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FINAL VACUUM EXTRACTION PILOT STUDY AND REMEDIAL INVESTIGATION REPORT
VOLUME I MILLINGTON SUPPACT TN
11/1/1990
ERC ENVIRONMENTAL AND ENERGY SERVICES COMPANY

FINAL

Vacuum Extraction Pilot Study and Remedial Investigation Report

November, 1990

NAS Memphis, Tennessee

Volume I

Contract #N62467-87-D-0264
Amendment #18

Southern Division
Naval Facilities Engineering
Command, Charleston, S.C.
29411-0068
code 11523

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS N/A
2a SECURITY CLASSIFICATION AUTHORITY N/A 2b DECLASSIFICATION / DOWNGRADE SCHEDULE N/A	3 DISTRIBUTION / AVAILABILITY OF REPORT Distribution limited to State and U.S. Government Agencies
4 PERFORMING ORGANIZATION REPORT NUMBER(S) A472-007	5 MONITORING ORGANIZATION REPORT NUMBER(S) Amendment #18
6a NAME OF PERFORMING ORGANIZATION ERC/EDGe Environmental and Energy Services Company 6b OFFICE SYMBOL (If Applicable) ERCE	7a NAME OF MONITORING ORGANIZATION Southern Division Naval Facilities Engineering Command
6c ADDRESS (*City, State, and ZIP Code*) 3325 Perimeter Hill Drive Nashville, TN 37211	7b ADDRESS (*City, State, and ZIP Code*) 2155 Eagle Drive Charleston, South Carolina 29411-0068
8a NAME OF FUNDING / SPONSORING ORGANIZATION Same as 7a 8b OFFICE SYMBOL (If Applicable) N/A	9a PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N62467-87-D0264
8c ADDRESS (*City, State, and ZIP Code*) Same as 7b	10 SOURCE FUNDING NUMBERS PA Funds PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11 TITLE (*Include Security Classification*)
Vacuum Extraction Pilot Study and Remedial Investigation

12 PERSONAL AUTHOR(S)
J.C. Rutherford and Barry Delzell

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (*Year, Month, Day*)	15 PAGE COUNT
FINAL	FROM ______ TO N/A	1990, November 15	68

16 SUPPLEMENTARY NOTATION
N/A

17 COSATI CODES			18 SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUB-GROUP	Vacuum Extraction, Remedial Investigation

19 ABSTRACT (*Continue on reverse if necessary and identify by block number*)

At the request of Southern Division Naval Facilities Engineering Command, Charleston, South Carolina, ERCE has completed the Vacuum Extraction Pilot Study and Remedial Investigation for NAS Memphis, Millington, Tennessee.

The purpose of this report is to detail the field activities utilized in assessing the extent of petroleum contamination and subsurface/hydrogeologic characteristics. Specific field activities included soil borings monitoring well installation, analytical sampling, vacuum extraction and specific capacity studies.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a NAME OF RESPONSIBLE INDIVIDUAL John Albrecht	22b TELEPHONE (*Include Area Code*) 803/743-0580	22c OFFICE SYMBOL

DD Form 1473, JUN 86 — *Previous editions are obsolete.* — SECURITY CLASSIFICATION OF THIS PAGE

VACUUM EXTRACTION PILOT STUDY
AND
REMEDIAL INVESTIGATION REPORT

NAVAL AIR STATION MEMPHIS
MILLINGTON, TENNESSEE

NOVEMBER, 1990

CONTRACT #N62467-87-D-0264
AMENDMENT #18

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EXECUTIVE SUMMARY

Previous environmental studies conducted since 1985 have identified three gasoline leak/spill events at the NEX Service Station. It is estimated that 5,400 gallons of gasoline have been released at the site.

The remedial investigation performed by ERCE at the NEX Service Station included four primary segments of study.

1. Implement a quarterly ground water sampling program and review of analytical data from previous sampling events.
2. Determine the vertical and horizontal extent of soil contamination and install five new monitoring wells at the outer limits of the identified plume boundary.
3. Perform a ground water pump test to determine the hydraulic characteristics of the aquifer at the site.
4. Perform a vapor extraction pump test to gather information necessary for determining the applicability of the *in situ* soil venting as a remedial method for soils containing gasoline constituents.

A review of the analytical data from 5 ground water sampling events over a 4 year period revealed no distinguishable patterns in Benzene concentration fluctuations. Ground water samples obtained from the 5 monitoring wells installed along the outer perimeter of the identified plume boundary displayed no detectable concentrations of Benzene upon initial well construction or 4 months later during resampling. Over the 4 month monitoring period, plume movement has not been measurably detected.

Ground water elevations at the site average 4 to 5 feet below ground surface. Fluctuations in elevation typically range between 2 and 3 feet.

The hydrocarbon plume in soil was identified to extend vertically to depths of 14 feet below surface grade. The identified plume extended across more than half of the site (approximately 1.5 acres). Total petroleum hydrocarbon (TPH) concentrations in soil were typically greatest at 6 to 8 feet below the ground surface. At least 3 source areas were identified, including an area where 3 tanks were abandoned 21 years ago.

Calculations based on results from the ground water pump test, indicate transmissivity and storativity coefficients ranging from 0.00354 to 0.001933 ft^3/min. and 0.0113 to 0.00212 respectively. Calculations projected 5.4 feet of drawdown at 2 feet from a 6 inch diameter well, screened 30 feet into the unconfined aquifer, pumping at a rate of 0.37 gpm.

An air pump test was performed to gather data for determining the applicability of a full scale vapor extraction system. Maximum sustained flow rates for the six inch and 4 inch diameter wells were 8.6 and 7.1 scfm at 90 and 100 inches of water yielding 4.2 and 8.6 feet radii of influences respectively.

Calculations derived from the ground water pump test indicate de-saturating the soil zone, most highly concentrated with petroleum hydrocarbons sufficiently to utilize vacuum extraction would require approximately 1,100 ground water recovery wells. Installation and maintenance costs incurred with a ground water recovery and vacuum extraction system of this complexity prevents vacuum extraction from being a practical remedial option.

ACKNOWLEDGEMENTS

In the execution of the effort required to generate this manual, the Underground Storage Tank personnel at ERCE commends the unwavering support, assistance, and cooperation provided by the personnel at Naval Air Station, Millington, Tennessee and Southern Division, Naval Facilities Engineering Command. In particular, we acknowledge the outstanding effort, dedication, and professionalism provided by the following people in the preparation of this manual:

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ACRONYMS, INITIALISMS, AND ABBREVIATIONS

The following list contains many of the acronyms, initialisms, and abbreviations, as well as the units of measure used in this report:

BTEX	Benzene, Toluene, Ethylbenzene, Xylene
cm	centimeters
EPA	Environmental Protection Agency
ERCE	ERC Environmental and Energy Services Company, Inc.
ft	foot
g	grams
GC	Gas Chromatograph
gpm	gallons per minute
min	minute
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAS	Naval Air Station
ND	Not detected at quantification limit
NEX	Navy Exchange Service Station
OVM	Organic Vapor Monitor
ppb	parts ber billion
ppm	parts per million
PSI	Professional Services Industries, Inc.
PTFE	polytetrafluorethylene
s	seconds
scfm	standard cubic feet per minute
TDHE	Tennessee Department of Health and Environment
TPH	Total Petroleum Hydrocarbons
ug/kg	micrograms per kilogram
ug/L	micrograms per liter
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW. ERC Environmental and Energy Services Company (ERCE) has been tasked to perform the vacuum extraction pilot study, contaminant migration investigation and quarterly ground water sampling at the Navy Exchange Service Station (NEX), Naval Air Station (NAS) Memphis. NAS Memphis is located in southwestern portion of the State of Tennessee approximately ten miles north of Memphis. The Navy Exchange Service Station is located along the northwestern perimeter of the base and adjacent to Old Navy Road.

1.1.1 NEX Background Summary Previous environmental studies conducted since 1985 have identified three gasoline leak/spill events at the NEX Service Station. It is estimated that 5,400 gallons of gasoline have been released at the site.

Separate field investigations performed by Pittsburgh Testing Laboratories (PTL) and Harding Lawson Associates (HLA) have identified petroleum hydrocarbon contamination within both the soil and ground water regimes at the subject site. Presently, petroleum hydrocarbon contamination at the NEX Service Station exceeds the State of Tennessee's ground water and soil cleanup criteria. Vacuum extraction has been proposed as a potential remedial technique for treatment of hydrocarbon contaminated soils at the subject site.

1.2 OBJECTIVE. The basic objective of the remedial investigation as described by the work plan was to determine various subsurface and ground water characteristics at the NEX Service Station and to provide prospective contractors with sufficient information for bidding design and construction of a site specific remediation system should vacuum extraction be deemed feasible. To accomplish this, the following specifics were proposed:

- Advancement of approximately twenty eight soil borings at various locations to delineate the horizontal and vertical limits of product migration. Soil samples were to be collected from each of the borings.
- Installation of five 4-inch monitoring wells at the subject site to determine the horizontal extent of ground water contamination. Ground water samples were to be obtained from these wells.
- Initiation of a quarterly ground water sampling program. Ground water samples were to be obtained from all existing monitoring wells at three month intervals.
- Installation of two 4-inch monitoring wells and one 6-inch monitoring well within the contaminant plume to be utilized for a ground water pump test and vacuum extraction pilot study.
- Vacuum extraction testing of the new and existing monitoring wells to determine the area of influence around each extraction point, optimum flow, spacing of recovery wells, and other additional data. Air samples were to be obtained and analyzed on-site with a organic vapor analyzer and a gas chromatograph.
- Ground water pump testing of the new and existing monitoring wells to determine various hydrogeologic characteristics.

- Collection of climatological data from the NAS Memphis weather station and determination of what effects seasonal precipitation has upon the hydrogeologic characteristics at the subject site.

2.0 QUARTERLY SAMPLING

2.1 INTRODUCTION. In addition to the vacuum extraction pilot study and remedial investigation, ERCE personnel initiated a quarterly sampling program at the NEX Service Station. The objective of the quarterly sampling program is to obtain periodic ground water samples from the newly installed, as well as existing, monitoring wells and monitor the hydrogeologic and contaminant plume characteristics. The sampling program consists of obtaining ground water on three month intervals and submitting the samples for analytical evaluation of petroleum hydrocarbons.

2.2 INITIAL SITE VISIT/PERMITTING. Prior to implementing the sampling program, ERCE personnel met with Ms. Tonya Barker, and Mr. Jimmie Black, NAS Public Works, to discuss aspects of the work and obtain the necessary permits and authorization.

Specific items included:

- authorization to enter upon NAS Memphis property.
- any health or hazard related permits which are required by the Public Works Office.
- site visit to the NEX Service Station.

2.3 GROUND WATER SAMPLING. On May 9, Mr. Barry Delzell and Mr. Chris Rutherford of ERCE arrived at NAS Memphis to initiate the quarterly sampling program. During this phase of the initial quarterly sampling program, the pre-existing fifteen monitoring wells at the subject area were sampled.

2.3.1 Measurement of Water/Product Depth The static water level and product thickness within each monitoring well was measured and recorded before purging and sampling. Water/product level readings were taken by use of an MMC battery-powered interface probe. All measuring devices were properly decontaminated prior to introduction into each well.

2.3.2 Well Purging After measurements of product thickness and water level were recorded, each well was purged with a clean decontaminated PTFE bailer. A volume of water equal to three times the submerged volume of the casing was removed from each well. As per Naval protocol, the physical parameters for each well such as temperature, pH and specific conductance were measured until stabilization (within 10%) was evident over a three sample interval.

2.3.3 Ground Water Monitoring Well Sampling Upon stabilization of the physical ground water parameters, the fifteen existing wells at the NEX Service Station were sampled. Up-gradient wells and wells less contaminated as indicated in previous reports were sampled first. The sequence for ground water sampling is presented below.

1	MEM-757-4	6	MEM-757-B4	11	MEM-757-B1
2	MEM-757-9	7	MEM-757-B4	12	MEM-757-B2
3	MEM-757-10	8	MEM-757-7	13	MEM-757-3
4	MEM-757-5	9	MEM-757--6	14	MEM-757-1
5	MEM-757-B3	10	MEM-757-8	15	MEM-757-2

A decontaminated PTFE bailer and dedicated, clean, unused cotton cord were utilized to obtain each ground water sample.

At the completion of the remedial investigation, the five monitoring wells (MEM-757-15,16,17, 18, and 19) installed along the perimeter of the contaminant plume were sampled in accordance with the quarterly sampling program.

Based upon field observations noted during the soil boring activities, the least contaminated monitoring wells were sampled first. Utilizing the previously described procedure, the wells were sampled in the following sequence:

1. MEM-757-17
2. MEM-757-15
3. MEM-757-16
4. MEM-757-19
5. MEM-757-18

3.0 REMEDIAL INVESTIGATION

3.1 INTRODUCTION. ERCE was tasked to perform a remedial investigation at the NEX Service Station. The objective of the remedial investigation was to determine the extent of the migratory plume of petroleum contamination. The installation of eight additional monitoring wells and twenty-eight exploratory soil borings has aided in defining the present horizontal and vertical limits of contamination.

3.2 INITIAL SITE VISIT. Prior to implementing the required field activities, Mr. Barry Delzell and Mr. Chris Rutherford of ERCE met with Ms. Tonya Barker and Mr. Jimmie Black, NAS Public Works Engineering, to review work plans and obtain the necessary permits and authorizations. In addition, updated site and utility plans were reviewed. All utilities identified within the work zone were field spotted and flagged.

3.2.1 Health and Safety Plan Review A site plan was drafted to establish a systematic methodology for protecting the health and safety of field personnel during the geo-environmental activities. The plan contained safety information, instructions, and procedures. The Health and Safety Plan was prepared and reviewed by qualified personnel, and addresses the hazards associated with various substances expected to be encountered at the NEX Service Station. Prior to the initiation of field activities, the safety plan was reviewed and discussed with all personnel involved in the field activities.

3.3 EXPLORATORY SOIL BORINGS. On May 31, 1990, Professional Services Industries, Inc. (under the on-site supervision of the ERCE Project Geologist) implemented the soil boring program at the NEX Service Station. To prevent unwarranted entry into the investigation area, access was restricted by the Site Project Manager and Health and Safety Officer.

3.3.1 Field Screening Throughout the boring program a MSA Minigard II combustible gas and oxygen indicator (explosimeter) was employed to continually monitor the working conditions.

Each boring was screened visually, olfactorily, and with a Thermo 580A Organic Vapor Monitor (OVM) for the presence of volatile organic vapors. In addition, the OVM was utilized in obtaining the required samples for analytical study.

3.3.2 Soil Boring Locations To assess the subsurface conditions at the NEX Service Station, twenty-eight soil boring locations were selected. In order to perform an adequate qualitative/quantitative investigation within the subject site, the borings were advanced at locations so as to define the horizontal limits of petroleum contamination. All twenty-eight soil borings were advanced within either the paved asphalt lot covering the NEX Service Station site or the grassed lawn surrounding the subject area. A site plan with boring/well and underground utility locations is presented within Appendix I. Boring log and well construction data is presented within Appendix II.

Each boring was continuously sampled in general accordance with ASTM D 1586 (Split-Barrel Sampling of Soils). This procedure utilizes a split-barrel sampler, 1.5 inches in diameter by 2 feet in length, to obtain a representative sample of the subsurface material. The sampler is continuously driven the length of the boring and is retrieved every 2 feet. This method allowed the ERCE project geologist to accurately classify soils and to obtain the necessary soil samples for analytical study. Each location was screened visually, olfactorily, and with the Thermo 580A OVM for the presence of contaminants.

All cuttings and excess soil materials were spread evenly on plastic sheeting in the northeast corner of the NEX Service Station Facility

3.3.3 Soil Sampling Program Upon opening of the split barrel sampler, the ERCE project geologist obtained the necessary samples for analytical evaluation. Approximately 50 grams of soil material was collected from each two-foot sample at the apparent zone of petroleum contamination. Sample depths ranged from zero to thirty feet below surface grade.

3.3.3.1 Analytical Samples A total of 199 soil samples were collected from the twenty eight borings. Each 50 gram sample was contained within a plastic bag and immediately transported to an on-site, mobile laboratory for analysis. The laboratory results are explained within Chapter 5.

3.3.3.2 Soil Characteristic Samples In addition to the analytical samples, soil samples were obtained from borings A5 and A7 for physical analysis of various soil characteristics. Specific characteristics include:

- Permeability
- Organic Content
- Total Porosity
- Bulk Density
- Particle Size
- % Moisture
- Conductivity
- Resistivity
- Particle Density
- pH

Under the on-site supervision of the ERCE project geologist, Professional Service Industries (PSI) personnel obtained one thin-walled tube sample from boring A5 at a depth of 14 to 16 feet below the surface grade. One thin-walled tube sample was obtained at a depth of 7 to 9 feet below the surface grade from boring A7. Two bag samples were obtained at depths of 3 to 5 feet and 5 to 7 feet below the surface grade from boring A7.

All four samples were properly sealed and labeled and transported to PSI's soil laboratory for physical analysis. The laboratory results from PSI are explained within Chapter 4.

3.4 GROUND WATER MONITORING WELL INSTALLATION. To adequately determine hydrogeologic characteristics and ground water contamination at the NEX Service Station, eight borings were converted to either six or four inch PVC ground water monitoring wells. The monitoring wells were installed by PSI, Inc. All well installation activities were performed in accordance with SOUTHNAVFACENGCOM's "Specifications for Groundwater Monitoring Well Installation and Sampling", and were consistent with the guidelines set forth in the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (EPA, 1986).

3.4.1 Well Construction Each well was constructed of flush threaded, six or four inch, Schedule 40 PVC material with a 0.010 inch slotted screen section. Monitoring well MEM-757-12 was initially designed for use as a pump test well, and as a vacuum extraction pump test well. A ten foot screened interval was placed at a depth of ten to twenty feet to adequately screen below the water table. A ten foot sump was installed below the screened interval.

Monitoring wells MEM-757-13 and 14 were initially designed as test wells. These four-inch diameter wells have a four foot screened interval placed at depth intervals of nine to thirteen and ten to fourteen feet, respectively, below surface. The screened intervals were placed at these depths to reach within the same screened zone as MEM-757-12..

The five remaining wells have four-inch diameter casings. A ten foot screened interval for monitoring wells MEM-757-15, 16, 17, 18, and 19 was placed at a depth interval of five to fifteen feet to correspond to the top of water, maximizing the natural fluctuations of the shallow water table present at this site. Upon lowering the well casing, the annulus surrounding the screen was backfilled with clean number 16/32 sized, quartz sand to a minimum of two feet above the top of the screen. A pelletized bentonite seal, two feet in thickness, was placed on top of the sand filter material. After allowing a minimum of six hours for hydration of the bentonite, the remaining annulus was filled with a cement/grout mixture.

To prevent unauthorized entry each well was completed with the installation of a waterproof locking cap. Monitoring wells MEM-757-12, 13, 14, and 15 were completed within a twelve-inch diameter, manhole cover, mounted flush to the existing pavement. Monitoring wells MEM-757-17, 17, 18, and 19 were completed with a twelve-inch diameter flush-mounted manhole cover within a two-foot by two-foot by six-inch concrete pad. Keys to each well cap were given to Mrs. Tonya Barker, NAS Public Works. Well diagrams are presented within Appendix II.

<u>3.4.2 Well Development</u> After allowing a twenty-four hour period for the grout to cure, each monitoring well was properly developed. Utilizing a pumping and surging method, each well was developed until the discharge was clear and sand-free.

<u>3.4.3 Quarterly Sampling</u> As described within Chapter 2, the five perimeter monitoring wells were installed after the completion of the remedial investigation. Each of these newly installed monitoring wells were sampled twenty-four hours following well development activities, in accordance with the quarterly sampling program protocol.

<u>3.4.4 Ground Water Samples</u> In order to determine petroleum hydrocarbon contamination levels within the ground water regime at the NEX Service Station, ground water samples were obtained from the site soil borings. Fourteen samples were collected at the potentiometric surface from fourteen soil borings that remained open at the completion of the drilling program. The fourteen soil borings are A1, A2, A3, A4, A5, A6, A9, A13, A16, A18, A20, A22, A27, and A28.

Ground water samples were collected with a decontaminated teflon bailer and dedicated, clean, unused cotton cord. Each sample was contained within a 40 milliliter VOA vial, filled to exclude any air, and capped with a Teflon-lined septa cap. All samples were immediately transported to an on-site, mobile laboratory for analytical evaluation. The results from the laboratory analysis are presented within Chapter 5.0.

3.5 DECONTAMINATION PROCEDURES. Decontamination protocol was maintained throughout the boring and sampling programs to prevent the possibility of cross-contamination. Personnel utilized a steam cleaning unit to decontaminate all downhole drilling tools including sampling tubes and rotary bits. The steam cleaner was restricted to a designated staging area so as not to pose a possible fire hazard.

All sampling equipment, such as sampling knives, spoons, trays and teflon bailers were scrubbed with a non-phosphatic detergent and rinsed with isopropyl alcohol and deionized water between each sampling point.

