 12/5/89	M88339-007-A

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

A perched water table was encountered in MW-1. The static water level in MW-1 is +329.33, which is higher than would be anticipated as shown by groundwater contours on Figure 6. This condition is believed to be a result of the large difference in hydraulic conductivity between the imported sand fill and the indigenous clayey silt sediments and the cement base pads of the removed UST's at the base of the tank excavation.

Because of the highly heterogeneous and interbedded nature of the unconfined sediments of the Patapsco Formation, hydraulic conductivities are anticipated to vary greatly with lithology. Relatively high hydraulic conductivities should be present in the sand layers, thus transmission of water (and any soluble contaminants) and attendant groundwater velocities will be greater in these zones than in adjacent silt and clay zones (Figure 7, from Discoll, 1986).



K = hydraulic conductivity

Figure 7

Comparison of the advance of contaminant zones influenced by hydrodynamic dispersion. (a) Perfectly homogeneous granular medium; (b) fingering caused by layered beds and lenses. (Driscoll, 1986)

4.0 GROUNDWATER CHEMISTRY

4.1 Nature of the Potential Groundwater Contaminants

The potential groundwater contaminants at the U.S. Navy White Oak, Maryland, Building 100 site consist of gasoline degradation products and lead.

Gasoline consists of a mixture of hydrocarbon molecules with 4 to 12 carbon atoms. Gasoline degradation products normally determined in chemical analyses are benzene (C_6H_6), toluene (C_7H_8), ethylbenzene (C_8H_{10}), and xylene (C_8H_{10}). Physical properties of the gasoline degradation products are as shown in Table 1.

TABLE 1 - Physical Properties of Gasoline Degradation Products (From Nyler, 1988)

Constituent	Molecular Weight	Specific Gravity	Solubility (ppm at 20°C)
Benzene	78.11	.88	1780
Toluene	92.13	.87	515
Ethylbenzene	106.16	.87	105
Xylene	106.16	.88	540

Due to a specific gravity of less than 1.0, each of these organic constituents, if present, would float on the water table or travel in the lower vadose zone. These gasoline constituents

would also dissolve in groundwater to varying degrees based upon their solubilities.

Benzene is a known carcinogen (Federal Register, 1984), while lead has long been associated with occupational and environmental disease (Fetter, 1980).

4.2 Sampling Results

Groundwater samples obtained from each well were collected in 40 milliliter (ml) septum-sealed glass bottles. Care was taken to be sure that no air was present in any of the filled sample vials. The bottles were cooled during transport to the laboratory. A proper chain-of-custody was maintained. The samples were analyzed by gas chromatography method for purgeable aromatics (benzene, toluene, ethylbenzene, and xylene) and lead.

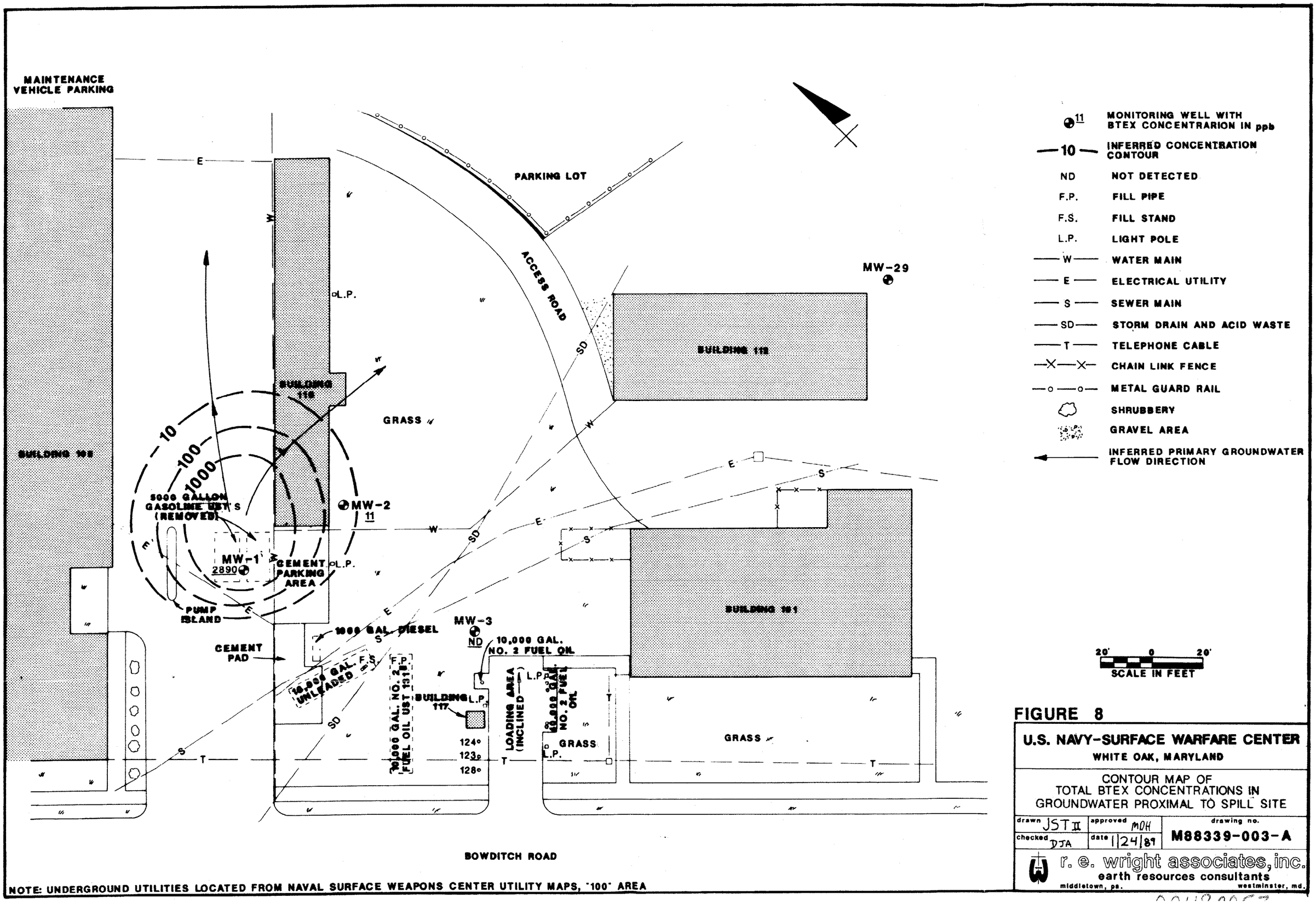
Analytical results of the groundwater samples are summarized in Table 2, and presented in detail as laboratory reports in Appendix C.