4.0 SITE CHARACTERISTICS

4.1 TOPOGRAPHY. NAS Memphis is located in the Coastal Plain physiographic province, within the flood plain of the Mississippi River. These plains are characterized by lowlands, natural levees, poorly drained back swamps, "oxbow" lakes and the broad, flat-bottomed valleys of numerous tributary streams. The bluffs which border the lowlands to the east and west attain an elevation of about one hundred to two hundred feet.

The Navy Exchange Service Station site is located in the northwestern quadrant of base activity. The subject area occupies approximately three acres. The site is relatively flat with surficial drainage to the west and is covered with an asphalt pavement.

4.2 SITE GEOLOGIC CONDITIONS. The extreme western portion of Tennessee is underlain by loess deposits of Quaternary Age. This loess is generally characterized as a gray to brown massive clayey and sandy silt. Its maximum thickness reaches one hundred feet along bluffs of the Mississippi River and thins eastward. The loess is in turn underlain by the Clairborne and Wilcox Formations, irregularly bedded sands locally interlayered with lenses and beds of gray to white clay, silty clay, lignitic clay and lignite.

Soils recovered from the boring program at the NEX Service Station displayed typical Western Tennessee loess and Mississippi River silt deposits. Beneath the thin veneer of asphalt or topsoil at the site, a clay and silty clay soil material was encountered to an average depth of seven feet. This soil material varied in color from greenish-gray to gray and brown. Underlying the gray and brown and silty clay layer, soils were classified predominantly as gray alluvial silts until soil boring termination at an average depth of 18 feet. The aquifer present within study area was classified as unconfined.

Ground water was first observed to enter the soil borings at an average depth of 9 feet and rose to within 4 feet of the ground surface.

The highest levels of petroleum hydrocarbon contamination were recorded at an average depth of 6 to 8 feet below the surface. Soils recovered from depths greater than 18 feet were extremely wet and did not display evidence of petroleum hydrocarbon contamination.

4.2.1 Soil Characteristics Analysis To assess the various subsurface characteristics, four geotechnical soil samples were obtained. One sample was collected at a depth of fourteen to sixteen feet in boring A5. Three samples were collected from depths of three to five feet, five to seven feet, and seven to nine feet in boring A7. All samples were properly collected, sealed, and transported to PSI's soil laboratory for evaluation. Test results for physical soil characteristics are presented in Appendix III.

4.2.1.1 Permeability As expected with poorly-sorted, fine-sized, alluvial sediments and loess, laboratory evaluation for vertical and horizontal permeability yielded low results. Evaluation of the sample collected from fourteen to sixteen feet below surface grade in boring A5 revealed vertical and horizontal permeability values of 4.13×10^{-7} and 3.4×10^{-7} cm/sec, respectively. Evaluation of the sample collected from seven to nine feet below surface grade in boring A7 revealed vertical and horizontal permeability values of 4.83×10^{-7} and 1.0×10^{-6} cm/sec, respectively.

4.2.1.2 Organic Content One sample was collected from the study area and submitted for analysis of organic content. Evaluation of the sample collected from three to five below surface grade in boring A7 revealed an organic content value of 0.9%. This low value for organic content is typical of loess deposits in the Memphis area.

4.2.1.3 Total Porosity and Bulk Density Analysis of two samples (depth five to seven feet, boring A7 and depth fourteen to sixteen feet, boring A5) for total porosity and bulk density did not reveal atypical values. As expected with poorly-sorted, silty clays, the sample collected at a depth of five to seven feet below surface from boring A7 displayed a total porosity of 33.2% and bulk density value of 108 pounds per cubic foot (pcf). The sample obtained at a depth of fourteen to sixteen feet below the surface in boring A5 (well-sorted silt) revealed a total porosity of 36.5% and a bulk density of 109 pcf. The difference between the two porosity values (33.2%, five to seven feet and 36.5%, fourteen to sixteen feet) may be attributed to the compaction and assemblage of the poorly-sorted, silty clays compared to the well-sorted silts.

4.2.1.4 Particle Size The sample collected from a depth of five to seven feet below the surface in boring A7 was analyzed for particle size. As shown on the attached grain-size distribution curve, approximately 100 percent of the sample passed the 200 mesh sieve. A hydrometer test was performed on the fines to gradate the fine sediments. Results from the hydrometer test indicate the sample to be a silty clay.

4.2.1.5 Moisture Content Four samples were collected from the study area and submitted for analysis of moisture content. One sample was obtained at a depth of fourteen to sixteen feet below surface grade in boring A5. Two duplicate samples were obtained at a depth of three to five feet below surface grade in boring A7. The remaining sample was obtained at a depth of seven to nine feet below surface grade in boring A7. Analytical results from the four samples displayed moisture content values of 26%, 22%, 26%, and 23%, respectively. The moisture content results appear to be natural background levels.

4.2.1.6 Conductivity and Resistivity Two samples were collected from the study area and submitted for resistivity and conductivity analysis. One sample was obtained at a depth of three to five feet below surface grade in boring A7. Evaluation of this sample revealed conductivity and resistivity values of 0.6 mmho/cm, 1600 ohm-cm respectively. The remaining sample was obtained at a depth of seven to nine feet below surface grade in boring A7. Evaluation of this sample revealed conductivity and resistivity values of 0.3 mmho/cm and 3300 ohm-cm, respectively.

4.2.1.7 pH One sample was obtained from the study area and submitted for pH analysis. Evaluation of the sample collected at a depth of three to five feet below surface grade in boring A7 displayed a pH value of 7.2.

4.3 SURFACE DRAINAGE AND GROUND WATER. Surface drainage in West Tennessee is dominated by the Mississippi River and its tributaries. Memphis borders two minor drainage basins; the city lies on the eastern border of the St. Francis basin and on the northern border of the Yazoo basin. With its characteristic lack of relief, the ground surface tends to drain poorly and readily accumulate excess surface water after heavy rains, and local flooding is not uncommon.

The presence of ground water was confirmed at the completion of each soil boring and monitoring well installation. Water level readings taken before and after well development indicated an average depth of four feet below surface grade.

4.4 AQUIFER CHARACTERISTICS.

4.4.1 Specific Capacity Test In order to determine the hydraulic characteristics of the aquifer at the subject site, a series of tests were performed which provided information on the specific capacity, transmissivity, storativity, and other factors affecting site hydrogeology. Prior to conducting a constant rate pump test, a specific capacity test was performed to assess the optimal rate of pumping for the constant rate test. The specific capacity test was conducted as a step-drawdown test. The objective of a step drawdown test is to pump the well for specific periods of time, increasing the pumping rate in several increments while simultaneously measuring the amount of drawdown that occurs within the pumping well during each pumping interval. The data can then be reduced to predict how much drawdown will occur within the pumping well as a specific discharge.

The test was conducted utilizing a five gpm submersible pump installed in pumping well W-12 and fitted with a one inch PVC discharge line. Where the discharge line emerged from the well casing, it was routed through an assembly of fittings and valves allowing the pump to be shut in, while permitting recirculation of the water back into the well to prevent excessive build up pressure in the discharge line and pump. At the discharge end of the recirculation mechanism, a flow meter was installed and one inch PVC hose was used to route the discharge water into a holding vessel for future treatment and or disposal. A two inch distilling pipe was installed to a depth of two feet above the top of the pump in order to prevent erroneous pressure transducer readings caused by pump turbulence and cascading recirculating water. The pressure transducer was placed inside the stilling tube and lowered to within approximately three feet of the bottom of the distilling pipe. Drawdown within the well was measured with an EL-200 data logger, and discharge measurements were conducted both with the flow meter and volumetrically.

Although step drawdown tests usually consist of multiple intervals of discharge and drawdown data, the maximum yield obtained from W-12 was insufficient to allow adequate variance in well discharge to accurately obtain data at multiple pumping intervals. The maximum yield acquired during the step-drawdown test was 0.3 gpm, which was only the second pumping interval of the test. The following table summarizes the data of the two pumping intervals.

TABLE 4-1
PUMPING RATES DURING STEP TEST

STEP NUMBER	PUMPING RATE (GPM)	ELAPSED TIME (MIN)	DRAWDOWN (FT)
1	0.2	260	4.8
2	0.3	260	11.3

During either pumping interval, the drawdown within the pumping well had not yet stabilized after a pumping period of 260 minutes. However, the relationship of drawdown to pumping rate after a pumping period of 260 minutes indicates that an increase of 0.1 gpm more than doubled the amount of drawdown. Therefore, based on a saturated depth within the pumping well of 24.7 feet, a conservative value of 0.2 gpm was chosen to conduct the ground water pump test.

4.4.2 Ground Water Pump Test

4.4.2.1 Methodology After allowing the aquifer to stabilize for twenty-four hours, the aquifer was pumped for a twenty-four hour period at a constant rate of 0.2 gpm. The same recirculation device, distilling device, and pressure transducer/data logger system used for the specific capacity test were used for the pump, or constant rate, test. In addition to monitoring of drawdown within the pumping well, two observation wells, W-13 and W-14, located a distance of 3.75 and 9.75 feet from the pumping well respectively, were monitored by the transducer/data logger system. Periodic measurements were made manually with an electronic water level indicator to confirm the accuracy of data collected by the transducer/data logger system. The following tables present the time versus drawdown data for each well.

The objective of pump test data is to calculate the aquifer characteristics of transmissivity and storativity (same as specific yield in unconfined aquifer systems). Interpretation of the data can be approached by several methods, but most employ a variation of the equations of C.V. Theis (1935).

$$s = Q/4 \times \pi \times T)\ w(u)$$

where, $u = r^2 \times s/(4 \times T \times t)$

and s = drawdown

Q = constant discharge rate

T = transmissivity

r = distance from the pumping well to the observation well

t = time since pumping began

s = storativity

and w(u) is the Theis well function, an intergral that can be evaluated by the following series:

$$w(u) = 0.5772 - \ln u + u - u^2/2*2! + u^3/3*3! \ldots$$

Assumptions for the proper use of this equation are as follows:

- aquifer has infinite areal extent
- aquifer is homogeneous , isotropic, and of uniform thickness
- aquifer potentiometric surface is initially horizontal
- pumping rate is constant
- pumping well is fully penetrating
- flow to pumping well is horizontal
- aquifer is confined
- flow is unsteady
- water is released instantaneously from storage with decline of hydraulic head

TABLE 4-2
TIME VERSUS DRAWDOWN DATA FOR CONSTANT RATE TEST

Time (min)	WELL 12	WELL 13	WELL 14
0	0	0	0
22	1	0.13	0.01
22.5	1.2	0.15	0.01
25.5	1.2	0.18	0.01
26.5	1.4	0.19	0.01
27.5	1.4	0.2	0.01
29	1.4	0.22	0.01
30	1.4	0.23	0.02
32	1.4	0.25	0.02
33.5	1.4	0.26	0.03
35	1.4	0.28	0.03
36.5	1.4	0.29	0.03
39	1.6	0.31	0.03
41	1.8	0.33	0.04
43	1.8	0.35	0.04
46	2	0.39	0.05
47	2.2	0.41	0.05
50	2.2	0.45	0.06
52	2.2	0.48	0.06
54	2.2	0.51	0.07
57	2.4	0.54	0.08
66	2.4	0.64	0.1
70	2.4	0.67	0.11
74	2.4	0.71	0.12
78	2.4	0.72	0.13
82	2.4	0.75	0.14
86	2.4	0.77	0.15

TABLE 4-2
TIME VERSUS DRAWDOWN DATA FOR CONSTANT RATE TEST

Time (min)	WELL 12	WELL 13	WELL 14
90	2.4	0.8	0.16
94	2.8	0.81	0.17
98	3	0.85	0.18
102	3.2	0.9	0.18
106	3.2	0.94	0.2
110	3.4	0.98	0.21
114	3.6	1.04	0.22
126	3.8	1.19	0.27
130	3.8	1.23	0.28
134	4	1.26	0.29
138	4	1.3	0.31
142	4	1.34	0.32
146	4	1.37	0.33
150	4	1.4	0.34
154	4.2	1.43	0.35
158	4.2	1.44	0.36
168	4	1.49	0.39
198	4.4	1.63	0.46
228	4.4	1.75	0.52
258	4.6	1.83	0.57
288	4.8	1.92	0.61
348	4.6	2.01	0.71
378	4.6	2.01	0.71
428	4.6	2.05	0.74
458	5.6	2.09	0.76
488	7.4	2.19	0.79
518	8.4	2.3	0.82

TABLE 4-2
TIME VERSUS DRAWDOWN DATA FOR CONSTANT RATE TEST

Time (min)	WELL 12	WELL 13	WELL 14
548	9	2.4	0.85
578	9.2	2.43	0.87
608	9.2	2.43	0.87
638	10	2.51	0.93
668	10.4	2.57	0.95
698	10.6	2.64	0.98
728	10.6	2.67	1.01
758	11	2.76	1.03
788	11.6	2.89	1.06
818	11.8	3.05	1.1
848	12	3.12	1.14
878	12.6	3.16	1.16
908	12.8	3.26	1.19
938	13.6	3.2	1.22
968	13.8	3.28	1.24
998	13.8	3.41	1.27
1028	13.8	3.48	1.3
1058	15.6	3.48	1.31
1088	16.6	3.74	1.35
1118	17.6	3.94	1.39
1148	18.8	4.04	1.42
1178	18.2	4.11	1.45
1208	17.4	4.08	1.47
1238	17.2	4.18	1.49
1268	17.4	4.13	1.5
1298	19	3.84	1.5
1328	18	4	1.51

TABLE 4-2
TIME VERSUS DRAWDOWN DATA FOR CONSTANT RATE TEST

Time (min)	WELL 12	WELL 13	WELL 14
1358	18.2	4.14	1.53
1388	17	4.18	1.56
1418	20.6	3.64	1.55
1448	19.6	3.68	1.54
1478	21.2	3.71	1.55

- diameter of pumping well is very small so that storage in the well can be neglected.

One of the assumptions is that the aquifer is confined rather than unconfined. However, if the well function is defined as T=K*b, with K being the aquifer Hydraulic Conductivity and b being the aquifer thickness, the Theis equation predicts drawdown in unconfined aquifers that are very close to actual drawdown. This method assumes that there is no delay yield in the aquifer, and also that flow is horizontal and uniform to the well. Also, the drawdown must be small in comparison with the total saturated thickness.

Two methods were used to interpret the constant rate test data. Both are graphical methods based on the Theis equation. The first method used was a graphical method devised by Wenzel (1942), that allows superposition of log-log curves of time versus drawdown data with theoretical (type) response curves. After the field data curve has been matched with the type curve, transmissivity and storativity can be directly calculated from the type curve. Computer software, AQTESOLV, which allows either automatic or visual curve matching, was used for the data analysis.

The second method used for analysis, Cooper and Jacob (1946) is a derivation of the Theis method. Cooper and Jacob demonstrated that for low values of u ($u<0.01$), only the first two terms of the Theis infinite series (shown above) are necessary for accurate prediction of w(u). Drawdown can therefore be predicted by the following linear equation (Cooper, Jacob, 1946):

$$s = Q/(4*pi*T) [-0.5.772-\ln r^2*s/4*T*t)]$$

When time versus drawdown data is plotted as a straight line on a semi-logarithmic scale, transmissivity and storativity can be calculated by the following expressions:

Where $T = (264*Q)/As$
As = the slope of time versus drawdown line, T = transmissivity (in gpd/ft), and
Q = constant discharge of the well in gpm
$S = (0.3*T*to)\ r^2$
to = zero drawdown intercept in days, and
r = distance from the pumping well to the observation well in feet.

Assumptions made for the use of this equation are as follows:

- aquifer has infinite areal extent
- aquifer is homogeneous, isotropic, and of uniform thickness
- aquifer potentiometric surface is initially horizontal
- pumping rate is constant
- pumping well is fully penetrating
- flow to pumping well is horizontal
- aquifer is confined

- flow is unsteady
- water is released instantaneously from storage with decline of hydraulic head
- diameter of pumping well is very small so that storage in the well can be neglected
- values of *u* are small (i.e., *r* is small and *t* is large)

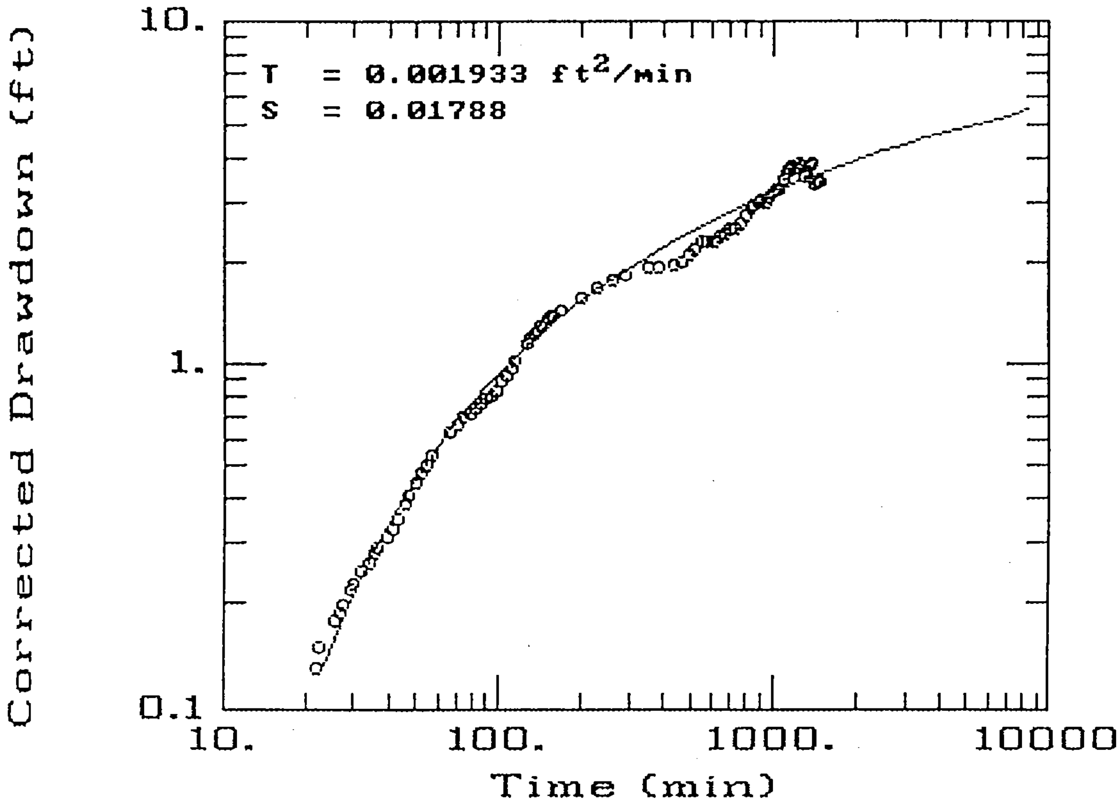
The computer software AQTESOLV was again used for the Cooper-Jacob data analysis.

4.4.2.2 Discussion of Results The results indicate that calculated transmissivities range from .003504 to .001933 ft^2/min and calculated storativities range from .0113 to .002588. The test results of data analyzed by both methods appear to generally be consistent. Transmissivities calculated by the Theis method result in very similar values, while calculated storativities indicate minor variations. Values calculated by the Cooper-Jacob method indicate similar values for storativity while indicating minor disparities between calculated values for transmissivity. However, both methods suggest that slight differences in transmissivity and storativity are present within the aquifer between the pumping well and wells W-13 and W-14.

4.4.2.3 Conclusions Transmissivity values calculated during the constant rate test ranged from .003504 to .0001933 ft^2/min. Storativity values ranged from .0113 to .00212. Theis and Cooper-Jacob curves for wells MEM757-1-13 and MEM-757-14 are presented in Figures 4-1 through 4-4. After review of the drawdown versus time data obtained from observation wells and results of calculations utilizing both the Theis and Cooper-Jacob methods, aquifer characteristics were determined for the design of an extraction well network. Well spacing for the extraction well network was calculated from these values using the Theis equation. Spacing was determined in order to provide a minimum drawdown of five feet between overlapping cones of depressions. The drawdown of five feet was chosen to effectively dewater those portions of the soil found to exhibit the highest concentrations of constituents. It is determined that to obtain five feet of drawdown at the site, that a four foot well spacing would be required. This appears to make dewatering of the site via extraction wells an unfeasible option.

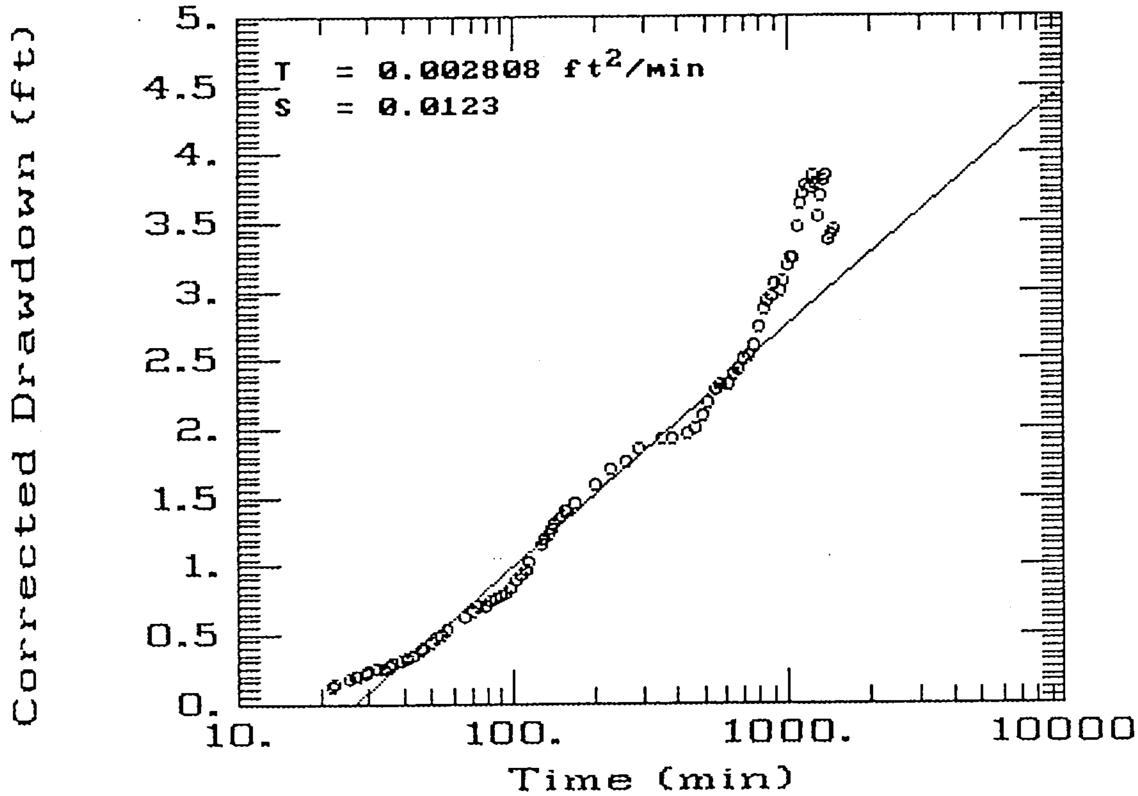
One additional possibility was examined to determine if an increase in drawdown could conceivably be achieved. At present, the thickness of the aquifer at the site has not been explored and it was conceived that a pumping well screened over the entire length of the aquifer would increase drawdown. Calculations were completed utilizing the Theis equation at increased aquifer thicknesses of thirty to one hundred feet. Pump discharge for these calculations were determined based on evaluation of specific capacity (ratio of discharge/drawdown) as observed during the pump test. Results of these calculations indicate that at aquifer thicknesses approaching one hundred feet that the required well spacing would still not be sufficient for the dewatering option to be deemed feasible.

4.5 CLIMATOLOGICAL DATA. Climatological data for the subject area was obtained from the weather station on base. Table 4-3 compares water level depths to monthly precipitation events for the preceding two months.



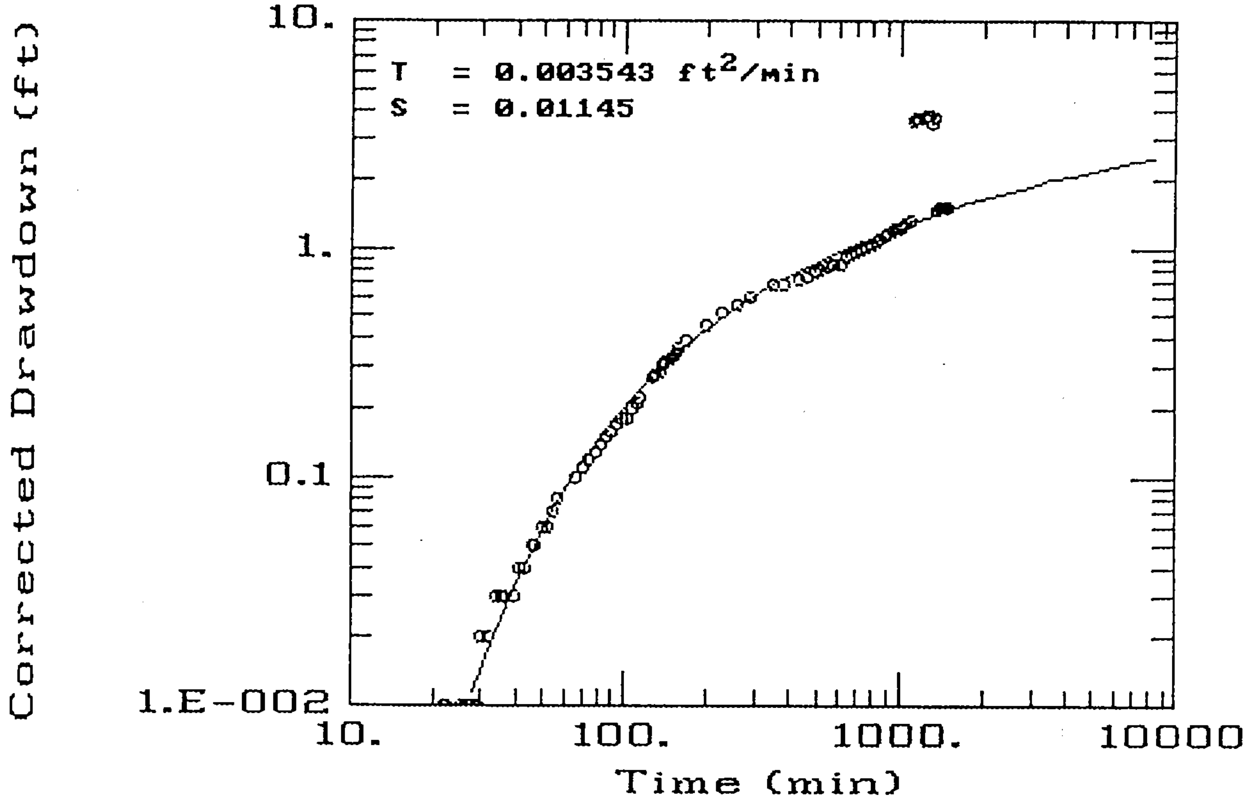
Theis Curve
Well MEM-757-13
FIGURE 4-1

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990



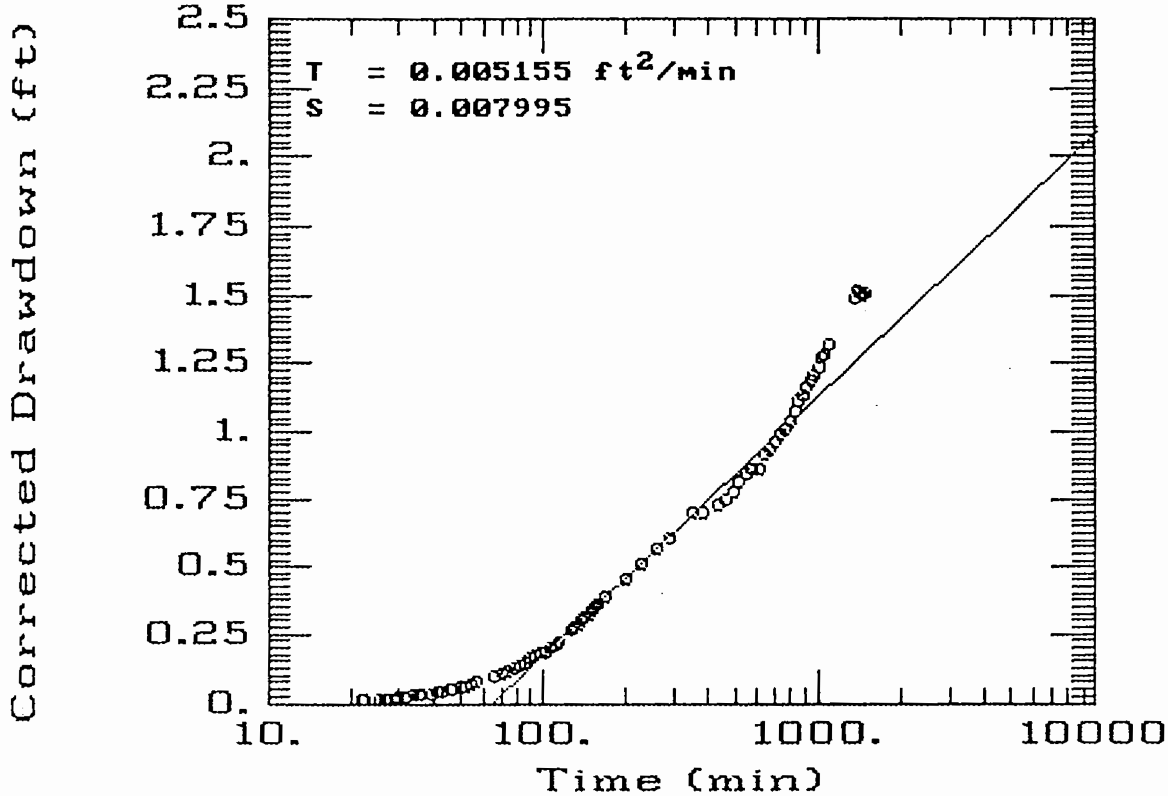
Cooper Jacob Curve
Well MEM-757-13
FIGURE 4-2

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990



Theis Curve
Well MEM-757-14
FIGURE 4-3

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990



Cooper Jacob Curve
Well MEM-757-14
FIGURE 4-4

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990

TABLE 4-3
PRECIPITATION EFFECTS ON WATER LEVELS

WELL	DATE	GROUND WATER ELEVATION (FT)	WATER LEVEL TO SURFACE (FT)	RAINFALL PRECEDING MONTH (IN)	RAINFALL SECOND PRECEDING MONTH (IN)
757-B1	08/04/87	267.13	5.7	3.39	3.67
	10/8/87	264.3	8.53	2.86	2.95
	12/29/87	271.19	1.64	4.76	4.40
	1/19/89	270.64	2.19	4.47	4.46
	5/8/90	270.09	2.74	6.93	5.65
	10/11/90	265.90	6.93		
757-B2	8/4/87	265.47	7.26		
	10/8/87	262.4	10.33		
	12/29/87	271.18	1.55		
	1/19/89	272.35	0.38		
	5/8/90	270.24	2.49		
	5/31/90	269.54	3.19		
	10/11/90	264.01	8.72		
757-B3	8/4/87	266.44	6.24		
	10/8/87	263.00	9.68		
	12/29/87	270.67	2.01		
	1/19/89	270.34	2.34		
	5/8/90	269.73	2.95		
	5/31/90	269.00	3.68		
	10/11/90	265.50	7.18		
757-B4	8/4/87	264.58	7.20		
	10/8/87	262.50	9.28		
	12/29/87	267.32	4.46		
	1/19/89	268.10	3.68		
	5/8/90	267.98	3.80		
	5/31/90	267.29	4.49		
	10/10/90	264.22	7.56		

TABLE 4-3
PRECIPITATION EFFECTS ON WATER LEVELS
(Continued)

WELL	DATE	GROUND WATER ELEVATION (FT)	WATER LEVEL TO SURFACE (FT)	RAINFALL PRECEDING MONTH (IN)	RAINFALL SECOND PRECEDING MONTH (IN)
757-1	8/4/87	264.22	6.56		
	10/8/87	262.94	7.84		
	12/29/87	265.13	5.65		
	1/20/89	264.85	5.93		
	5/8/90	265.14	5.64		
	5/31/90	264.99	5.79		
	10/12/90	264.42	6.36		
757-2	8/4/87	263.92	7.06		
	10/8/87	262.63	8.35		
	12/29/87	265.73	5.25		
	1/20/89	265.76	5.22		
	5/8/90	265.42	5.56		
	5/31/90	265.76	5.22		
	10/11/90	263.85	7.13		
757-3	8/4/87	263.28	7.38		
	10/8/87	264.26	6.40		
	12/29/87	265.54	5.12		
	1/20/89	265.01	5.65		
	5/8/90	264.96	5.70		
	5/31/90	264.89	5.77		
	10/12/90	264.71	5.95		
757-4	8/4/87	263.79	5.35		
	10/8/87	263.16	5.98		
	12/29/87	264.02	6.12		
	1/18/89	264.01	5.13		
	5/8/90	263.94	5.20		
	10/11/90	264.18	4.96		

TABLE 4-3
PRECIPITATION EFFECTS ON WATER LEVELS
(Continued)

WELL	DATE	GROUND WATER ELEVATION (FT)	WATER LEVEL TO SURFACE (FT)	RAINFALL PRECEDING MONTH (IN)	RAINFALL SECOND PRECEDING MONTH (IN)
757-5	8/4/87	263.03	8.51		
	10/8/87	261.50	10.04		
	12/29/87	266.59	4.95		
	1/19/89	266.81	4.73		
	5/8/90	270.04	1.50		
	5/31/90	269.17	2.37		
	10/10/90	263.21	8.33		
757-6	8/4/87	264.36	7.46		
	10/8/87	262.55	9.27		
	12/29/87	267.15	4.67		
	1/20/89	267.75	4.07		
	5/8/90	268.44	3.38		
	5/31/90	267.82	4.00		
	10/11/90	264.51	7.31		
757-7	12/29/87	265.44	5.07		
	1/19/89	265.23	5.28		
	5/8/90	265.08	5.43		
	5/31/90	265.06	5.45		
	10/11/90	264.85	5.66		
757-8	12/29/87	265.81	5.43		
	1/20/89	265.45	5.79		
	5/8/90	265.18	6.06		
	5/31/90	265.96	5.28		
	10/12/90	264.21	7.03		
757-9	12/29/87	266.22	5.14		
	1/18/89	265.28	6.08		
	5/8/90	262.86	8.50		
	5/31/90	264.7	6.66		
	10/11/90	265.02	6.34		

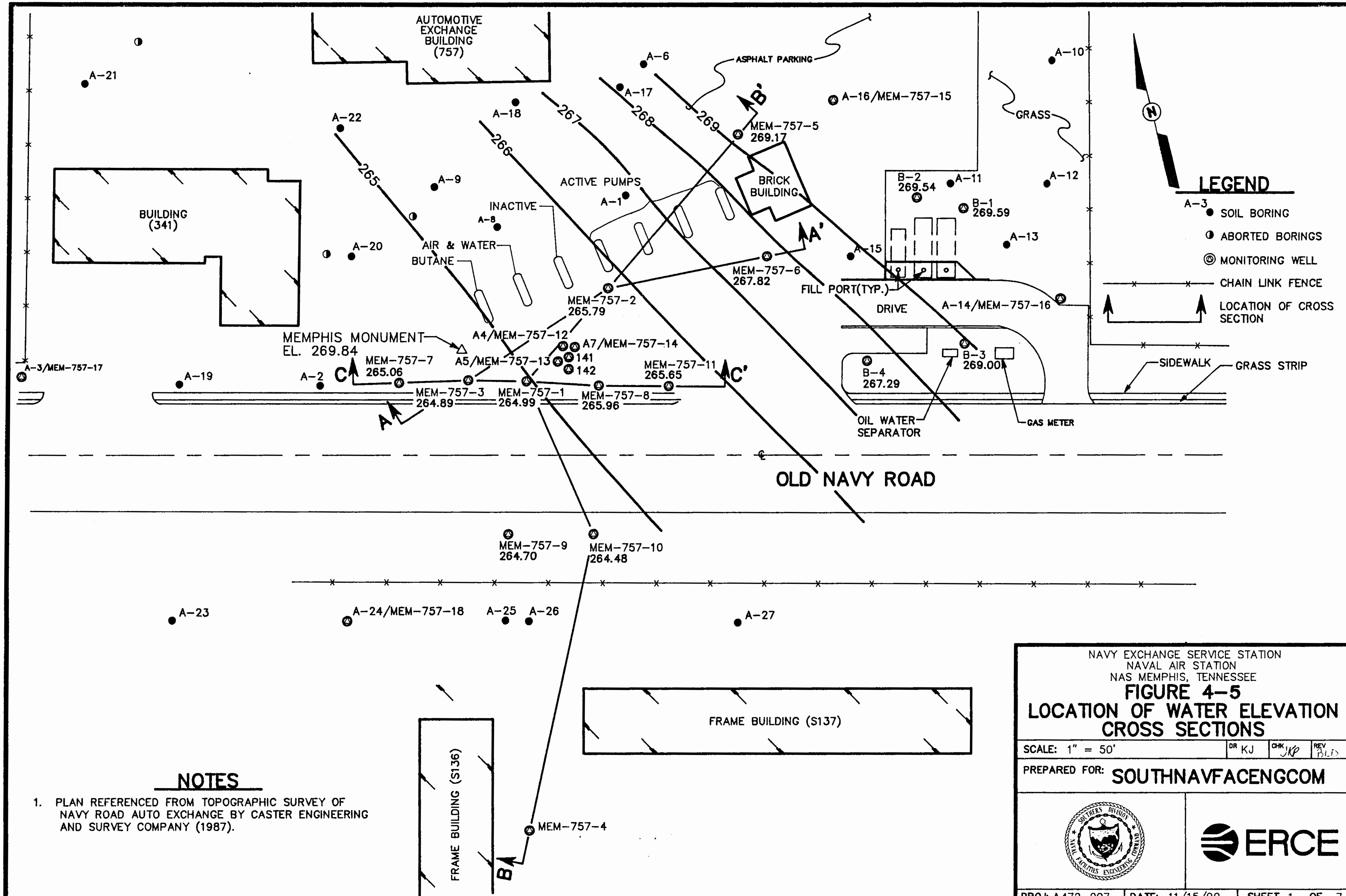
TABLE 4-3
PRECIPITATION EFFECTS ON WATER LEVELS
(Continued)

WELL	DATE	GROUND WATER ELEVATION (FT)	WATER LEVEL TO SURFACE (FT)	RAINFALL PRECEDING MONTH (IN)	RAINFALL SECOND PRECEDING MONTH (IN)
757-10	12/29/87	266.49	5.11		
	1/18/89	265.22	6.38		
	5/8/90	264.66	6.94		
	5/31/90	264.48	7.12		
	10/11/90	264.73	6.87		
757-11	12/29/87	266.13	5.38		
	1/19/89	265.90	5.61		
	5/8/90	264.84	6.67		
	5/31/90	265.65	5.86		
	10/11/90	264.35	7.16		
757-12*	6/5/90		5.75		
757-13*	6/5/90		6.04		
757-14*	6/5/90		6.09		
	10/12/90		6.39		
757-15*	6/15/90		3.75		
	10/10/90		9.95		
757-16*	6/15/90		4.03		
	10/9/90		9.69		
757-17*	6/15/90		3.81		
	10/9/90		4.57		
757-18*	6/15/90		3.45		
	10/9/90		3.28		
757-19*	6/15/90		3.52		
	10/10/90		5.04		

* Elevations for wells 12,13, 14,15, 16, 17, 18, and 19 have not been surveyed. Water level measurements are from top of well casings.

The highest observed fluctuations in ground water levels occurred near the active tank pit and the northeastern corner of the paved site. Water level changes in MEM-757-B2 have been as high as 8.72 feet during extremely dry periods but appear to commonly change in the 2-3 foot range. Water level fluctuations toward the central region of contamination near MEM-757-2 have been observed to fluctuate 3.13 feet but typically fluctuate only 0.5 to 1.0 feet.

The higher ground water fluctuations noted in the active tank pit area can be attributed to rainfall infiltration around the unpaved surface in this area and the upgradient, open field. Figures 4-5 through 4-11 graphically represent the ground water fluctuations observed in select wells over time.