TABLE 2 - Chemical Analyses of Monitoring Well Groundwater Samples (concentrations in ppb)

Constituent	MW-1	MW-2	MW-3
Benzene	1220	3	N.D.
Toluene	340	5	N.D.
Ethylbenzene	520	2	N.D.
Total Xylenes	810	1	N.D.
Total BTEX	2890	11	N.D.
Lead	130	N.D.	N.D.

(N.D. = not detected)

Groundwater quality criterion for these constituents are presented in Table 3. It will be noted that the groundwater proximal to MW-1 exceeds contaminant levels for each of these constituents. A contour map of BTEX concentrations is also provided (Figure 8).



NOTE: UNDERGROUND UTILITIES LOCATED FROM NAVAL SURFACE WEAPONS CENTER UTILITY MAPS, '100' AREA

FIGURE 8

U.S. NAVY-SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

CONTOUR MAP OF
TOTAL BTEX CONCENTRATIONS IN
GROUNDWATER PROXIMAL TO SPILL SITE

drawn JSTII	approved MOH	drawing no.
checked DJA	date 1/24/89	M88339-003-A

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

TABLE 3 - Groundwater Quality Criteria for Gasoline Constituents and Lead (Concentrations in ppb)

Constituent	MCL[1]	MDE[2]	ADI[3]
Benzene	5	5	25
Toluene	-	-	-
Ethylbenzene	-	-	-
Total Xylenes	-	-	-
Total BTEX	-	100	-
Lead	50	50	-

1 Maximum Contaminant Level, Federal Register, July 8, 1987

2 Title 26, Maryland Department of the Environment

3 Acceptable Daily Intake (carcinogenic effects not considered), Federal Register, November 13, 1985.

5.0 OVERVIEW OF POTENTIAL REMEDIATION OPTIONS

Remediation options for gasoline spills can be broadly classified into two main categories. These are physical containment and aquifer restoration (Quince and Gardner, 1982).

5.1 Physical Containment

Physical containment is an attempt to immobilize the contaminant plume, limiting environmental damage to that which most already occurred. In general, containment options are more useful immediately following a spill rather than as a long-term solution to a low level leak of long duration.

One form of containment is hydrodynamic control, whereby upgradient wells are pumped in an attempt to reverse the hydraulic gradient in the local spill area, thus suspending plume migration. Another form of physical containment is emplacement of a grout curtain whereby closely spaced holes are drilled into the water table around the contaminant plume, and filled with cement grout under pressure, thus forming a continuous subsurface enclosure. Many other forms of physical containment have also been utilized with varying degrees of success and expense; these include slurry walls, cut-off trenches and sheet pilings (American Petroleum Institute, 1972).

5.2 Aquifer Restoration

The object of aquifer restoration is to remediate contaminated groundwater problems, and return the aquifer to its pre-contamination condition of water quality.

The most common method of aquifer restoration is through the utilization of recovery wells, to pump contaminated water from the subsurface. The contaminated water is then treated at the surface. Surface treatment methods include air stripping towers (AST's) for volatile organic contaminant problems; adsorption by activated carbon or synthetic resins; or surface bioremediation through which naturally-occurring or artificially-created microbes utilize contaminants as sources for their energy transformations, thus converting the contaminants to simple innocuous compounds such as water, nitrogen, and carbon dioxide. Treated water is then returned to the subsurface in wells or infiltration trenches located upgradient from the recovery well(s), providing additional head to move the contaminant plume toward the pumping wells and alleviating the water disposal problem.