NOTES

1. PLAN REFERENCED FROM TOPOGRAPHIC SURVEY OF NAVY ROAD AUTO EXCHANGE BY CASTER ENGINEERING AND SURVEY COMPANY (1987).

NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
NAS MEMPHIS, TENNESSEE

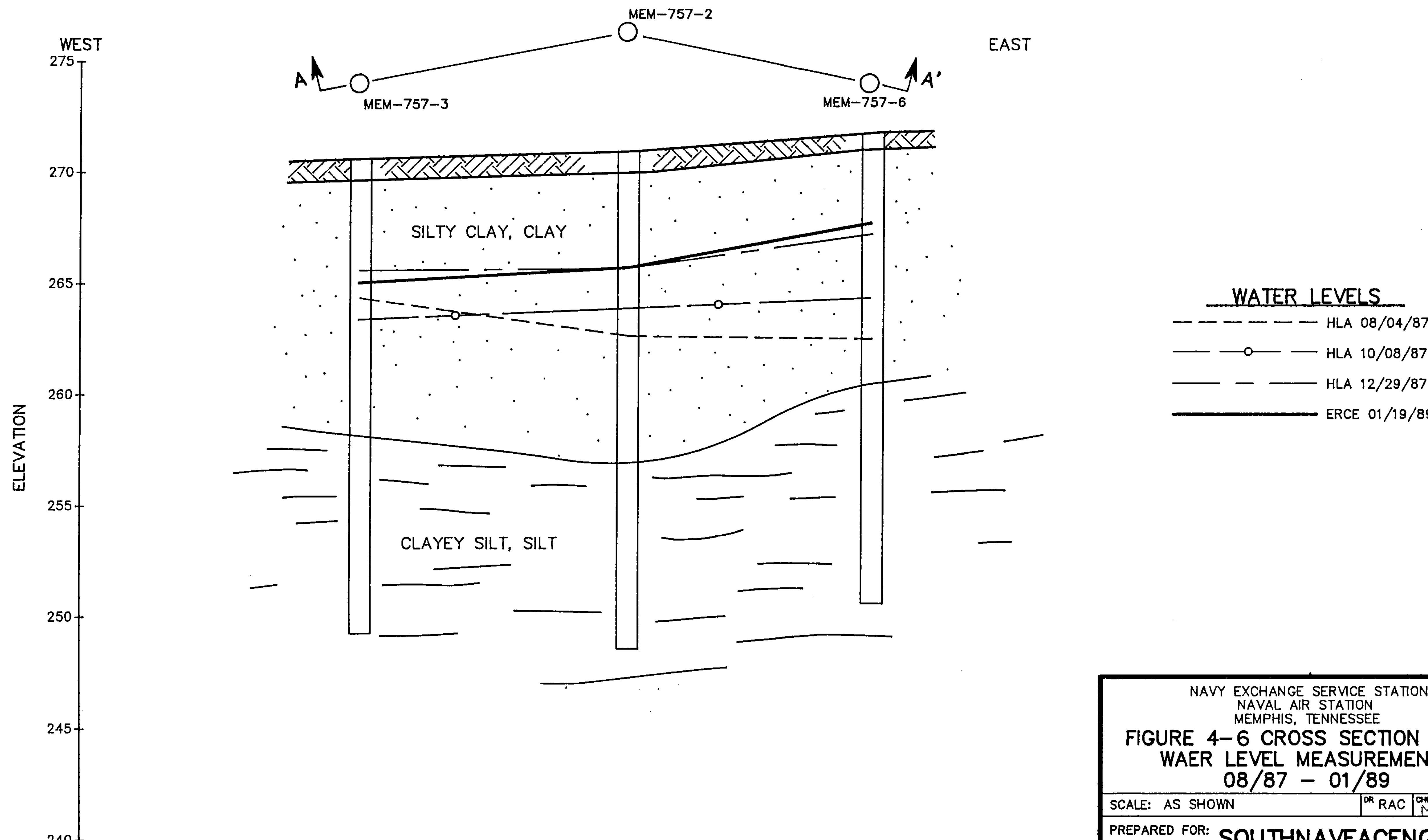
FIGURE 4-5
LOCATION OF WATER ELEVATION CROSS SECTIONS

SCALE: 1" = 50' | DR KJ | CHK JKP | REV BLD

PREPARED FOR: SOUTHNAVFACENGCOM

ERCE

PROJ: A472-007 | DATE: 11/15/90 | SHEET 1 OF 7



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

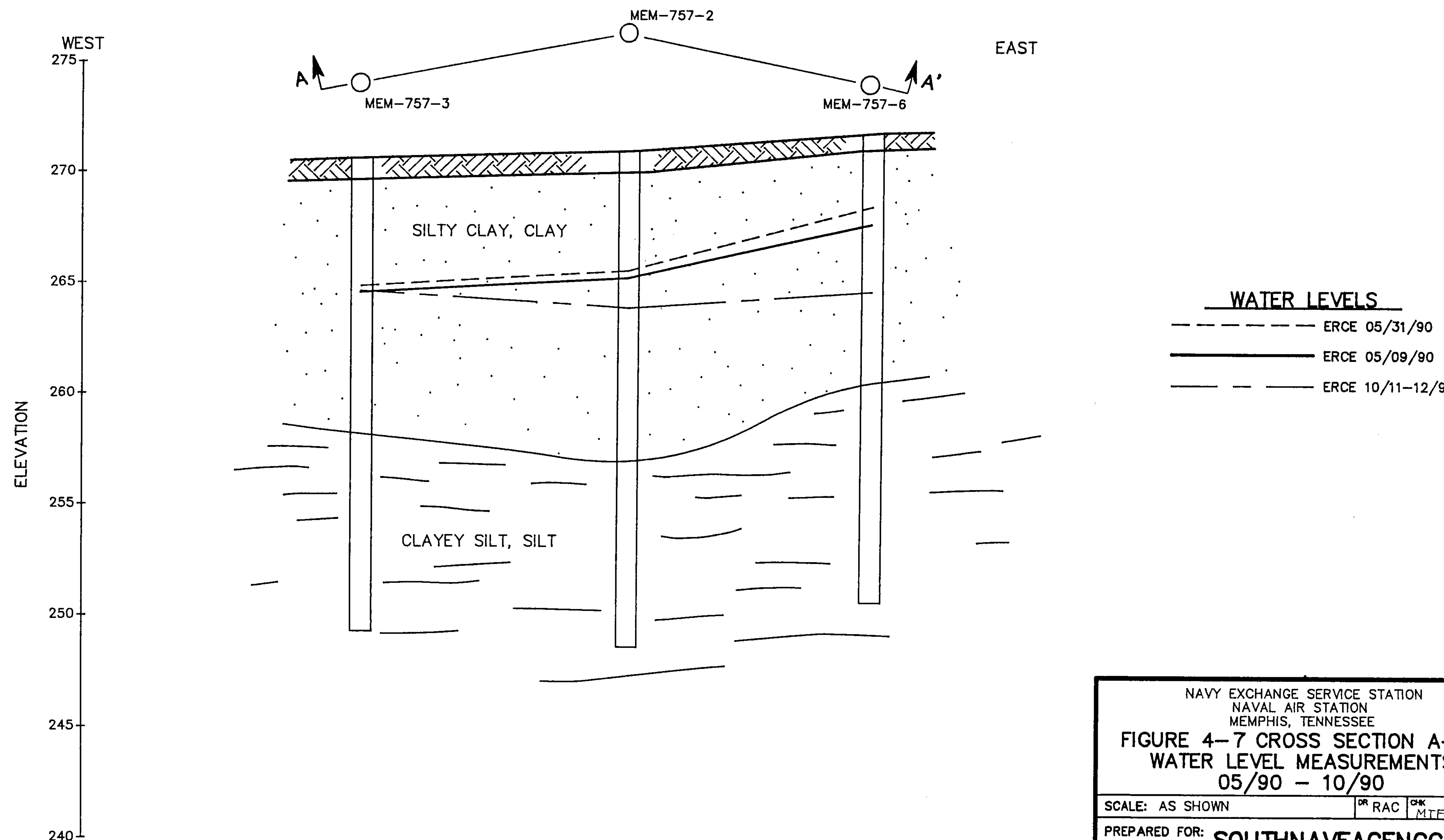
FIGURE 4-6 CROSS SECTION A-A', WAER LEVEL MEASUREMENTS 08/87 - 01/89

SCALE: AS SHOWN | DR RAC | CHK MTF | REV BLD

PREPARED FOR: SOUTHNAVFACENGCOM

ERCE

PROJ: A472-007 | DATE: 11/15/90 | SHEET 2 OF 7



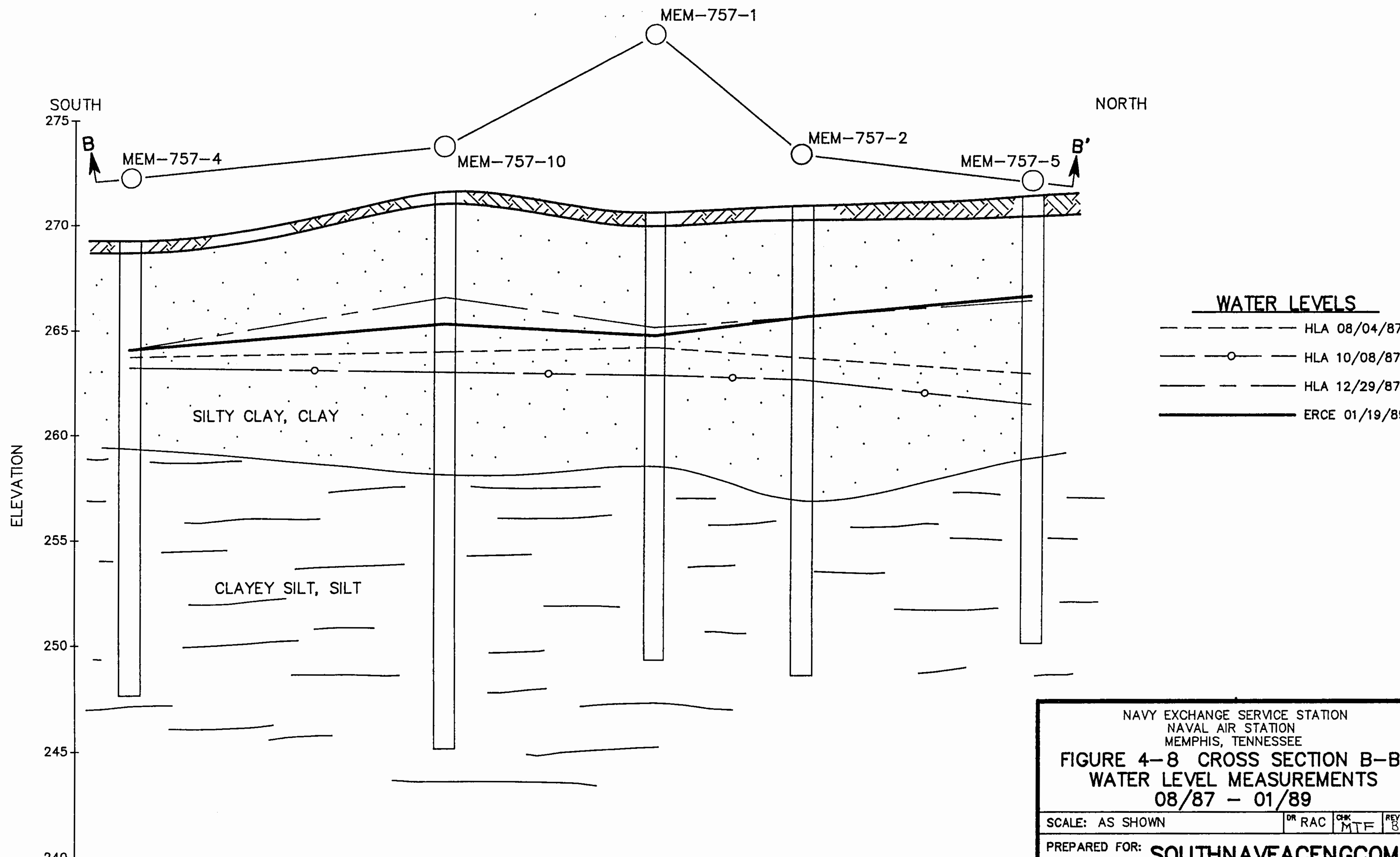
NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

FIGURE 4-7 CROSS SECTION A-A', WATER LEVEL MEASUREMENTS 05/90 - 10/90

SCALE: AS SHOWN	DR RAC	CHK MTF	REV BLD

PREPARED FOR: SOUTHNAVFACENGCOM

PROJ: A472-007	DATE: 11/15/90	SHEET 3 OF 7



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

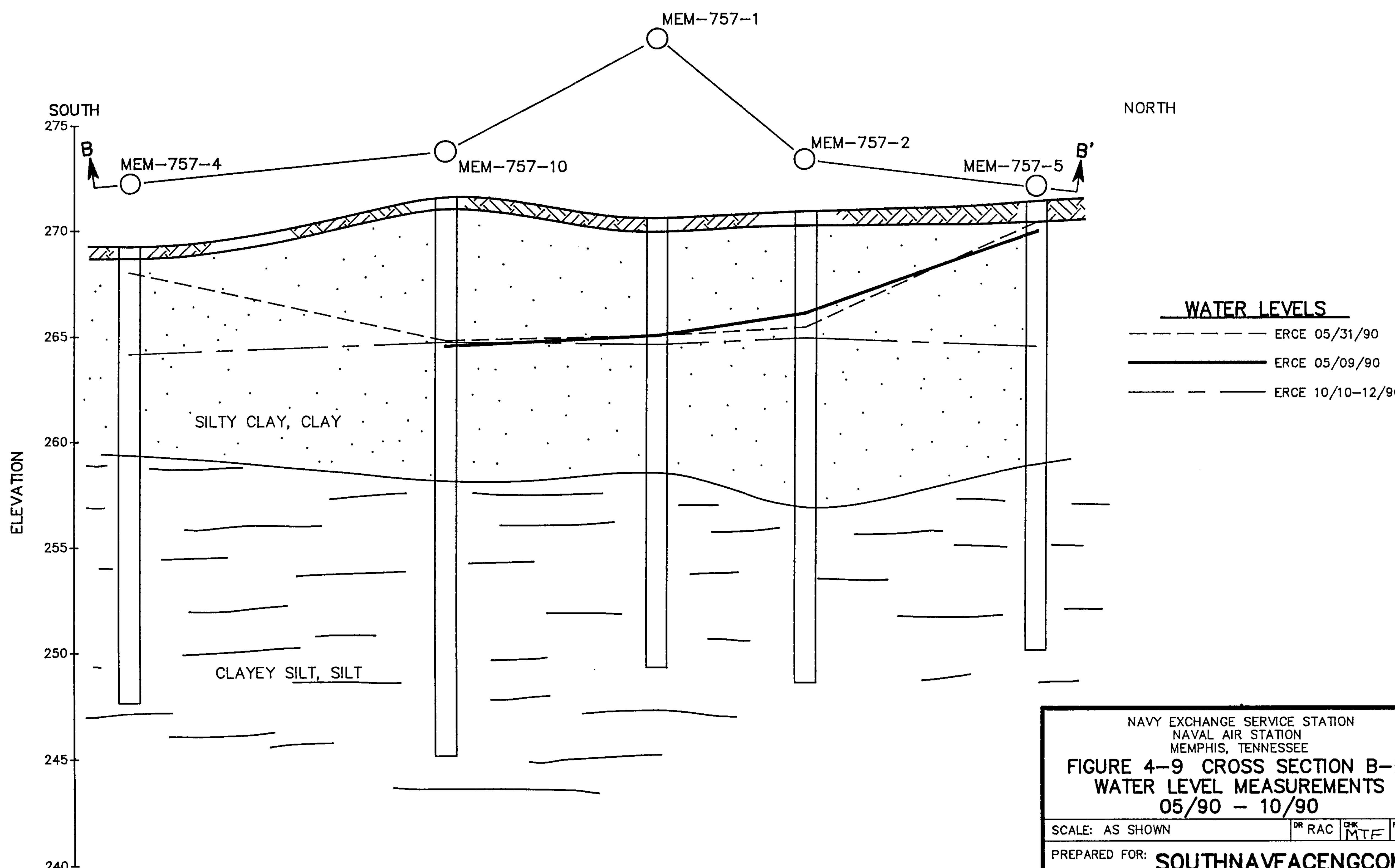
FIGURE 4-8 CROSS SECTION B-B'
WATER LEVEL MEASUREMENTS
08/87 - 01/89

SCALE: AS SHOWN | DR RAC | CHK MTF | REV BLD

PREPARED FOR: SOUTHNAVFACENGCOM

ERCE

PROJ: A472-007 | DATE: 11/15/90 | SHEET 4 OF 7



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

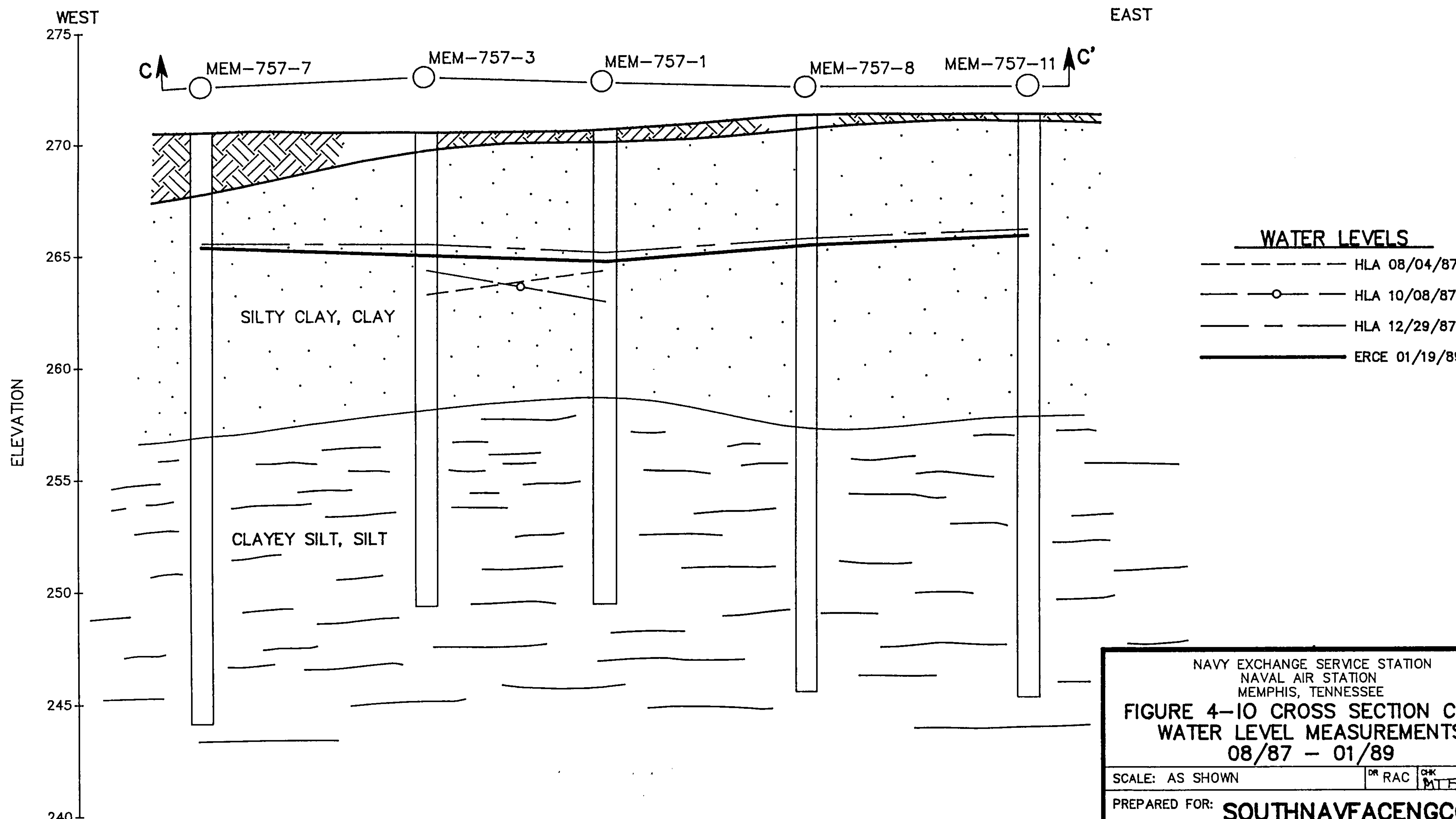
FIGURE 4-9 CROSS SECTION B-B'
WATER LEVEL MEASUREMENTS
05/90 - 10/90

SCALE: AS SHOWN	DR RAC	CHK MTF	REV BLD

PREPARED FOR: **SOUTHNAVFACENGCOM**

ERCE

PROJ: A472-007	DATE: 11/15/90	SHEET 5 OF 7



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

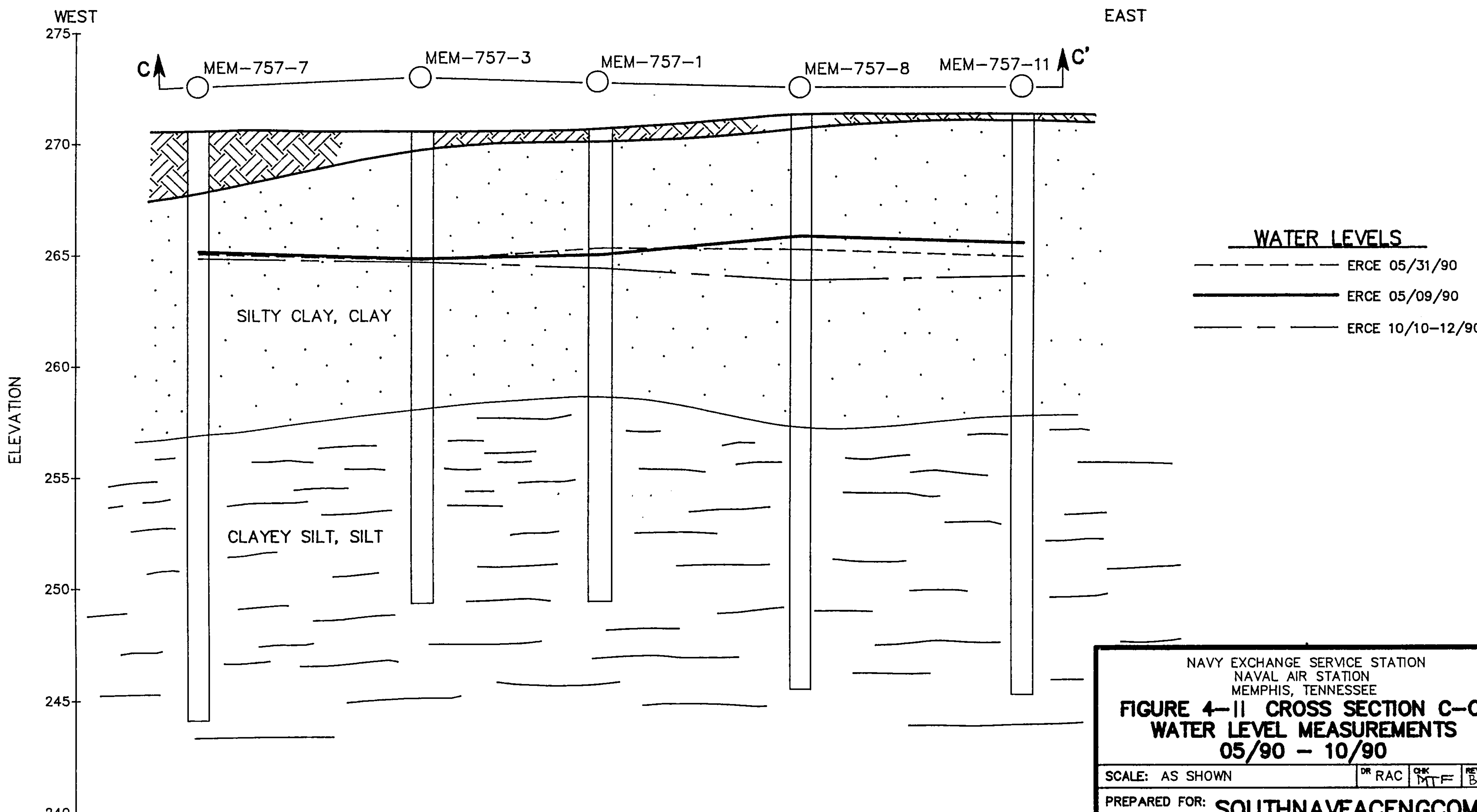
FIGURE 4-10 CROSS SECTION C-C', WATER LEVEL MEASUREMENTS 08/87 - 01/89

SCALE: AS SHOWN	DR RAC	CHK MTF	REV BLD

PREPARED FOR: **SOUTHNAVFACENGCOM**

ERCE

PROJ: A472-007	DATE: 11/15/90	SHEET 6 OF 7



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
MEMPHIS, TENNESSEE

FIGURE 4-11 CROSS SECTION C-C'
WATER LEVEL MEASUREMENTS
05/90 - 10/90

SCALE: AS SHOWN	DR RAC	CHK MTF	REV BLD

PREPARED FOR: **SOUTHNAVFACENGCOM**

ERCE

PROJ: A472-007 | DATE: 11/15/90 | SHEET 7 OF 7

5.0 CONTAMINATION ASSESSMENT

5.1 ANALYTICAL PROTOCOL. During the initial quarterly sampling program, twenty-two ground water samples were obtained from the previously installed monitoring wells and from the newly installed perimeter monitoring wells and submitted to Pioneer Laboratories of Pensacola, Florida. The requested analytical program specified the identification and quantification of benzene, toluene, ethylbenzene and xylene (BTEX). The EPA approved test methodology utilized by Pioneer Laboratories for BTEX analysis is SW-846, 8020.

During the remedial investigation and vapor extraction study, one hundred ninety-nine soil samples and fourteen ground water samples were obtained from the twenty-eight soil borings. All samples collected during this part of the remedial investigation were submitted to Tracer Research Corporation of Tuscon, Arizona. Tracer Research utilized a one ton Ford analytical field van that was equipped with one gas chromatograph and two Spectra Physics computing integrators to analyze each sample on-site. The requested analytical program specified the identification and quantification of BTEX and total petroleum hydrocarbons (TPH).

5.2 TRACER RESEARCH. A Varian 3300 gas chromatograph (GC), equipped with a flame ionization detector (FID), was used for the vapor, soil, and ground water analyses. Compounds were separated on a 6' by 1/8" OD packed column with OV-101 as the stationary phase in a temperature controlled oven at 100°C. Nitrogen was used as the carrier gas.

Hydrocarbon compounds detected in the samples were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day. Air samples were also routinely analyzed to check for background levels in the atmosphere.

The GC was calibrated for soil and ground water headspace analysis by decanting 10 to 20 mL off of the known aqueous standard to leave approximately the same amount of headspace that was in the soil and ground water headspace samples. The bottle was then resealed and shaken vigorously for 30 seconds. An analysis of the headspace in the vial determines the Response Factor (RF) which is then used to estimate soil and ground water concentrations.

Detection limits for the compounds of interest are a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit varies with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest must be kept within the linear range of the analytical equipment. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses.

The detection limits for the selected compounds were approximately 0.03 micrograms per liter (ug/L) for hydrocarbons detected in the vapor samples, 0.4 micrograms per kilogram (ug/kg) for hydrocarbons detected in the soil samples, and 0.2 ug/L for hydrocarbons detected in the ground water sample, depending on the conditions of the measurement, and in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <0.1 ug/L). Detection limits obtained from GC analyses are calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

All test results reported by Tracer Research are included in Appendix III. Soil samples are identified by borehole number and the depth from which the sample was obtained. Sample A1/10.2-12.2, for example was obtained from borehole number A1 at a depth interval of 10.2-12.2 feet below surface grade.

Water samples are identified by borehole number and a HS prefix. Sample HS/A1 identifying the headspace test results for ground water obtained from borehole number A1.

Soil gas test results are identified by a "W" prefix and are numbered consecutively as they were obtained and analyzed.

Samples identified AIR are test results of ambient air samples obtained from within the staging area.

5.3 INITIAL QUARTERLY SAMPLING PROGRAM ASSESSMENT. Laboratory analysis of ground water samples obtained during the initial quarterly sampling program (May and June 1990) displayed evidence of petroleum hydrocarbon contamination. Analysis of fourteen samples obtained from twelve monitoring wells revealed benzene concentrations ranging from four parts per billion (ppb) in well MEM-757-4, to 9,026,000 ppb Well MEM-757-1. Analysis of the remaining eight ground water samples did not reveal detectable concentrations of benzene.

Analysis of additional petroleum hydrocarbons revealed the presence of toluene within thirteen ground water samples obtained from eleven monitoring wells. Detectable toluene concentrations ranged from 17 ppb (monitoring wells MEM-757-10 and B4) to 115,000 ppb (monitoring well MEM-757-1).

The presence of ethylbenzene was displayed within ten ground water samples obtained from eight monitoring wells. Detectable ethylbenzene concentrations ranged from 40 ppb, MEM-757-2, to 25,000 ppb, MEM-757-1.

The presence of xylene was displayed within eleven ground water samples obtained from nine monitoring wells. Detectable xylene concentrations ranged from 80 ppb, well MEM-757-6, to 80,000 ppb, Well MEM-757-1.

Analytical results from the Quarterly Sampling Program are presented within Table 5.1.

Ground water samples obtained during May 1990 indicate higher benzene concentrations within monitoring wells MEM-757-1,3,4,7,8,9,11 and B3 as compared to January 1990 benzene levels. The greatest increase in benzene levels occurred within monitoring well MEM-757-1. Benzene concentrations increased from 4,700 ppb to 926,000 ppb.

In addition, benzene concentrations within monitoring wells MEM-757-2,6,B1, and B2 decreased from January 1989 levels. The greatest decrease in benzene levels

TABLE 5.1
BTEX AND TPH CONCENTRATIONS FROM THE QUARTERLY SAMPLING PROGRAM
AT THE NAVY EXCHANGE SERVICE STATION, NAS MEMPHIS

Location	Date	Sample No.	Benzene, (ug/l)	Ethyl Benzene (ug/l)**	Toluene (ug/l)	Xylene (ug/l)	Total Petroleum Hydrocarbon (mg/l)
MEM-757-1	1/87*	-	4,800	-	6,500	4,800	
	11/87*	-	14,000	-	19,000	15,000	
	1/89	0120-5	4,700	200	3,500	3,300	
	5/90	0510-2	926,000	25,000	115,000	80,000	
	10/90	1012908					7
	10/90	10129010					8
	10/90	1012909	11,000	ND	6,000	6,000	
		10129011	11,000	1,300	4,000	5,000	
MEM-757-2	1/87*	-	5,400	-	8,200	5,300	
	11/87*	-	23,000	-	36,000	20,000	
	1/89*	0120-6	6,700	200	5,600	4,000	
	5/90	0510-6	700	40	360	450	
	10/90	10119013					8
	10/90	10119014	5,800	400	2,900	2,700	
MEM-757-3	1/87*	-	2,400	-	1,200	1,400	
	11/87*	-	3,000	-	4,300	14,000	
	1/89	0120-4	880	60	660	650	
	5/90	0510-4	1,500	140	450	570	
	5/90	0510-3	830	100	350	410	
	10/90	1012902					3
		1012903	6,500	700	2,100	2,000	
MEM-757-4	1/87*	-	3.8	-		260	
	1/89	0118-1	ND	ND	ND	ND	
	5/90	0509-1	10	ND	ND	ND	
	10/90	1010909					ND
	10/90	10109011					ND
	10/90	10109010	ND	ND	ND	ND	
	10/90	10109012	3	ND	9	ND	
MEM-757-5	1/87*	-	ND	-	15	1	
	11/87*	-	2	-	3	ND	
	1/89	0119-1	ND	ND	ND	ND	
	1/89	0119-2	ND	ND	ND	ND	
	5/90	0509-6	ND	ND	31	ND	
	10/90	1010907					ND
		1010908	ND	ND	ND	ND	
MEM-757-6	1/87*	-	35	-	ND	210	
	11/87*	-	640	-	660	2,200	
	1/89	0120-1	230	6	3	203	
	5/90	0509-7	120	ND	ND	80	
	10/90	1011905					ND
		1011906	600	1,350	60	630	

ND- Not detected at laboratory quantitation level
* Samples obtained by Harding Lawson Associates during investigation phase.
** Ethyl Benzene not reported by Harding Lawson Associates
BTEX determined by EPA test method.
TPH determined by EPA test method 418.1.

TABLE 5.1
BTEX AND TPH CONCENTRATIONS FROM THE QUARTERLY SAMPLING PROGRAM
AT THE NAVY EXCHANGE SERVICE STATION, NAS MEMPHIS

Location	Date	Sample No.	Benzene, (ug/l)	Ethyl Benzene (ug/l)**	Toluene (ug/l)	Xylene (ug/l)	Total Petroleum Hydrocarbon (mg/l)
MEM-757-7	11/87*	-	230	-	28	91	
	1/89	0119.6	630	160	20	200	
	5/90	0510-5	830	230	50	260	
	10/90	10119015					ND
		10119016	430	140	ND	50	
MEM-757-8	11/87*	-	2,100	-	5,900	9,000	
	1/89	0120-2	800	90	600	580	
	1/89	0120-3	880	60	660	650	
	5/90	0510-1	3,600	100	500	650	
	10/90	1012906					3
		1012907	6,100	500	900	1,500	
MEM-757-9	11/87*	-	2	-	7	74	
	1/89	0118.2	ND	ND	ND	ND	
	5/90	0509-2	4	ND	ND	ND	
	10/90	1011903					ND
		1011904	ND	ND	ND	ND	
MEM-757-10	11/87*	-	ND	-	ND	ND	
	1/89	0118-3	ND	ND	ND	ND	
	5/90	0509-3	ND	ND	17	ND	
	10/90	1011901					ND
		1011902	ND	ND	ND	ND	
MEM-757-11	11/87*	-	11	-	6	39	
	1/89	0119-5	ND	2	ND	ND	
	5/90	0509-8	130	ND	ND	ND	
	10/90	1011907					7
		1011908	5	3	ND	3	
MEM-757-14	10/90	1012904					
		1012905	21,000	2,000	14,000	11,000	
MEM-757-15	6/90	0615-1	ND	ND	ND	ND	
	10/90	1010905					ND
		1010906	ND	ND	ND	ND	
MEM-757-16	6/90	0615-2	ND	ND	ND	ND	
	10/90	109903					ND
		109904	ND	ND	ND	ND	
MEM-757-17	6/90	0615-3	ND	ND	ND	ND	
	10/90	109905					ND
		109906	ND	ND	7	ND	

ND- Not detected at laboratory quantitation level
* Samples obtained by Harding Lawson Associates during investigation phase.
** Ethyl Benzene not reported by Harding Lawson Associates
BTEX determined by EPA test method.
TPH determined by EPA test method 418.1.

TABLE 5.1
BTEX AND TPH CONCENTRATIONS FROM THE QUARTERLY SAMPLING PROGRAM
AT THE NAVY EXCHANGE SERVICE STATION, NAS MEMPHIS

Location	Date	Sample No.	Benzene, (ug/l)	Ethyl Benzene (ug/l)**	Toluene (ug/l)	Xylene (ug/l)	Total Petroleum Hydrocarbon (mg/l)
MEM-757-18	6/90	0615-4	ND	ND	ND	ND	
	10/90	109902					ND
		109901	ND	ND	ND	ND	
MEM-757-19	6/90	0615-5	ND	ND	ND	ND	
	10/90	1010903					ND
		1010904	ND	ND	ND	ND	
MEM-757-B1	11/87*	-	1,700	-	7,700	15,000	
	1/89	0119-7	900	2,600	5,200	15,900	
	5/90	0510-9	490	70	540	1,170	
	10/90	1011909					ND
		10119010	200	1,100	1,200	9,500	
MEM-757-B2	11/87*	-	6,800	-	5,700	12,000	
	1/89	0119-8	3,400	700	3,400	7,000	
	5/90	0510-8	520	107	570	1,250	
	5/90	0510-7	250	1,200	2,200	1,250	
	10/90	10119011					6
		10119012	5,100	1,100	1,900	4,700	
MEM-757-B3	11/87*	-	ND	-	ND	ND	
	1/89	0119-3	270	11	7	200	
	5/90	0509-5	840	150	220	720	
	10/90	10119017					2
		10119018	190	160	ND	360	
MEM-757-B4	11/87	-	ND	-	ND	ND	
	1/89	0119-4	ND	ND	ND	ND	
	5/90	0509-4	ND	ND	1.7	-7	
	10/90	10109013					ND
		10109014	ND	ND	ND	ND	

ND- Not detected at laboratory quantitation level
* Samples obtained by Harding Lawson Associates during investigation phase.
** Ethyl Benzene not reported by Harding Lawson Associates
BTEX determined by EPA test method.
TPH determined by EPA test method 418.1.

occurred within monitoring well MEM-757-2. Benzene concentrations decreased from 6,700 ppb to 700 ppb.

Monitoring wells MEM-757-5,10, and B4 did not display detectable concentrations of benzene in January 1989 and May 1990.

Of the 23 monitoring wells sampled in October 1990, 9 wells did not display detectable concentrations of benzene in ground water. Of these 9 wells, 5 were the newest wells installed outside the perimeter of the identified contaminant plume. Duplicate samples obtained from monitoring well MEM-757-4 reported benzene concentrations of 3 ppb and non-detectable.

Duplicate samples were obtained from monitoring well MEM-757-1. Both test results reported a benzene concentration of 11,000 ppb's. These test results more reasonably reflect the concentrations present within the subject area than the 926,000 ppb benzene concentration reported in May 1990.

Additional analytical information is presented on the benzene concentration map presented in Appendix IV. Ground water analytical data is presented in Appendix III.

5.4 SOIL SAMPLE ASSESSMENT One hundred ninety-nine soil samples were obtained during the remedial investigation at the Navy Exchange Service Station. As stated within Section 5.1, all soil samples were submitted to Tracer Research for on-site analysis of benzene, toluene, ethylbenzene, and xylene (BTEX) utilizing the head space analysis method. Presently, Tracer Research is not an approved laboratory by the Tennessee Department of Health and Environment. The purpose of using Tracer Research was to field verify the extent of soil contamination. Five new monitoring wells were installed around the outer perimeter of the plume that was identified by field analysis. Of the five wells located outside the plume boundary none have displayed detectable concentrations of gasoline constituents in ground water when analyzed by a state approved lab.

All soil samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) and total petroleum hydrocarbons (TPH). It is expected that the BTX and TPH values displayed by the head space analysis method are lower than the values displayed by the standard analytical test method BTEX (EPA 602 and 8020) and TPH (EPA 4181). The analytical test procedure utilized by Tracer assumes hydrocarbon concentrations in solid, liquid and vapor phase are in equilibrium. Highly volatile compounds, therefore, may be more readily detected than less volatile compounds.

Chemical analysis of the soil samples indicate that hydrocarbon contamination has extended to a depth of twelve feet below surface grade. At a depth of two to four feet below surface grade, hydrocarbon concentrations were most notable at boring A2, located south of building 341. Concentrations at this depth were reported to be 150 mg/kg. TPH and BTEX concentrations are presented below within Table 5-2. The TPH concentration contour maps are located in Appendix IV. TPH concentration maps were developed from hydrocarbon concentrations as analyzed by Tracer Research. Due to an irregular boring pattern, some of the concentration contours are estimates.

Hydrocarbons detected at depths of 4-6 feet below surface grade are extended across more than half the site. Samples analyzed from borings A4, A5 and A7, downgradient from the original leak source, were reported as high as 1,700 mg/kg.

TABLE 5-2
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
5/31/90	0.2-2.2	1400	320	50	60	1,780	3,500
A1	2.2-4.2	480	460	280	60	1,000	3,200
	4.2-6.2	23,000	40,000	21,000	6,200	69,200	200,000
	6.2-8.2	120,000	160,000	19,000	5,400	285,400	800,000
	8.2-10.2	40,000	80,000	13,000	4,000	124,000	380,000
	10.2-12.2	820	1000	440	180	2,000	7,400
	12.2-14.2	75	90	40	6	171	590
	14.2-16.2	2	6	2	3	11	26
	21.2-23.2	0.5	0.6	0.6	0.7	1.8	0.5
HS/A1	WATER	4,500	7,500	4,500	2,200	14,200	41,000
5/31/90	2.5-4.5	21,000	28,000	25,000	7,200	56,200	150,000
A2	4.5-6.5	290,000	137,000	68,000	20,000	447,000	860,000
	6.5-8.5	1,400	40	50	60	1,500	3,500
	8.5-10.5	530	20	24	30	580	1,700
	10.5-12.5	4	4	5	6	14	4
	15-17	160	120	45	1	281	590
	20-20.4	1,200	670	670	270	2,140	4,700
	20.4-20.8	33	25	20	3	61	100
HS/A2	WATER	8,800	2,400	9,300	60	11,260	39,000
5/31/90	2-4	0.8	0.9	1	1	2.7	0.8
A3	4-6	0.8	0.9	1	1	2.7	0.8
	6-8	12	20	6	1	33	86
	8-10	0.5	0.6	0.6	0.7	1.8	0.5
	14-16	2	3	0.5	0.6	5.6	6
	19-21	0.7	2	0.8	1	3.7	3
HS/A3	WATER	2	2	2	3	7	2
5/31/90	1-3	1,600	1,900	980	110	3,610	6,600
A4	3-5	1,200	1,500	1,000	110	2,810	6,600
	5-7	175,000	240,000	35,000	11,000	426,000	1,700,000
	7-9	90,000	150,000	33,000	12,000	252,000	930,000
	9-11	3,400	2,200	1,000	60	5,660	17,000
	11-13	1,100	60	60	70	1,230	3,100
	13-15	8,800	13,500	6,200	1,900	24,200	89,000
	19-20	2	12	2	3	7	82
	23-25	4	4	5	6	14	4
HS/A4	WATER	22,000	8,100	5,300	1,400	31,450	71,000