Another method of aquifer restoration is through the utilization of naturally occurring subsurface microbes naturally found in the aquifer. These biological components can be numerically enhanced through the introduction of nutrients into the aquifer (Neely, 1986). Both aerobic and anaerobic microbes have been successfully used as hydrocarbon scavengers. Oxygen enhanced methods necessitate the introduction of oxygen (O^2) or hydrogen peroxide (H^2O^2) or injected air to stimulate aerobic degradation of gasoline. In-situ bioremediation has the advantage of being

theoretically more effective than pump-treat-reinject methods, since pump-treat-reinject methods can leave relatively large volumes of gasoline components in the subsurface adsorbed to the soil matrix. A combination of pump-treat-reinject and in-situ bioremediation has been found to be particularly effective in remediating subsurface contamination. The disadvantages of biological methods are that they may adversely impact nearby surface waters through the introduction of nutrients. The method may not be effective for aquifers with low permeabilities (Sheehan, et al, 1988).

6.0 CONCLUSIONS AND RECOMMENDATIONS

Groundwater contamination has occurred near Building 100 at the Naval Surface Warfare Center in White Oak, Maryland. The contamination is likely the result of gasoline leakage from a corroded UST. Chemical analyses of groundwater samples obtained from the monitoring well installed by REWAI at the former UST location, indicated BTEX and lead levels well over the MCL's allowed by Maryland law.

Groundwater in the unconsolidated Patapsco Formation (Upper Cretaceous) has a gradient to the northeast towards an unnamed tributary of the Paint Branch tributary of the Anacostia River. Groundwater velocities are unknown as no permeability testing was performed on the three monitoring wells installed. Anticipated groundwater velocities based upon the encountered lithologies should vary vertically and horizontally due to the interbedded nature of the fine- and coarse-grained sediments. Therefore, the contaminant plume could have advanced a considerable distance in the higher permeability zones, especially in light of the advanced age of the UST.

The present three monitoring well array is inadequate to define the full extent of the contaminant plume.

It is recommended that an additional four groundwater monitoring wells be drilled (Figure 9) to more adequately define the plume configuration and allow for remediation of the contaminated groundwater. Three of the wells should be located in the anticipated downgradient flow direction and one well should be located upgradient. It is anticipated that the upgradient well