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/1/90	2-4	4,600	6,100	4,200	1,500	12,200	18,000
A5	4-4.5	1,300	1,500	870	220	3,020	5,400
	7-9	2,200	460	620	80	2,740	9,100
	9-11	2,900	210	200	27	3,137	9,900
	11-13	50	14	5	2	66	170
	16-18	10	7	2	0.7	17.7	50
	23-25	0.4	0.4	0.4	0.5	1.3	0.8
	28-30	38	34	12	4	76	170
HS/A5	WATER	4,600	1,500	780	210	6,310	20,000
6/4/90	.5-2.5	0.4	0.4	0.4	0.6	1.4	13
A6	2.5-4.5	0.4	0.4	0.4	0.6	1.4	0.9
	4.5-6.5	0.4	0.4	0.4	0.6	1.4	8
	6.5-8.5	0.7	0.4	0.4	0.6	1.7	0.7
	8.5-10.5	0.4	0.3	0.3	0.4	1.1	0.7
	14.5-16.5	1	1	0.2	0.3	2.3	2
	19-21	1	0.2	0.2	0.3	1.5	1
HS/A6	WATER	0.2	0.2	0.2	0.3	0.7	0.2
6/4/90	1-3	8,100	8,800	4,300	1,700	18,600	35,000
A7	3-5	2,200	2,700	690	190	5,090	5,300
	5-7	200,000	330,000	75,000	29,000	559,000	2,000,000
	7-9	9,900	7,200	3,000	710	17,810	66,000
	9-11	22,000	23,000	14,000	2,000	47,000	180,000
	11-13	2,100	110	40	40	2,250	6,900
	18-20	0.9	0.8	0.8	1	2.7	0.9
	23-25	14	12	2	1	27	90
	28-30	3	2	0.8	0.3	5.3	14
6/4/90	0-2	7,700	11,000	4,300	1,500	20,200	60,000
A8	2-4	1,100	1,000	360	160	2,260	5,900
	4-6	88,000	140,000	27,000	9,100	237,100	780,000
	6-8	75,000	150,000	40,000	15,000	240,000	890,000
	8-10	2,700	1,800	1,000	240	4,740	26,000
	10-12	80	30	30	40	150	740
	12-14	130	100	60	5	235	1,300
	14-16	2	2	2	2	6	6
	19-21	0.5	0.5	0.4	0.6	1.6	2
HS/A8	WATER	33,000	36,000	23,000	11,000	79,000	240,000

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/4/90	1-3	220	120	20	20	360	1,100
A9	3-5	110,000	190,000	47,000	17,000	317,000	1,100,000
	5-7	110,000	210,000	51,000	19,000	339,000	1,100,000
	7-9	2,100	800	1,000	50	2,950	20,000
	9-11	50	40	30	4	94	540
	11-13	4	2	0.4	0.5	6.5	14
	18-20	0.4	0.7	0.4	0.5	1.6	7
	23-25	1	0.4	0.4	0.5	1.9	2
HS/A9	WATER	5,000	5,300	850	2	10,302	34,000
6/5/90	0-2	1	0.9	0.8	1	2.9	1
A10	2-4	0.4	0.4	0.3	0.5	1.3	3
	4-6	0.4	0.4	0.3	0.5	1.3	0.4
	6-8	0.4	0.4	0.3	0.5	1.3	2
	8-10	0.4	0.4	0.3	0.5	1.3	0.4
	14-16	96,000	48,000	11,000	5,700	149,700	310,000
	19-21	7,400	1,500	70	45	8,945	21,000
6/5/90	0-2	0.4	0.4	0.3	0.4	1.2	0.4
A11	2-4	0.4	0.4	0.3	0.4	1.2	0.4
	4-6	0.4	0.4	0.3	0.4	1.2	1
	6-8	34,000	46,000	29,000	11,000	91,000	270,000
	8-10	19,000	21,000	13,000	4,800	44,800	140,000
	10-12	34,000	36,000	22,000	7,600	77,600	280,000
	12-14	6,000	2,000	2,600	180	8,180	31,000
	14-16	1,900	25	1,300	30	1,955	9,400
	19-21	140	9	38	5	154	540
	24-26	80	4	0.8	1	85	200
	29-31	80	3	0.3	0.5	83.5	200
6/5/90	0-2	30	20	3	1	51	180
A12	2-4	1	0.4	0.4	0.6	2	4
	4-6	0.5	0.4	0.4	0.6	1.2	1
	6-8	0.4	0.4	0.3	0.5	1.3	2
	8-10	0.4	0.4	0.3	0.5	1.3	2
	14-16	1	0.9	0.8	1	2.9	1
	19-21	0.4	0.4	0.3	0.5	1.3	3

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/5/90	0-2	0.4	0.4	0.3	0.5	1.3	1
A13	2-4	0.4	0.4	0.3	0.5	1.3	0.8
	4-6	0.4	0.4	0.3	0.5	1.3	0.4
	6-8	15,000	12,000	11,000	3,300	30,300	71,000
	8-10	7,500	6,900	3,000	1,800	16,200	56,000
	10-12	3,100	2,000	460	60	5,160	19,000
	12-14	500	150	3	5	655	1,900
	19-21	100	0.9	0.8	1	101.9	150
HS/A13	WATER	6,500	120	1,400	230	6,850	30,000
6/5/90	0-2	2	1	0.4	0.6	3.6	18
A14	2-4	0.6	0.4	0.4	0.6	1.6	5
	4-6	0.6	0.4	0.3	0.5	1.5	3
	6-8	0.6	0.9	0.3	0.5	2	20
	8-10	1	0.9	0.8	1	2.9	30
	14-16	1	1	0.3	0.5	2.5	30
	19-21	0.6	0.4	0.3	0.5	1.5	6
6/5/90	1-3	2,800	36	190	40	2,876	12,000
A15	3-5	74,000	86,000	35,000	40	160,040	480,000
	5-7	43,000	52,000	20,000	7,100	102,100	320,000
	7-9	27,000	33,000	19,000	8,200	68,200	230,000
	9-11	2,100	450	380	40	2,590	6,200
	11-13	550	4	3	4	558	1,900
	18-20	2	0.9	0.8	1	3.9	2
6/5/90	1-3	0.4	0.4	0.3	0.5	1.3	11
A16	3-5	0.8	0.4	0.3	0.5	1.7	0.8
	5-7	3	0.7	0.7	0.9	4.6	3
	7-9	2	0.4	0.3	0.5	2.9	2
	14-16	0.5	0.4	0.3	0.5	1.4	1
	19-21	1	0.4	0.3	0.5	1.9	2
HS/A16	WATER	2	2	1	2	6	8

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/6/90	1-3	830	280	160	40	1,150	8,100
A17	3-5	40	30	30	40	110	480
	5-7	13,000	27,000	8,700	3,400	43,400	160,000
	7-9	24,000	46,000	12,000	4,500	74,500	270,000
	9-11	15,000	29,000	7,600	2,800	46,800	190,000
	11-13	1,700	2,400	700	130	4,230	22,000
	19-21	650	800	560	300	1,750	7,800
6/6/90	1-3	2,400	2,100	430	40	4,540	38,000
A18	3-5	21,000	45,000	12,000	4,600	70,600	240,000
	5-7	28,000	59,000	16,000	6,200	93,200	350,000
	7-9	22,000	43,000	14,000	5,000	70,000	290,000
	9-11	3,700	3,100	890	210	7,010	37,000
	11-13	1,600	910	370	60	2,570	15,000
	18-20	2	2	2	2	6	2
HS/A18	WATER	93,000	180,000	50,000	20,000	293,000	1,200,000
6/6/90	1-3	6	2	2	2	10	8
A19	3-5	10,000	13,000	21,000	6,800	29,800	100,000
	5-7	450,000	230,000	110,000	49,000	729,000	15,000,000
	7-9	11,000	3,200	4,800	530	14,730	43,000
	9-11	180	20	20	20	220	630
	11-13	2	2	2	2	6	20
	18-20	1	0.7	0.6	0.8	2.5	1
6/7/90	1-3	1,100	50	240	30	1,180	3,000
A20	3-5	36,000	84,000	41,000	17,000	137,000	370,000
	5-7	23,000	37,000	24,000	7,900	67,900	270,000
	7-9	4	2	2	2	8	30
	9-11	1	0.8	0.8	1	2.8	6
	11-13	1	1	0.4	0.5	2.5	2
	18-20	0.8	0.3	0.3	0.4	1.5	0.8
HS/A20	WATER	15,000	20,000	30,000	13,000		133,000
6/7/90	1-3	0.4	0.3	0.3	0.4	1.1	0.4
A21	5-7	0.4	0.3	0.3	0.4	1.1	0.4
	9-11	0.4	0.3	0.3	0.4	1.1	0.4
	16-18	2	0.3	0.3	0.4	2.7	2

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/7/90	1-3	60	3	3	4	67	770
A22	3-5	40	3	3	4	47	430
	5-7	2	1	1	2	5	40
	7-9	0.8	0.7	0.7	0.9	2.4	5
	9-11	0.5	0.5	0.5	0.6	1.6	2
	16-18	0.4	0.4	0.4	0.4	1.2	5
HS/A22	WATER	4	3	3	4	11	120
6/8/90	0-2	0.4	0.4	0.4	0.4	1.2	0.7
A23	2-4	0.4	0.4	0.4	0.4	1.2	0.4
	4-6	0.4	0.4	0.4	0.4	1.2	0.4
	6-8	0.4	0.4	0.4	0.4	1.2	0.4
	8-10	0.4	0.4	0.4	0.4	1.2	0.4
	15-17	0.4	0.4	0.4	0.4	1.2	0.4
	20-22	0.4	0.4	0.4	0.4	1.2	0.4
HS/A23	WATER	0.4	0.4	0.4	0.5	1.3	11
6/8/90	0-2	0.4	0.4	0.4	0.4	1.2	0.4
A24	2-4	0.4	0.4	0.4	0.4	1.2	0.4
	4-6	0.4	0.4	0.4	0.4	1.2	0.4
	6-8	0.4	0.4	0.4	0.4	1.2	0.4
	8-10	0.4	0.4	0.4	0.4	1.2	0.4
	15-17	0.3	0.3	0.3	0.4	1	0.3
HS/A24	WATER	0.4	0.4	0.4	0.5	1.3	0.4
6/8/90	0-2	0.4	0.4	0.4	0.4	1.2	3
A25	2-4	0.5	0.4	0.4	0.4	1.3	5
	4-6	0.4	0.4	0.4	0.4	1.2	5
	6-8	0.3	0.3	0.3	0.4	1	4
	8-10	0.3	0.3	0.3	0.4	1	3
	15-17	0.3	0.3	0.3	0.4	1	3
6/11/90	0-2	0.4	0.4	0.4	0.5	1.3	0.4
A26	2-4	0.8	0.4	0.4	0.5	1.7	0.8
	4-6	0.4	0.4	0.4	0.5	4.9	4
	6-8	0.6	0.4	0.4	0.5	1.5	0.6
	8-10	6	0.4	0.4	0.5	6.9	6
	15-17	1	0.4	0.4	0.5	1.9	2

TABLE 5-2 (Continued)
ANALYTICAL DATA FOR PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL

BORING	DEPTH (FT)	BENZENE	TOLUENE	ETHYLBENZENE	XYLENE	BTX	TPH (ug/kg)
6/11/90	0-2	1	0.8	0.4	0.5	2.3	4
A27	2-4	4	0.4	0.4	0.5	4.9	6
	4-6	1	0.9	0.4	0.5	2.4	5
	6-8	1	0.4	0.4	0.5	1.9	1
	8-10	0.9	0.4	0.4	0.5	1.8	3
HS/A27	WATER	4	0.2	0.2	0.3	4.5	5
6/11/90	0-2	8	2	0.3	0.4	10.4	90
A28	2-4	8	2	0.3	0.4	10.4	100
	4-6	8	2	0.3	0.4	10.4	90
	6-8	6	2	0.3	0.4	8.4	60
	8-10	5	2	0.3	0.4	7.4	80
	15-17	5	2	0.3	0.4	7.4	50
HS/A28	WATER	4	1	0.3	0.4	5.4	40

All soil sample concentrations reported in ug/kg.
All water sample concentrations reported in ug/L.

Boring A9, located between building 757 and the end pump island, also had a TPH concentration above 1,000 mg/kg. Borings A2 and A19, located in front of building 341 near Old Navy Road, displayed hydrocarbon concentrations of 860 and 100 mg/kg respectively. The TPH concentrations in this area indicate the presence a hydrocarbon source other than the pipe leak near MEM-757-2. A review of old site plans indicate one 10,000 and two 6,000 gallon UST's were abandoned in place 21 years ago. Since that time, Old Navy Road has been widened and possibly covers the old tanks. It is not known if these tanks were removed during road construction.

The highest hydrocarbon levels were typically encountered at a depth of six to eight feet below surface grade. Hydrocarbon contamination was centered at two different areas. TPH contamination within boring A19 near Old Navy Road was 15,000 mg/kg. Contamination was also centered around borings A4, A5, A7, near the pump islands with TPH concentrations reported to be within the 1,500 to 2,000 mg/kg range. Contamination at this depth extend across two-thirds of the site and under Old Navy Road.

At a depth of eight to ten feet below surface grade, hydrocarbon contamination is centered immediately downgradient from the initial leak source. TPH concentrations within the center of this area appear to be within the 900 mg/kg range. Contamination appears to extend from monitoring well MEM-757-7, under building 757, and upgradient from the active tank pit area. In addition, TPH was encountered in the area around boring A19.

At a depth of ten to twelve feet below surface grade three distinct areas of TPH contamination were encountered. In the first area, contamination is centered northeast of borings A4 and A7. TPH concentrations within the center of this area are within the 160 to 180 mg/kg range. Contamination in this area extends from well MEM-757-3 to boring A15, west to east, and from Old Navy Road to borings A1 and A8, north to south. In the second area, contamination is centered around A17, south of building 757. TPH concentrations within the center of this area appear to be within the 180 to 200 mg/kg range. Contamination extends from building 757 to just beyond boring A6, west to east, and from boring A1 to building 757, south to north. In the third area, contamination is centered around boring A11, near the north end of the active tank pit. TPH concentrations within the center of this area are within the 260 to 280 mg/kg range. This area has been impacted by the adjacent UST system.

Soil analytical data, as presented by Tracer Research Corporation, is presented in Appendix III.

<u>5.5 GROUND WATER ASSESSMENT</u>. Fourteen ground water samples were obtained from various soil borings during the remedial investigation at the Navy Exchange Service Station as stated within Section 5.1. All ground water samples were submitted to Tracer Research for on-site analysis of BTEX and TPH utilizing the head space analysis method.

All ground water samples were analyzed for BTEX and TPH. Due to the large number of samples tested and the need for immediate test results, head space analysis was chosen as the field method to quantify hydrocarbon concentrations in soil and water. It is expected that the BTEX and TPH values displayed by the head space analysis method would be lower than values displayed by the standard analytical test method for BTEX (EPA 602 and 8020) and TPH (California GC Method).

Analysis of the fourteen ground water samples revealed additional evidence of petroleum hydrocarbon contamination. All fourteen samples displayed benzene concentrations ranging from 0.2 to 93,000 milligrams per liter (mg/l). Field evaluation of the ground water samples obtained from borings A1, A2, A4, A5, A9, A13, A18, and A20 revealed benzene concentrations of 4,500, 8,800, 22,000, 4,600, 5,000, 6,500, 93,000 and 15,000 ug/L respectively.

Additional analytical information is presented within Table 5.2 and Appendix III.

6.0 VES PILOT STUDY

6.1 PURPOSE. Vapor extraction has been recommended as a possible method of removing gasoline constituents from subsurface soils at the Navy Exchange (NEX) Service Station at the Naval Air Station (NAS) Memphis. The purpose of the vapor extraction pilot test was to gather site specific data necessary for calculating air flow requirements, operating vacuums, and the number, spacing and location of the required wells.

6.2 PERMITTING. Prior to the commencement of field activities at the NEX Service Station both air and ground water discharge permits were obtained.

6.2.1 Water Permits Permission to discharge recovered ground water into an on-site oil water separator that flows into the sanitary sewer system was granted by the Water and Wastewater Manager for the City of Millington, Tennessee. Although no flow restrictions were imposed, contaminant concentrations in the discharge were to be below detectable limits.

6.2.2 Air Permits A temporary construction permit allowing a 30-day operating period was issued by the Shelby County Air Pollution Control Division. The permit did not require the treatment of exhaust gases generated during the pilot test.

6.3 TEST LOCATION. The pilot test staging area was located approximately 50 feet southwest of pump island four where the original gasoline leak occurred. This area was identified as having limited vehicular traffic and high concentrations of gasoline constituents in the soil and water (refer to Figure 6-1).

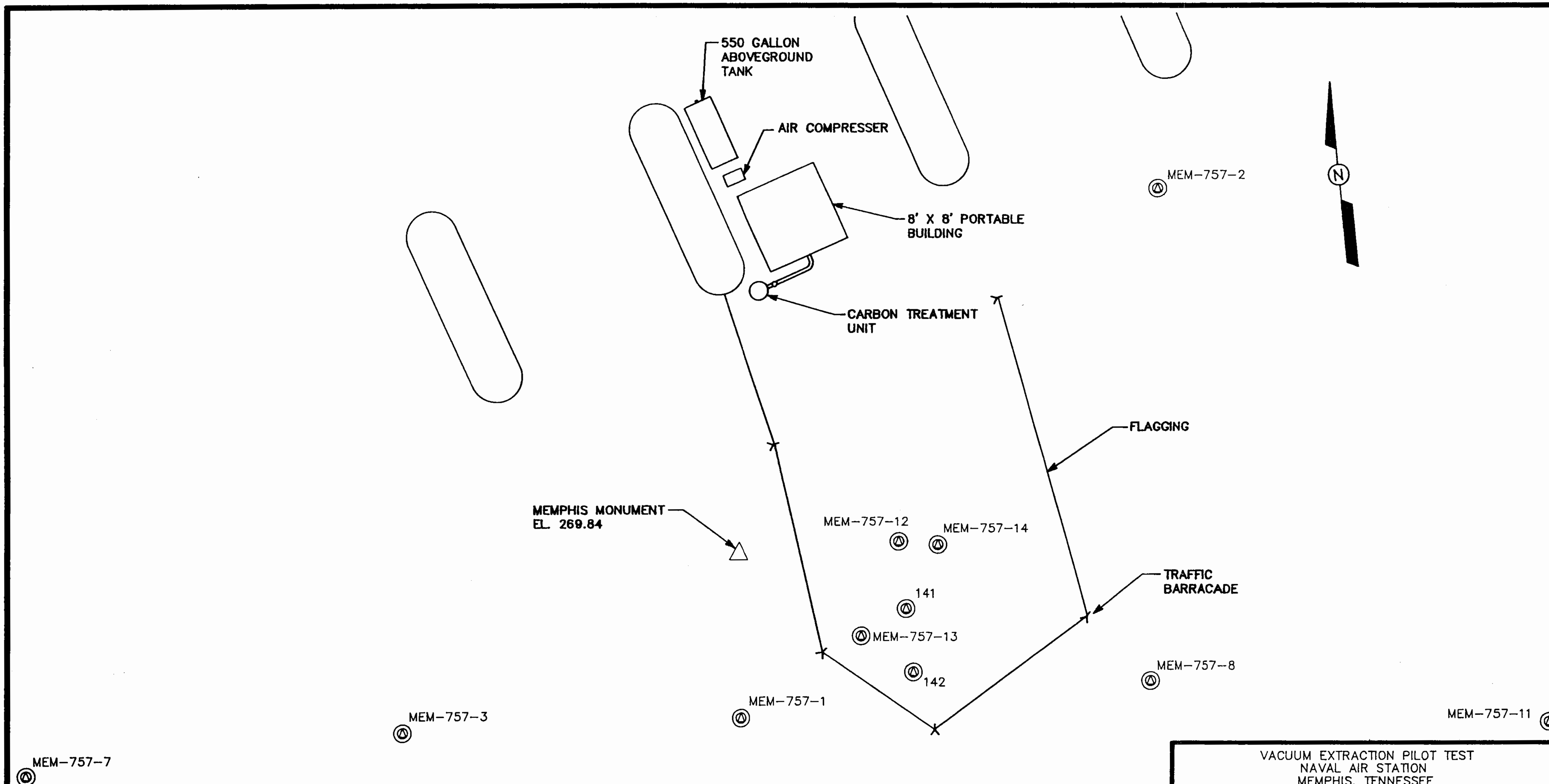
The pilot test was to be executed with minimal disruption to traffic and daily operations at the NEX Service Station. The primary traffic pattern at this facility flows through the active pumps toward building 757 and exits to Old Navy Road near building 341. Traffic barricades flagged with fluorescent tape were placed around the perimeter of the staging area to divert vehicular traffic.

Based on information presented in previous reports and ground water laboratory test results, the area southwest of monitoring well MEM-757-2 was identified as the area of highest hydrocarbon concentration.

6.4 TEST EQUIPMENT. An 8'x8' portable building, located between inactive pump islands five and six, was utilized to store field equipment and supplies. A 550-gallon bubble diffusion unit, also located between inactive pump islands five and six, was used to strip volatile organic compounds from the ground water recovered during pump tests and dewatering operations.

6.4.1 Blowers The air tests were conducted with two, Rotron model DR4 explosion proof blowers. Each blower assembly was equipped with Magnahelic vacuum and air velocity gages and an exhaust gas sample port. Each blower was also modified with an exhaust recirculation valve which was used to reduce well head vacuum pressure.

6.4.2 Temperature Gauges A Dwyer, Model 470-1, temperature compensating, thermal anometer was used to measure gas velocities exiting the exhaust stack. This unit was calibrated to air velocity readings measured using a pitot tube, inclined



VACUUM EXTRACTION PILOT TEST
NAVAL AIR STATION
MEMPHIS, TENNESSEE

FIGURE 6-1 ENLARGED SITE PLAN LOCATING STAGING AREA AND EXTRACTION/OBSERVATION WELLS

SCALE: 1" = 10' | DR RAC | CHK JKP | REV BLD

PREPARED FOR: **SOUTHNAVFACENGCOM**

ERCE

PROJ: A472-007 | DATE: 11/15/90 | SHEET 1 OF 1

manometer, and type k thermocouple. Prior to each reading, the indicator needle was reset to zero. Type K thermo couples and an Omega, model HH-71-T, hand held meter were used to measure blower, exhaust gas, ambient, and subsurface soil temperatures.

<u>6.4.3 Pressure Gauges</u> A Dywer, model 100.5, inclined manometer with a range from -0.10 to 1.00 inch water column (0.01-inch increments) was used to measure low pressures at the observation wells. A Dywer Magnahelic gauge was used to measure pressures greater than 1.0 inches of water.

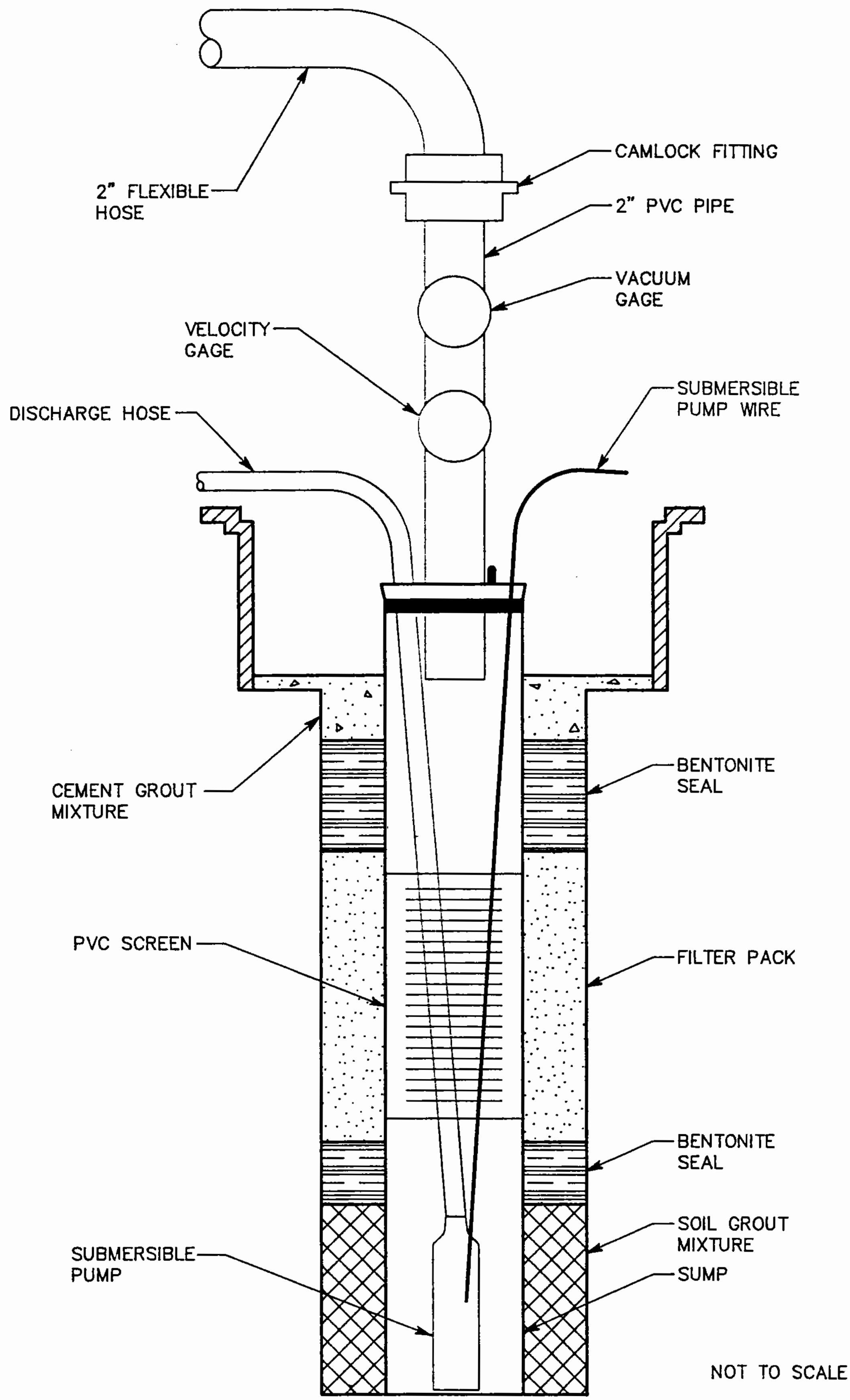
<u>6.4.4 Well Seals</u> Wells used simultaneously as ground water recovery and vacuum extraction/observation wells were fitted with modified well caps. Each cap sealed electrical pump cable, ground water discharge hose, vacuum extraction fittings, and needle valves. Observation wells were fitted with a 4-inch PVC cap containing a threaded needle valve for pressure measurement, and was sealed to the well casing with silicone. Refer to figures 6-2, 6-3 and 6-4.

<u>6.5 EXTRACTION/OBSERVATION WELL INSTALLATION</u>. A concern was expressed by the Department of the Navy, Southern Division Facilities Engineering Command, to use existing wells for the ground water and vacuum pump tests whenever possible and install a minimum number of new wells within the test area. Therefore, the pumping well used for the ground water pump test was also used as a dewatering and vacuum extraction test well. One six-inch and two four-inch wells were planned for the pilot test.

In addition to ground water and air pump tests, these wells were to be used to measure subsurface soil temperatures at three depths by attaching type k thermocouples to the well casings prior to well construction. During the installation of these wells, two of the three thermocouples were damaged beyond repair. Subsequently, two, 2-inch diameter shallow wells were installed for additional pressure and soil temperature monitoring points. Extraction and observation well information is summarized in Table 6-1.

<u>6.5.1 Well Construction</u> Soil boring A4 was advanced to a depth of 30 feet below surface grade and used to construct well MEM-757-12. The highest hydrocarbon concentrations were encountered at a depth of six to eight feet below ground surface. Ground water level in this area was at 5.5 feet below ground surface. The well was constructed of six-inch diameter, schedule 40 PVC well material. A 10 foot 0.010 inch slotted screen section extended from 10 to 20 feet below surface grade. Six-inch PVC riser was installed across the 0 to 10 and 20 to 30 foot intervals with a PVC plug at the bottom. A two foot thick bentonite seal was placed above and below the silica filter pack that extended three feet above and below the well screen. A cement grout mixture topped the upper bentonite seal into the manhole.

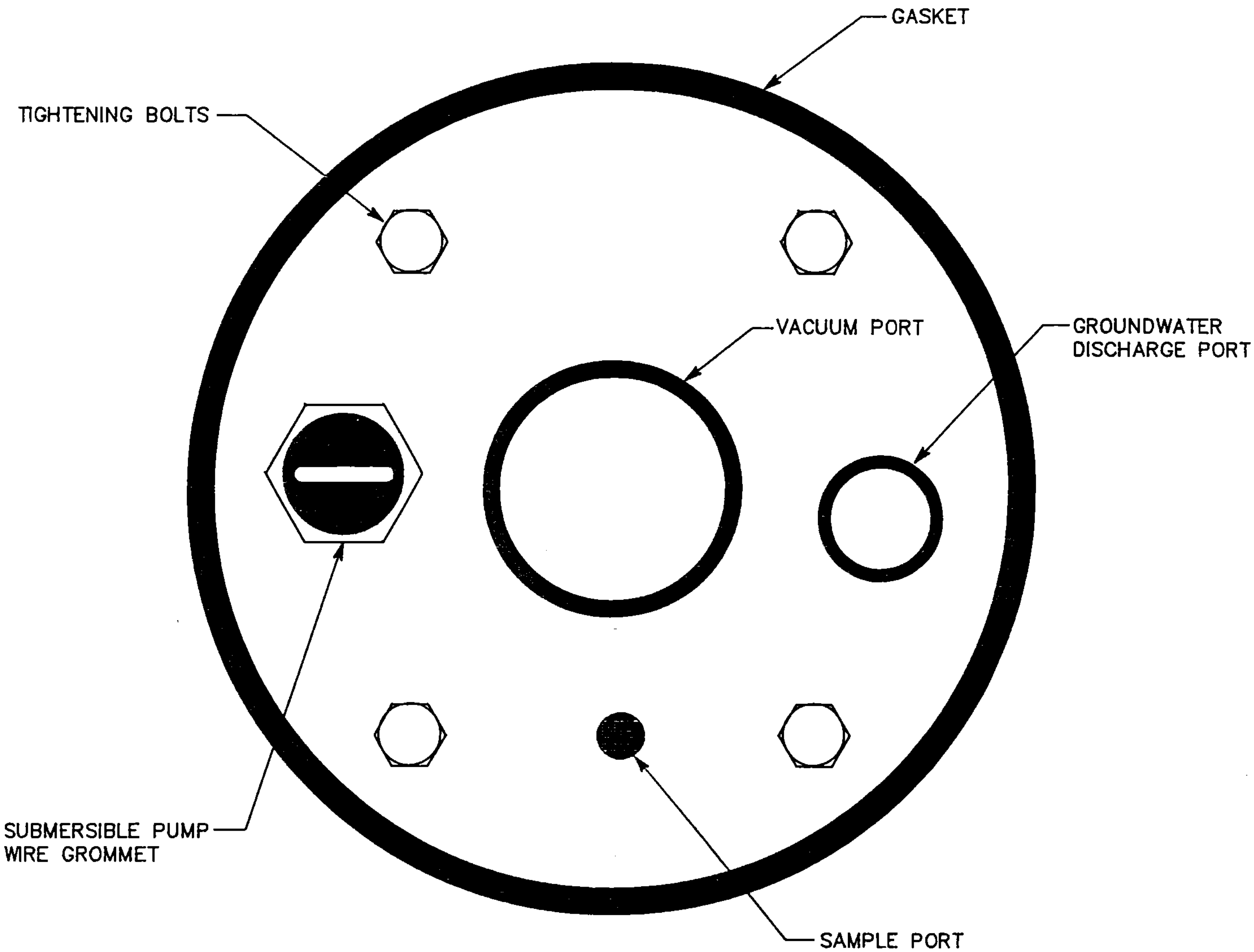
Sumps were included on Wells MEM-757-12, MEM757-13 and MEM-757-14 to prevent silt from settling in the lower segments of well and inhibiting air from flowing through the lower portion of the screen. Also, a sump was installed since dewatering would be required from the wells used as vapor extraction points. Low ground water recovery rates were anticipated from both the four and six inch wells. The capacity in each sump would allow intermittent operation of the ground water pump and would reduce the chance of pumping the well dry and destroying the submersible pump.



Groundwater/Vacuum Extraction Well Diagram

FIGURE 6–2

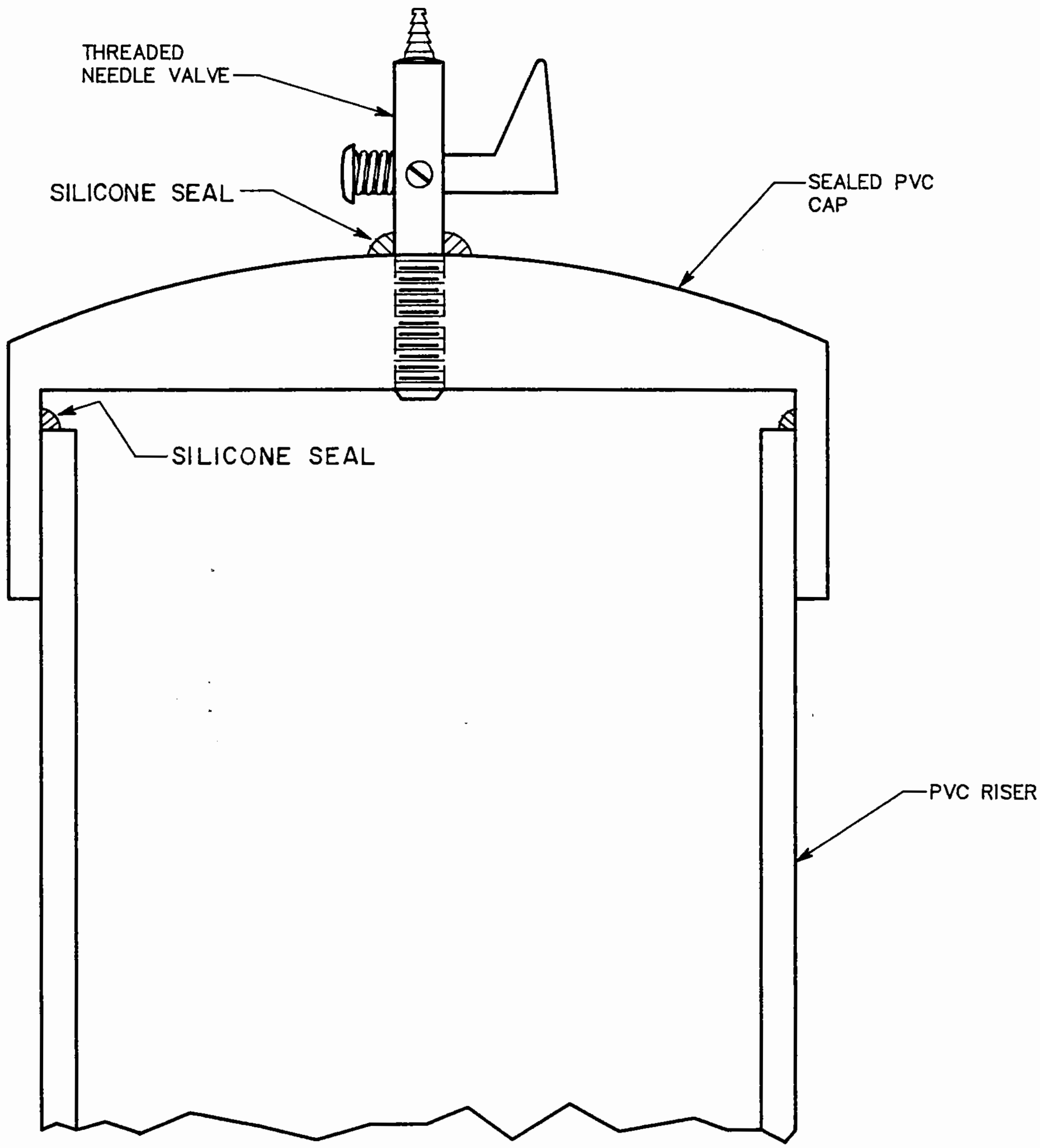
Navy Exchange Service Station NAS Memphis, Tn NOVEMBER, 1990



NOT TO SCALE

Well Seal Detail
FIGURE 6-3

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990



NOT TO SCALE

Observation Well Cap
FIGURE 6-4

Navy Exchange
Service Station
NAS Memphis, Tn
NOVEMBER, 1990

TABLE 6-1

EXTRACTION AND MONITORING WELL SUMMARY

Well	Diameter (IN)	Screened Interval Elevations	Static Water Elevations (Prior to Ground Water Recovery)	Distance from MEM 757-12 (FT)	Distance from MEM 757-14 (FT)
MEM-757-1	4	264.88 - 250.08	264.99	12.9	25.3
MEM-757-2	4	266.18 - 251.38	265.76	42.2	40.7
MEM-757-3	4	265.56 - 250.76	264.89	51.1	54.8
MEM-757-7	4	264.58 - 244.58	265.06	89.0	92.7
MEM-757-8	4	265.98 - 245.98	265.96	27.9	24.3
MEM-757-11	4	265.72 - 245.72	265.65	65.8	62.0
MEM-757-12*	6	259.84 - 249.84	265.84	0	3.8
MEM-757-13*	4	260.84 - 256.84	265.84	9.8	11.5
MEM-757-14*●	4	259.84 - 255.84	NR	3.8	0
MEM-757-141*●	2	264.64 - 262.14	NR	7.0	7.2
MEM-757-142*●	2	264.64 - 262.14	NR	12.6	12.5

* Well elevations not surveyed.
● Installed after ground water recovery initiated.
NR - Not Recorded

Soil borings A5 and A7 were advanced to depths of 30 and 29 feet below surface grade respectively, and developed into four-inch diameter air/monitoring wells. A type k thermo couple was attached to the PVC casing of MEM-757-13 at a depth of 16.5 feet. Well MEM-757-13 was constructed in boring A5, screened across the interval from 9.0 to 13.0 feet, and included a 17 foot section of 4" PVC riser from 13 to 30 feet. Well MEM-757-14 was constructed in boring A7, screened across the interval from 10 to 14 feet, and included a 15-foot section of 4" PVC riser from 14 to 29 feet.

Two temporary 2-inch monitoring wells (141 and 142) were installed at a depth of 7.7 feet below surface grade with a screened interval from 4.7 to 7.2 feet below the surface. Each well was constructed with a silica filter pack extended from 3.0 to 7.2 feet and finished with a 2.8 feet thick bentonite seal. These wells were grouted flush with the surface at the end of the pilot test.

6.5.2. Well Development Well development was required for wells MEM-757-12, MEM-757-13, and MEM-757-14 since the water table extended above the screened intervals. Refer to Section 3.4.2 for well development protocol.

6.6 PILOT TEST DATA COLLECTION. The vapor extraction pilot test was completed June 13, 1990. Wells 757-12 and MEM 757-14 were used as extraction wells.

6.6.1 Test Methodology Ground water pump test data, collected prior to the vapor extraction tests, revealed ground water drawdown was less than that necessary to expose the screened interval of the two closest observation wells MEM 757-13 and MEM-757-14. A submersible pump and modified well seal was fitted to each of the two, 4-inch observation wells and operated intermittently to maintain an exposed section of well screen to the unsaturated soil zone.

Changes in extraction well flow/vacuum and observation well pressures were recorded with respect to time. High, medium, and low well head vacuums were applied to each extraction well and corresponding vapor flow rates and observation well pressures were recorded with respect to time.

After vacuum/flow rates were conducted with the observation wells closed, two observation wells, along the outer edges of influence, were opened to monitor the effects, if any, on the extraction well pressure and flow rate.

6.6.2 Background Data Based on the distance from the extraction points, Well B4 was selected as a background well and was monitored for daily fluctuations in pressure. In order to observe individual well fluctuations each well was observed under static conditions (no vacuum applied) for a period of 26 hours. Subsurface soil temperatures near the extraction wells were also monitored.

Hourly barometric pressure readings were obtained from the Navy base weather station and compared to fluctuations in pressure at the observation wells. Barometric pressure readings are included in Appendix V.

Subsurface soil temperatures at depths of 3.7, 7.7 and 16.5 feet below surface grade were monitored and compared to pressure fluctuations in nearby observation wells.

6.6.3 Vapor Monitoring Extraction vapor samples were periodically collected from the sampling port on the blower, in 10 cubic centimeter (cc) glass syringes, and analyzed for BTEX and TPH. Hydrocarbon concentrations in the exhaust gas were analyzed on-site with a Varian Model 3300 gas chromatograph (GC) equipped with flame ionization detector (FID). Analytical instruments were calibrated each day by analytical standards from Clean Service, Inc. Calibrtion checks were also run after approximately every five sampling locations. Analytical detection limits for hydrocarbons in the exhaust gas were approximately 0.03 mg/L, depending on the gas sample volume and concentration. Ambient air concentrations were screened throughout the pilot test using both the organic vapor monitor (OVM) and the field GC.

6.7 TEST RESULTS. Complete results for extraction well vacuum/air flow rates, observation well pressures, and subsurface temperature readings are presented in Appendix V. High, medium and low vacuums were applied to the extraction wells to derive flow rate versus well head vacuum regression curves. The curves developed can be used to estimate a particular air flow recovery rate for a given vacuum.

Negative gage pressures from selected monitoring wells were recorded for each vacuum rate applied to an extraction well. Flow rates, well head and monitoring well pressures, and the distances of the monitoring wells were used to estimate air permeability ranges for the subject soil mass.

The effective radius of influence is the distance from the extraction well, that soil is significantly affected by forced venting. Vapor recovery flow rate and the thickness of the soil layer to be vented are variables.

Soil vapor partitioning coefficients are a ratio of observed VOC concentrations in recovered vapors and VOC concentrations in soil. These coefficients can be useful in estimating compound removal rates and the duration of system operation.

6.7.1 Temperature and Pressure Subsurface soil temperatures were monitored throughout the pilot test. Maximum soil temperature fluctuations at depths of 3.7, 7.7, and 16.5 feet below ground surface ranged from 77.5 to 83.8, 69.8 to 72.5, and 66.5 to 68.3° F respectively. Temperature, barometric pressure and static pressures within the observation wells (no vacuum extraction applied) were reviewed. No distinct pattern in fluctuations was correlated. Therefore, observation well pressure readings were not corrected.