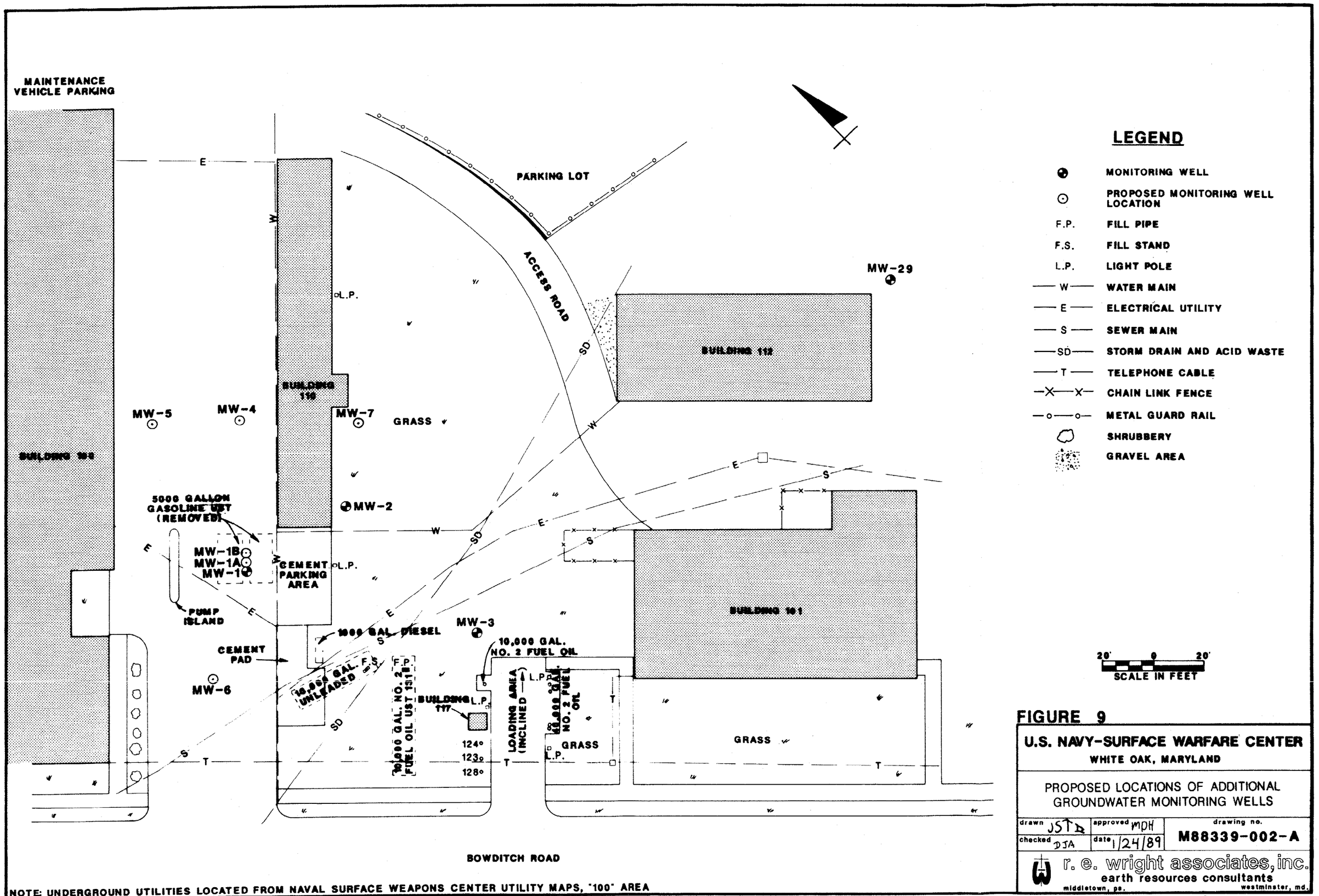


FIGURE 9

U.S. NAVY-SURFACE WARFARE CENTER
WHITE OAK, MARYLAND

PROPOSED LOCATIONS OF ADDITIONAL GROUNDWATER MONITORING WELLS

drawn JSTD	approved MDH	drawing no.
checked DJA	date 1/24/89	M88339-002-A

r. e. wright associates, inc.
earth resources consultants
middletown, pa. westminster, md.

may eventually be utilized to return treated water to the subsurface, in combination with, or in lieu of, infiltration trenches. This will create additional head towards any pumping wells and facilitate a more efficient and expeditious cleanup should a pump-treat-reinject remediation plan be adopted.

It is also recommended in view of the perched water condition in the vicinity of MW-1, that MW-1 be grouted and plugged and be replaced by two monitoring wells. This would eliminate the potential hydraulic connection between the perched zone and the lower sand which the monitoring well presently provides. The two replacement wells, one shallow and screened in the perched water table, and one deeper and screened in the natural water table, will allow a better understanding of the vertical potentiometric differences within the aquifer, and a more thorough investigation of the plume extent in the vicinity of the former UST. It is possible that attenuation of leaking hydrocarbons by clayey silts may have adsorbed most of the contaminants and localized the leakage to the immediate vicinity of the former UST area.

It is further recommended that after the completion of drilling and development operations on the six proposed groundwater monitoring wells, that groundwater samples be obtained from each of these wells, as well as from MW-2, and be chemically analyzed for BTEX compounds and lead.

It is further recommended that the hydraulic conductivity in the subsurface beneath the spill site be tested in order that groundwater velocities may be calculated, the interconnected nature of the water-bearing horizons may be determined, and the

feasibility of a pump-treat-reinject remediation option may be evaluated. This may be accomplished through simple testing by pumping of recovery wells on-site, or by slug testing of each individual monitoring well.

Based upon the results of the sampling and permeability testing, a specific remediation plan can be then recommended.

It is suggested that at some point in the future, the Navy may also wish to obtain groundwater samples from MW-3, because of its proximity to the 50,000 gallon No. 2 fuel oil UST system, and have chemical analyses performed for No. 2 fuel oil on these samples.

BIBLIOGRAPHY

American Petroleum Institute, 1972, The Migration of Petroleum Products in Soil and Ground Water: Principles and Countermeasures: API, Washington, D.C. p. 28 - 30.

Cleaves, E.T., Edwards, J., Jr., and Glaser, J.D., 1968, Geologic Map of Maryland: Maryland Geological Survey, Baltimore, MD

Driscoll, F.G., 1968, Groundwater and Wells, Second Edition: Johnson Division, St. Paul, Minnesota, p. 712.

Federal Register, June 12, 1984.

Fetter, C.W., Jr. 1980, Applied Hydrogeology: C.E. Merrill Publishing Company, Columbus, Ohio, p.355 - 356.

Froelich, G.J., 1975, Thickness of Overburden Map of Montgomery County, Maryland: U.S. Geological Survey, Miscellaneous Investigation Series Map I-920-B, 1:62,500.

Hack, J.T., 1977, Geologic Map for Land-Use Planning, Prince Georges County, Maryland: U.S. Geological Survey, Miscellaneous Investigation Series Map I-1004, 1:62,500.

Maryland Department of the Environment, Title 26, Code of Maryland Regulations.

Maryland Geological Survey, 1964, The Geology of Howard and and Montgomery Counties: Maryland Geological Survey, Baltimore, MD.

National Fire Protection Association, 1987, Underground Leakage of Flammable and Combustible Liquids: NFPA 329, Quincy, Massachusetts.

Neely, R., Gillespie, D., Schaut, F. and Walsh, Jr., 1986, Survey of On-Going and Completed Remedial Action Projects, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Nyler, E.K., 1988, Treatment of BTXE compounds at low flow rates: Groundwater Monitoring Review, Spring, 1988, V. 8, No. 2, p. 42 - 46.

Quince, J.R. and Gardner, G.L., 1982, Recovery and treatment of contaminated ground water, part 1: Ground Water Monitoring Review, V. 2, No. 3, p. 18 - 22

Sheehan, P.J., Schneiter, R. W., and Mohr, T.K.G., 1988, Bioreclamation of gasoline contaminated groundwater without oxygen addition: Proceedings of the Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, May, 1988, Las Vegas, NWWA, Dublin, Ohio

U.S. Department of Agriculture, 1961, Montgomery County, Maryland Soil Survey: Series 1958, No. 7, p. 107

Weast, R.C., ed., 1988, Handbook of Chemistry and Physics: CRC Press Inc., Boca Raton, Florida, p. B-33.

U.S. Environmental Protection Agency, Office of Water Regulations, November 28, 1980, Ambient Water Quality Criteria for Various Substances, Federal Register.

U.S. Environmental Protection Agency, November 13, 1985, Acceptable Daily Intake, (no adverse effect level, carcinogenic effects no considered), Federal Register.

U.S. Environmental Protection Agency, Office of Water Regulations, July 8, 1987, National Primary Drinking Water Regulations Final Rule-Maximum Contaminant Levels (MCL's), effective January 9, 1988, Federal Register.

GLOSSARY OF TERMS

Adsorption - The attraction and adhesion of a layer of ions from an aqueous solution to the solid mineral surfaces with which it is in contact.

Air stripping - a mass transfer process in which a substance in water is transferred to solution in a gas, usually air.

Alluvial - sediments deposited by a stream or running water; during periods of flooding, alluvium is deposited in the channel as well as the flood plain; coarser material is deposited in the channel and finer material is deposited on the levees of flood-plain.

Deltaic - sediments deposited at the mouth of a river where it enters the sea or a lake.

Desorption - the process whereby ions adsorbed onto a media return to the aqueous solution when their concentration in the solution has become reduced significantly.

Head - energy contained in a water mass, produced by elevation, pressure, or velocity.

Hydraulic Conductivity - the rate of flow of water (usually expressed in gallons per day) through a cross-section of one square foot (ft^2) under a unit hydraulic gradient, at the prevailing temperature; units of hydraulic conductivity are gallons per day per square foot (gpd/ft^2).

Metamorphic - general classification of rocks formed from preexisting rocks which were exposed to heat, pressure, or chemically active fluids, either within the earth's crust or at the surface (contact metamorphic).

Molecular weight - the sum of the atomic weights of a molecule's constituent atoms.

Perched Water - unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone; usually created by the existence of an underlying low permeability zone which acts to reduce infiltration to the main groundwater body.

Permeability - the capacity of a rock or sediment for transmitting a fluid; a measure of the relative facility of fluid flow under unequal pressure; units are Darceys; same as hydraulic conductivity if water is the fluid.

Plume - the area in which a contaminant entrained in an aqueous solution is present, usually emanating from a point source of solution.

Porosity - the ratio of the volume of void space in a rock or sediment to the total volume of the rock or sediment.

Saprolite - a product of chemical weathering of igneous and metamorphic rocks which contain some of the characteristics of the unweathered rock; for example, if the parent rock is schist, the saprolite will retain the schistosity.

Slug Test - an aquifer test made by either pouring a small instantaneous charge of water into a well, or by withdrawing a slug of water from the well and recording the rate of change in water level during its recovery to its original level.

Specific Conductance - the ability of water to transmit an electrical current; it is related to the concentration and charge of ions present in the water.

Specific Gravity - the ratio of the mass of a solid or liquid to the mass of an equal volume of distilled water at 40 celsius.

Transmissivity - the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient; it is a function of the water density and viscosity, the porous media, and the thickness of the porous media, and is therefore, the hydraulic conductivity of an aquifer multiplied by its saturated thickness; units are gallons per day per foot (gpd/ft).

Total Dissolved Solids - The quantity of dissolved material in a sample of water, either the residue of evaporation, dried at 180°C, or the sum of the chemical constituents.

Vadose Zone - the zone between the water table and the ground surface which contains water under pressure less than one atmosphere, including soil water and capillary water.

LIST OF ABBREVIATIONS

ADI	- Acceptable Daily Intake
BTEX	- benzene, toluene, ethylbenzene, xylene
EPA	- United States Environmental Protection Agency
ID	- inside diameter
LUST	- leaking underground storage tank
MCL	- Maximum Contaminant Level
MDE	- Maryland Department of the Environment
ml	- milliliter
MW	- monitoring well
ND	- not detected
NWWA	- National Water Well Association
OD	- outside diameter
ppb	- parts per billion
ppm	- parts per million
PVC	- polyvinyl chloride
REWAI	- R. E. Wright Associates, Inc.
SCS	- Soil Conservation Service
TDS	- total dissolved solids
USDA	- United States Department of Agriculture
USGS	- United States Geological Survey
UST	- underground storage tank
WLSI	- Wright Lab Services, Inc.

APPENDIX A

Site Complaint and Pertinent Sections of Code of Maryland Title 26

L

STATE OF MARYLAND
DEPARTMENT OF THE ENVIRONMENT
HAZARDOUS AND SOLID WASTE
MANAGEMENT ADMINISTRATION
ANNAPOLIS, MARYLAND 21401
(301) 974-3551

SITE COMPLAINT

NUMBER	DATE
SC-OV-89- 0906	10-21-88

1. Principal: NAVAL SURFACE WEAPONS CENTER
(Address): WHITE OAKS LABORATORY
10901 NEW HAMPSHIRE AVE. (PHONE) 394-1419
SILVERSPRING, MD 20903
2. Agent or Contractor:
(Address): BUILDING 100 TRANSPORTATION SHOP
(PHONE)
3. Violation of ☐ Environment Article, Section 4-401 through 418
☐ Code of Maryland Regulations. Section(s) Violated:
4. Specifically: I John Smiechowski performed an inspection on two gasoline storage tanks that were removed from the ground. I found a perforation near the bottom of one tank. Thus discharging gasoline to waters of the state.
5. Accordingly it is "ORDERED" that NAVAL SURFACE WEAPONS CENTER
☐ Cease and desist by _____ hrs, _____ 19 ____ : _____
■ Other: BY NOV 25, 1988 INSTALL (3) OBSERVATIONAL WELL IN THE AREA OF LEAKING TANK. IF LIQUID GASOLINE IS ENCOUNTERED ON THE WATER TABLE THE D.O.E. WILL REQUIRE CLEAN-UP. DETERMINE GROUNDWATER FLOW DIRECTION, SEND PLOT PLAN ILLUSTRATING TANK AREA ALONG W/ WELL INSTALLATION. ANY SURFACE DISCHARGE COMING FROM RECOVERY SYSTEMS MUST MEET STATE STANDARDS OF 100 PPB. TOTAL BTX'S.

Please be advised that you are entitled to a hearing before the Administration as a result of this Order. If you wish to schedule a Hearing on this matter, the Administration must be so notified in writing within (10) days.

6. "I hereby acknowledge receipt of this Site Complaint by my Signature, which is not an admission of guilt."

Person issued to: X Edward J. Dengenstein Jr.

AUTHORIZED BY: RONALD NELSON ISSUED BY: [signature]
Director Inspector

☐ Addendum Attached

DENV 80 White - UST and LUST Projects Divisions Yellow - File Pink - Principal

.02 Prohibition Against Oil Pollution.

A. A person may not pump, discharge, spill, throw, drain, deposit, or cause to be deposited, oil or other matter containing oil into, near, or in an area likely to pollute, waters of the State.

B. A person may not pump, discharge, deposit or cause to be deposited, bilge or ballast water, or water from any receptacle containing oil, in a manner by which oil may escape into, or in an area likely to pollute, waters of the State.

C. A person violating these prohibitions is subject to sanctions under Environment Article, §4-417, Annotated Code of Maryland, in addition to the permit and license modification, suspension, or revocation proceeding and in addition to any other sanctions provided by law.

r.e. wright associates, inc.

APPENDIX B

Schematic Logs of Monitoring Well Lithology and Construction

GEOLOGIC DRILLING LOG

BORING NO. MW-1

CLIENT: U.S. Navy - Surface Warfare Center

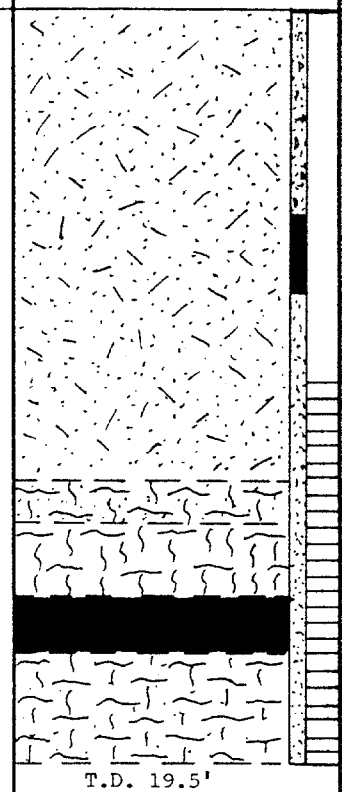
PROJECT NAME: White Oak, MD PROJECT NO. 88339

SURFACE ELEV. 340.41 (Approx) T.O.C. ELEV. 340.41 (Approx)

LOCATION

PAGE 1 OF 1

Depth Feet	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION (Trace-0 to 10%, Little-10 to 20%, Some-20 to 35%, And-35 to 50%)	VOLATILE SCAN	GRAPHIC LOG	WELL CONSTRUCTION DETAILS
		Ground Surface			
		Fill - Reddish yellow silty sand (SM)			Locking steel drive-over. Portland cement to surface.
5					Top of bentonite 5.0'
					Top of sand (Morie #2) at 7.0'
10					Top of 4" PVC screen at 9.5'
		Brown clayey silt (SM) with strong hydrocarbon odors			
		Light olive brown silty clay (CL) with some micaceous sand			
15		Black organic material/peat (Pt)			
		Olive brown clayey silt (MH) with some micaceous sand			
20				T.D. 19.5'	8" diameter hole to T.D.



DRILLER: Hardin-Huber

LOGGED BY: DJA/JBH

DRILLING STARTED: 12/19/88

DRILLING COMPLETED: 12/19/88

WELL CONSTRUCTION

DRILLING METHOD Hollow Stem Auger

STATIC WATER LEVEL 11.08' (1/4/89)

WATER BEARING ZONES 14.5' while drilling

NOTES:

Continuous split spoon samples from 10.0 to 19.5'.

GEOLOGIC DRILLING LOG

BORING NO. MW-2

CLIENT: U.S. Navy - Surface Warfar Center

PROJECT NAME: White Oak, MD PROJECT NO. 88339

SURFACE ELEV. 322.43 (Approx.) T.O.C. ELEV. 325.43 (Approx.)

LOCATION

PAGE 1 OF 1

Depth Feet	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION (Trace-0 to 10%, Little-10 to 20%, Some-20 to 35%, And-35 to 50%)	VOLATILE SCAN	GRAPHIC LOG	WELL CONSTRUCTION DETAILS
		Ground Surface			6.5" Steel protective casing, stickup 3.0' Locking 4" PVC cap
		Yellowish brown sandy silt (ML), micaceous			
		Yellowish brown clayey silt (CL)			
5		Pale brown sandy silt (ML)			
		Brownish yellow clayey silt (CL)			
10		Brownish yellow to reddish yellow sandy silt (ML), micaceous, moist at 9.5'			Portland cement to surface. Top of bentonite at 11.0'
		Reddish yellow clayey and sandy silt (CH), moist			Top of sand (Morie #2) at 13.0'
15		Pale brown clayey silt (OL), with some organics, moist			Top of 4" PVC screen at 16.7'
		Pale brown sandy silt (OL), increase in organics, micaceous, slightly moist			
20		Medium dark brown silty sand (SC), much organics, micaceous, moist			
		Yellowish red silty sand (SC), minor organics, slightly micaceous, minor hydrocarbon odor			
		Light gray sand (SW), micaceous, good porosity			
25					
		Light brown sandy silt, wet			Bottom of 4" PVC screen at 26.7'
30					8" diameter hole to T.D.

DRILLER: Hardin-Huber

LOGGED BY: DJA

DRILLING STARTED: 12/20/88

DRILLING COMPLETED: 12/20/88

WELL CONSTRUCTION

DRILLING METHOD Hollow Stem Auger

STATIC WATER LEVEL 17.57'(1/4/89)

WATER BEARING ZONES 19.5' while drilling

NOTES:

Continuous split spoon samples from surface to 24.0'.
Split spoon refusal at 24.0'.

GEOLOGIC DRILLING LOG

BORING NO. MW-3

CLIENT: U.S. Navy - Surface Warfare Center

SURFACE ELEV. 338.72 (Approx) T.O.C. ELEV. 341.42 (Approx)

PROJECT NAME: White Oak, MD PROJECT NO. 88339

LOCATION

Depth Feet	SAMPLE NUMBER	LITHOLOGIC DESCRIPTION (Trace-0 to 10%, Little-10 to 20%, Some-20 to 35%, And-35 to 50%)	VOLATILE SCAN	GRAPHIC LOG	WELL CONSTRUCTION DETAILS
		Ground Surface			6.5" O.D. - Steel protective casing stickup 2.7' Locking 4" PVC cap
		Dark yellowish brown sandy silt (OL)			Portland cement to surface.
		Yellowish brown silty sand (SM)			
5		Strong brown gravelly silt (ML)			Top of bentonite at 4.0'
		Light gray silty clay (CH), micaceous			Top of sand (Morie #2) at 6.0'
		Yellowish brown silty sand (SM), micaceous			
10		Dark yellow brown clayey silt (OL), micaceous, minor organics, slight hydrocarbon odor			Top of 4" PVC screen at 10.0'
		Reddish yellow sandy silt (ML), with some rounded white quartz gravel			
15		Light yellowish brown silty sand (SM)			
		Red gravelly silt (ML), slightly moist			
		Red silty sand (SM), wet			
20		Reddish brown sandy (ML), wet, heavy water inflow			Bottom of 4" PVC screen at 20.0'
				T.D. 22.0'	8" diameter hole to T.D.

DRILLER: Hardin-Huber

LOGGED BY: DJA

DRILLING STARTED: 12/20/88

DRILLING COMPLETED: 12/21/88

WELL CONSTRUCTION

DRILLING METHOD Hollow Stem Auger

STATIC WATER LEVEL 15.75' (1/4/89)

WATER BEARING ZONES 18.0' while drilling

NOTES:

Continuous split spoon samples from surface to T.D.

APPENDIX C

Chemical Analyses of Groundwater Samples

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7783-2

ATTN: Mr. Michael Haufler
R. E. Wright Associates Inc.
125 Airport Drive, Suite 36
Gateway West
Westminster MD 21157

January 12, 1989

LAB ANALYSIS REPORT

Job Name	: U.S. Navy-SWC	Customer PO#	: 107653
Job Number	: 88339-99-99	Date Sampled	: 12/30/88
Location	: MW-1	Date Received	: 01/03/89
Sample State	: Water	Date Completed	: 01/11/89
Collector	: DJA	Discard Date	: 01/20/89

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT
GAS CHROMATOGRAPH ANALYSES			
PURGEABLE AROMATICS			
Benzene	1220	ug/l	20
Ethylbenzene	520	ug/l	20
Toluene	340	ug/l	40
o-Xylene	240	ug/l	20
m-Xylene	370	ug/l	20
p-Xylene	200	ug/l	20
METALS			
Lead, Dissolved	0.13	mg/l	0.10

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
GAS CHROMATOGRAPH ANALYSES		

**** Continued ****

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Page # 2
Sample # 7783-2

January 12, 1989

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
PURGEABLE AROMATICS		
a,a,a-Trifluorotoluene	107	% Recovery Surrogate

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

34 Dogwood Lane Middletown, Pa. 17057 [717] 944-5541

• Water/ Wastewater
• Soils / Solids
• Air / Gases
• Atomic Absorption
• Gas Chromatography
• Wet Chemistry

Wright Lab Services, Inc.

Sample # 7783-1

ATTN: Mr. Michael Haufler
R. E. Wright Associates Inc.
125 Airport Drive, Suite 36
Gateway West
Westminster MD 21157

January 12, 1989

LAB ANALYSIS REPORT

Job Name	: U.S. Navy-SWC	Customer PO#	: 107653
Job Number	: 88339-99-99	Date Sampled	: 12/30/88
Location	: MW-2	Date Received	: 01/03/89
Sample State	: Water	Date Completed	: 01/11/89
Collector	: DJA	Discard Date	: 01/20/89

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT
GAS CHROMATOGRAPH ANALYSES			
PURGEABLE AROMATICS			
Benzene	3	ug/l	1
Ethylbenzene	2	ug/l	1
Toluene	5	ug/l	2
o-Xylene	N.D.	ug/l	1
m-Xylene	1	ug/l	1
p-Xylene	N.D.	ug/l	1
METALS			
Lead, Dissolved	N.D.	mg/l	0.10

N.D. - Not Detected

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
GAS CHROMATOGRAPH ANALYSES		

**** Continued ****

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7783-1

January 12, 1989

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
PURGEABLE AROMATICS		
a,a,a-Trifluorotoluene	97	% Recovery Surrogate

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

34 Dogwood Lane Middletown, Pa. 17057 [717] 944-5541

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7772-1

ATTN: Mr. Michael Haufler
R. E. Wright Associates Inc.
125 Airport Drive, Suite 36
Gateway West
Westminster MD 21157

January 12, 1989

LAB ANALYSIS REPORT

Job Name	: U.S. Navy-SWC	Customer PO#	: 107653
Job Number	: 88339-99-99	Date Sampled	: 12/29/88
Location	: MW-3	Date Received	: 01/03/89
Sample State	: Water	Date Completed	: 01/11/89
Collector	: DJA	Discard Date	: 01/20/89

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT
GAS CHROMATOGRAPH ANALYSES			
PURGEABLE AROMATICS			
Benzene	N.D.	ug/l	1
Ethylbenzene	N.D.	ug/l	1
Toluene	N.D.	ug/l	2
o-Xylene	N.D.	ug/l	1
m-Xylene	N.D.	ug/l	1
p-Xylene	N.D.	ug/l	1
METALS			
Lead, Dissolved	N.D.	mg/l	0.10

N.D. - Not Detected

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
GAS CHROMATOGRAPH ANALYSES		

**** Continued ****

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7772-1

January 12, 1989

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
PURGEABLE AROMATICS		
a,a,a-Trifluorotoluene	99	% Recovery Surrogate

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

34 Dogwood Lane Middletown, Pa. 17057 [717] 944-5541

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7783-3

ATTN: Mr. Michael Haufler
R. E. Wright Associates Inc.
125 Airport Drive, Suite 36
Gateway West
Westminster MD 21157

January 12, 1989

LAB ANALYSIS REPORT

Job Name	: U.S. Navy-SWC	Customer PO#	: 107653
Job Number	: 88339-99-99	Date Sampled	: 12/30/88
Location	: Trip Blank	Date Received	: 01/03/89
Sample State	: Water	Date Completed	: 01/11/89
Collector	: DJA	Discard Date	: 01/20/89

TEST/PARAMETER	RESULT	UNITS	DETECTION LIMIT
GAS CHROMATOGRAPH ANALYSES			
PURGEABLE AROMATICS			
Benzene	N.D.	ug/l	1
Ethylbenzene	N.D.	ug/l	1
Toluene	N.D.	ug/l	2
o-Xylene	N.D.	ug/l	1
m-Xylene	N.D.	ug/l	1
p-Xylene	N.D.	ug/l	1
METALS			
Lead, Dissolved	N.D.	mg/l	0.10

N.D. - Not Detected

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
GAS CHROMATOGRAPH ANALYSES		

**** Continued ****

- WATER/ WASTEWATER
- SOILS / SOLIDS
- AIR / GASES

Wright Lab Services, Inc.

- ATOMIC ABSORPTION
- GAS CHROMATOGRAPHY
- WET CHEMISTRY

Sample # 7783-3

January 12, 1989

QUALITY ASSURANCE REPORT

Q/A PARAMETER	RESULT	
PURGEABLE AROMATICS		
a,a,a-Trifluorotoluene	94	% Recovery Surrogate

Respectfully Submitted,
WRIGHT LAB SERVICES

Ian Milnes
Laboratory Manager

34 Dogwood Lane Middletown, Pa. 17057 [717] 944-5541