6.7.2 Air Permeability Extraction well vacuum reading, corresponding air flow rate, and estimated air permeability ranges derived from the two test wells are presented in Table 6-2. Table 6-3 lists a range of air permeability values common for various soil types. The air permeability equation presented below is dependent on the following assumptions:

- Air flows to the screened section of the well are in a uniform, radial pattern;
- Horizontal air flow through soil macropores is minimal;
- Air density is unaffected by the vacuum pressures at the well head;
- A steady state condition was achieved when well head vacuum pressure and flow rate remained relatively constant;
- Soil temperature was constant; and
- Subsurface air flow rates are equal to blower discharge rates.

$$K = [(Qn)/(h\pi Pw)] \ln (Rw/Rm)/[1-(Pm/Pw)^2]$$
(Johnson, Kemblowski, Byers, Colthart, 1990)

Where,
K = gas permeability (cm^2)
Q = air flow rate (cm^3/s)
n = air viscosity (1.8×10^{-4} g/cm-s)
h = screened interval of extraction well (cm)
π = 3.1416
Rw = radius of extraction well (cm)
Rm = distance from extraction well to observation well (cm)
Pw = pressure at well head ($g/cm\text{-}s^2$)
Pm = pressure at observation well ($g/cm\text{-}s^2$)

TABLE 6-2
AIR FLOW/VACUUM AND ESTIMATED AIR PERMEABILITIES

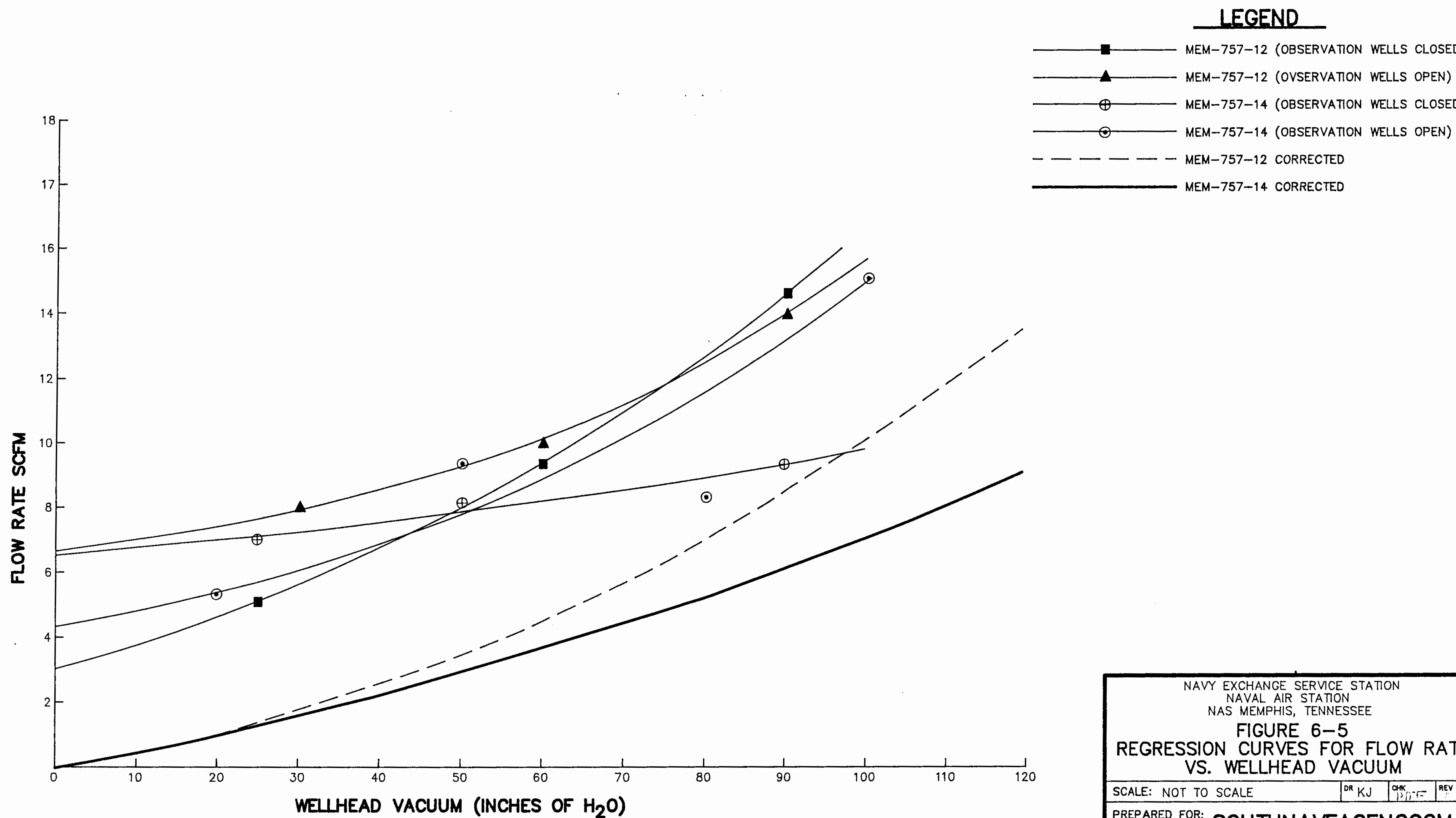
Extraction Well	Flow (scfm)	Vacuum (inches of H_2O)	Estimated Permeabilities (cm^2)
MEM-757-12	14.5	90	7.15×10^{-9} - 2.98×10^{-8}
MEM-757-14	9.8	80	1.57×10^{-8} - 2.75×10^{-8}

TABLE 6-3
GENERAL AIR PERMEABILITY RANGES FOR VARIOUS SOIL TYPES

Soil Types	Air Permeability Ranges (cm^2)
Clayey Sands	9.87×10^{-11} - 9.87×10^{-10}
Fine Sands	9.87×10^{-10} - 9.87×10^{-9}
Medium Sands	9.87×10^{-9} - 9.87×10^{-8}
Coarse Sands	9.87×10^{-8} - 9.87×10^{-7}

Permeability calculations were based on pressure values recorded from monitoring wells in different directions and distances from the extraction well. The assumption regarding a uniform, radial air flow pattern to the well screen was violated due to the irregular saturated soil profile in and around the extraction well to the two nearest observation wells during ground water recovery. This condition reflected permeability values 1 to 2 orders of magnitude higher than what is normally expected. Underground utilities running through the test area, the exposed strip of soil between the sidewalk and Old Navy Road, and heterogenous characteristics found in most soils are also factors that may add to non-uniform, radial air flow patterns. In addition, as noted in Section 6.7.1, soil temperatures were observed to decrease as vertical depth increased. The permeability equation used does not account for changes in subsurface temperatures.

6.7.3 Vacuum/Flow Rates. Results of the vacuum/flow rate step tests are represented graphically on Figure 6-5. Similar to the estimated permeability values, the vacuum/ flow rates were adversely influenced by difficulties with depressing the



NAVY EXCHANGE SERVICE STATION
NAVAL AIR STATION
NAS MEMPHIS, TENNESSEE

FIGURE 6-5
REGRESSION CURVES FOR FLOW RATE VS. WELLHEAD VACUUM

SCALE: NOT TO SCALE	DR KJ	CHK	REV

PREPARED FOR: SOUTHNAVFACENGCOM

ERCE

PROJ: A472-007	DATE: 11/15/90	SHEET 1 OF 1

water table. Flow rates at a given vacuum appear typically higher for both extraction wells MEM-757-12 and MEM-757-14 when wells MEM-757-1 and MEM-757-2 were opened. Using the thermal anometer, a one inch stand pipe, and a 1"x4" reducer bushing. At the well casing, air flow entering the subsurface through the 4-inch wells was monitored. Air flow into MEM-757-1 was below the accuracy range of the thermal anometer and was noted as detectable but not measurable. Air flow into MEM-757-2 was not detectable using the thermal annometer. No air movement was observed to enter through MEM-757-2. Increases measured in the exhaust flow exceeded the flow rates estimated to enter MEM-757-1. Step tests performed on each extraction well with the observation wells closed were followed by air step tests with the observation wells open. The increases in exhaust flow was probably due to a longer dewatering period of the test area rather than to air recharge.

6.7.4 Air Partitioning Coefficients The observed soil-vapor partitioning coefficient was calculated by the following equation.

$$Svp = Cg/[Cs\ bd]$$

(Hern, Melancon, 1986)

where,
- Svp = soil-vapor partition coefficient (dimensionless)
- Cg = volatile organic carbon (VOC) concentration in soil gas (mg/l)
- Cs = VOC concentration in soil (mg/kg)
- bd = dry bulk density of soil (kg/l)

Soil-vapor partitioning values ranged from 0.055 to 1.77 and were dependent primarily upon the VOC concentration of the soil sample used in the calculation. A decrease in VOC concentrations in the exhaust gases was not observed and indicates 1 or more pore volumes of air from beyond the extent of the contaminant plume were not removed from the soil mass during the test period. Considering the areal extent of soil contamination with respect to test location, the assumption is valid. The value for Cg is based on the assumption that the vapors in the air filled pores contained in the contaminated soil mass have been replaced by at least one pore volume of air from beyond the plume boundaries. The consistent VOC concentrations in the recovered vapors can be translated to higher than actual values for Cg, resulting in high partitioning coefficients. Svp values calculated using VOC concentrations from the more highly concentrated soil depths ranged from 0.065 to 0.112, actual Svp values should be below the lower end of this range. Dry bulk density (bd) of the soil was determined to be 1.62 to 1.73 (kg/l) by laboratory analysis (refer to Section 4.2.1). Soil gas analytical test results, W1-W33 are included in Appendix III. Soil gas samples analyzed for TPH ranged from 135,000 to 310,000 ug/L and averaged 230,000 ug/L throughout the tests. TPH concentrations were not affected by varying air flow rates Field GC test methodology (Section 5.2) targets gasoline range compounds consisting of C_4-C_9 aliphatic, alicyclic, and aromatic compounds. The test method assumed hydrocarbon concentrations in solid, liquid, and gas phases reached equilibrium. Therefore, the total petroleum hydrocarbon concentrations used as Cs values are probably low, resulting in a higher-than-actual soil-vapor partitioning coefficients. It should also be noted that the equation does not take into account the changes in chemical composition or concentration over time.

6.7.5 Radius of Influence The effective radius of influence can be calculated using the following equation.

$$Rie = Q/2 \pi v h$$

Where, Rie = effective radius of influence (ft)
Q = flow rate (ft^3/min)
π = 3.1416
v = soil in air velocity (ft/min)
h = unit thickness (ft)

Extraction well spacings are typically designed to induce a soil air velocity equal to or greater than one centimeter per minute (3.28×10^{-2} ft/min). (Johnson, Kemblowski, Byers, Colthart, 1990). The maximum effective radius of influence sustained during the air flow tests from extraction well MEM-757-12 was 4.2 feet at 90" H_2O. The maximum effective radius of influence sustained during air flow tests from extraction well MEM-757-14 was 8.6 feet at 100" H_2O. The larger radius of influence calculated for MEM-757-14 is attributed to the irregular saturated soil profile around the extraction wells.

Estimating the time required to reduce hydrocarbon concentrations in soil to a specified limit are highly dependent on changes in the soil-vapor partitioning coefficients (svp) with time. The following equation is based on a model which combines the equilibrium partitioning of VOC's with a calculation for the number of air pore volumes required to reduce the contaminant mass or concentration in soil.

$N = \ln(Cs^*/Cs)/\ln(1-svp)$

$t = Rie^2 \pi N h\, ap/Q$ (Hartley, 1987)

Where, t = time (s)
Rie = effective radius of influence (cm)
π = 3.1416
h = unit thickness (cm)
ap = air-fill porosity (dimensionless)
Q = flow rate
Svp = soil vapor partitioning coefficient (dimensionless)
N = required number of pore volumes
Cs* = target concentration in soil (mg/kg)
Cs = initial concentration in soil (mg/kg)

6.8 PHYSICAL DESIGN CONSTRAINTS. Shallow ground water, approximately four to five feet below the surface is common throughout the area of contamination. Calculations, based on the ground water pump test results, indicate that a maximum drawdown of 5.4 feet can be obtained a distance of two feet from a six inch diameter well, screened 30 feet into the saturated soil, pumping at a rate of 0.37 gallons per minute (gpm).

The actual thickness of the saturated zone at this site has not been determined in this investigation or previous investigations. Assuming that a saturated layer 100 feet thick existed at this site, and a six inch well was screened across this interval, drawdown would be increased to 5.5 feet at a distance of two feet from the well, pumping at a rate of 1.5 gpm.

6.8.1 Hydrocarbon Concentration Based on soil borings and field GC soil analyses, hydrocarbon concentration maps were developed for soil layers 2-4, 4-6, 6-8, 8-10, and 10-12 feet below the surface (refer to Appendix IV). The maximum allowable hydrocarbon concentrations in soil and ground water set by the Tennessee Department of Health and Environment (TDHE) Division of Underground Storage Tanks, is presented in Table 6-4. The "Procedure to Determine the Soil Permeability of a Site" and "Petroleum Contamination Clean-up Levels" from Appendices 3 and 4 of Tennessee's Petroleum Underground Storage Tank Regulations, Chapter 1200-1-15 are presented in Appendix VI. Also included in Appendix VI is a draft copy of the "Procedure to Determine the Ground Water Classification of a Site". Hydrogeologic conditions at this site suggest the aquifer may be classified as of non-drinking water quality with soil permeabilities between 10^{-4} and 10^{-6} cm/sec. However, determining the ground water classification at this site was not an objective of this study.

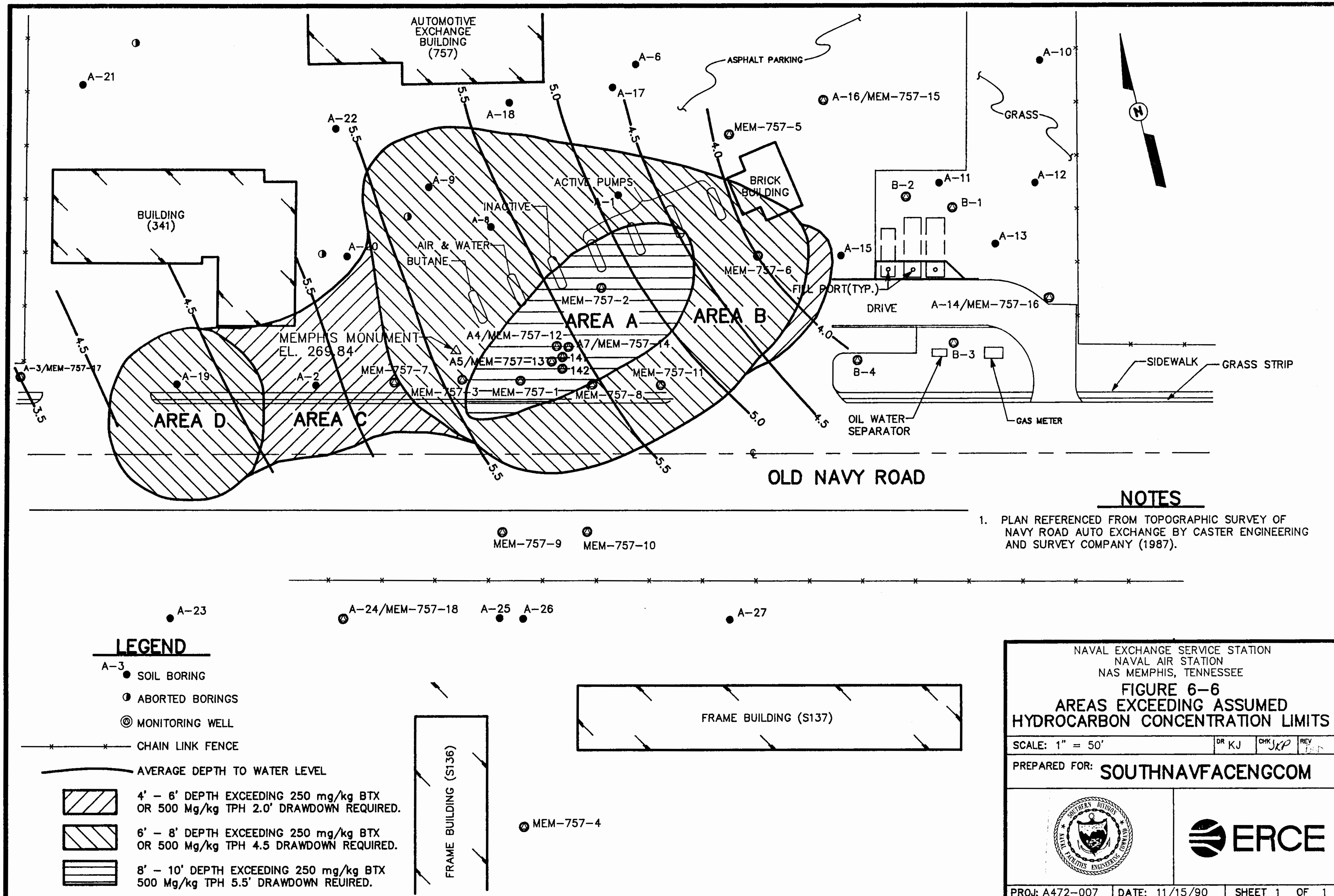
TABLE 6-4
PETROLEUM CONTAMINATION CLEAN UP LEVELS

Soil Permeability	< 10^{-4} cm/sec	10^{-4} - 10^{-6} cm/.sec	< 10^{-6} cm/sec
BTX Soil (ppm)			
Drinking Water	10	50	100
Non-Drinking Water	50	250	500
TPH Soil (ppm)			
Drinking Water	100	250	500
Non-Drinking Water	250	500	1000

Ground Water	Benzene (ppm)	TPH (ppm)
Drinking Water	0.005	0.100
Non-Drinking Water	0.070	1.0

The maximum allowable BTX concentrations in soil at this site will probably be 50 ppm or 250 ppm based on the aquifer ground water classification. The maximum allowable TPH concentrations in soil at this site will probably be 250 ppm or 500 ppm, again based on the aquifer ground water classification. Figure 6-6 represents hydrocarbon concentrations exceeding either 250 ppm BTX or 500 ppm TPH at the indicated depth and the average depths to ground water measured at the site. This condition assumes the most lenient clean-up levels that would probably be permitted. Had additional soil borings been advanced to the east and west of borings A4, A5, and A7, hydrocarbon concentrations may have been identified over a greater horizontal extent than is represented graphically in Appendix IV.

6.8.2 Dewatering Based on the clean-up criteria assumed in Section 6.8.1 and the ground water pump test results, for the soil identified in Area A, Figure 6-6, to be dewatered 8-10 feet below grade for the removal of hydrocarbons by vapor extraction, 6 inch diameter, 35 feet deep ground water recovery wells would need to be spaced no more than 4 feet apart. Figure 6-7 shows calculated ground water drawdown contours at distances of 2,4.5, and 9 feet away from a theoretical 6-inch diameter recovery well screened into the upper 30 feet of the unconfined aquifer. With Area A covering 8,000 square feet (ft^2), approximately 550 ground water recovery wells would be required to marginally desaturate the area.


AUTOMOTIVE EXCHANGE BUILDING (757)
BUILDING (341)
ASPHALT PARKING
GRASS
BRICK BUILDING
ACTIVE PUMPS
INACTIVE
AIR & WATER
BUTANE
MEMPHIS MONUMENT EL. 269.84
AREA A
AREA B
AREA C
AREA D
FILL PORT(TYP.)
DRIVE
A-14/MEM-757-16
SIDEWALK
GRASS STRIP
OIL WATER SEPARATOR
GAS METER
OLD NAVY ROAD
A-1
A-2
A-3/MEM-757-17
A4/MEM-757-12
A5/MEM=757=13
A-6
A7/MEM-757-14
A-8
A-9
A-10
A-11
A-12
A-13
A-15
A-16/MEM-757-15
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MEM-757-3
MEM-757-4
MEM-757-5
MEM-757-6
MEM-757-7
MEM-757-8
MEM-757-9
MEM-757-10
MEM-757-11
141
142
3.5
4.0
4.5
5.0
5.5
N
FRAME BUILDING (S137)
FRAME BUILDING (S136)
NOTES
1. PLAN REFERENCED FROM TOPOGRAPHIC SURVEY OF NAVY ROAD AUTO EXCHANGE BY CASTER ENGINEERING AND SURVEY COMPANY (1987).
LEGEND
A-3 SOIL BORING
ABORTED BORINGS
MONITORING WELL
CHAIN LINK FENCE
AVERAGE DEPTH TO WATER LEVEL
4' – 6' DEPTH EXCEEDING 250 mg/kg BTX OR 500 Mg/kg TPH 2.0' DRAWDOWN REQUIRED.
6' – 8' DEPTH EXCEEDING 250 mg/kg BTX OR 500 Mg/kg TPH 4.5 DRAWDOWN REQUIRED.
8' – 10' DEPTH EXCEEDING 250 mg/kg BTX 500 Mg/kg TPH 5.5' DRAWDOWN REUIRED.
NAVAL EXCHANGE SERVICE STATION
NAVAL AIR STATION
NAS MEMPHIS, TENNESSEE
FIGURE 6-6
AREAS EXCEEDING ASSUMED HYDROCARBON CONCENTRATION LIMITS
SCALE: 1" = 50'
DR KJ
CHK JKP
REV
PREPARED FOR: SOUTHNAVFACENGCOM
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
ERCE
PROJ: A472-007
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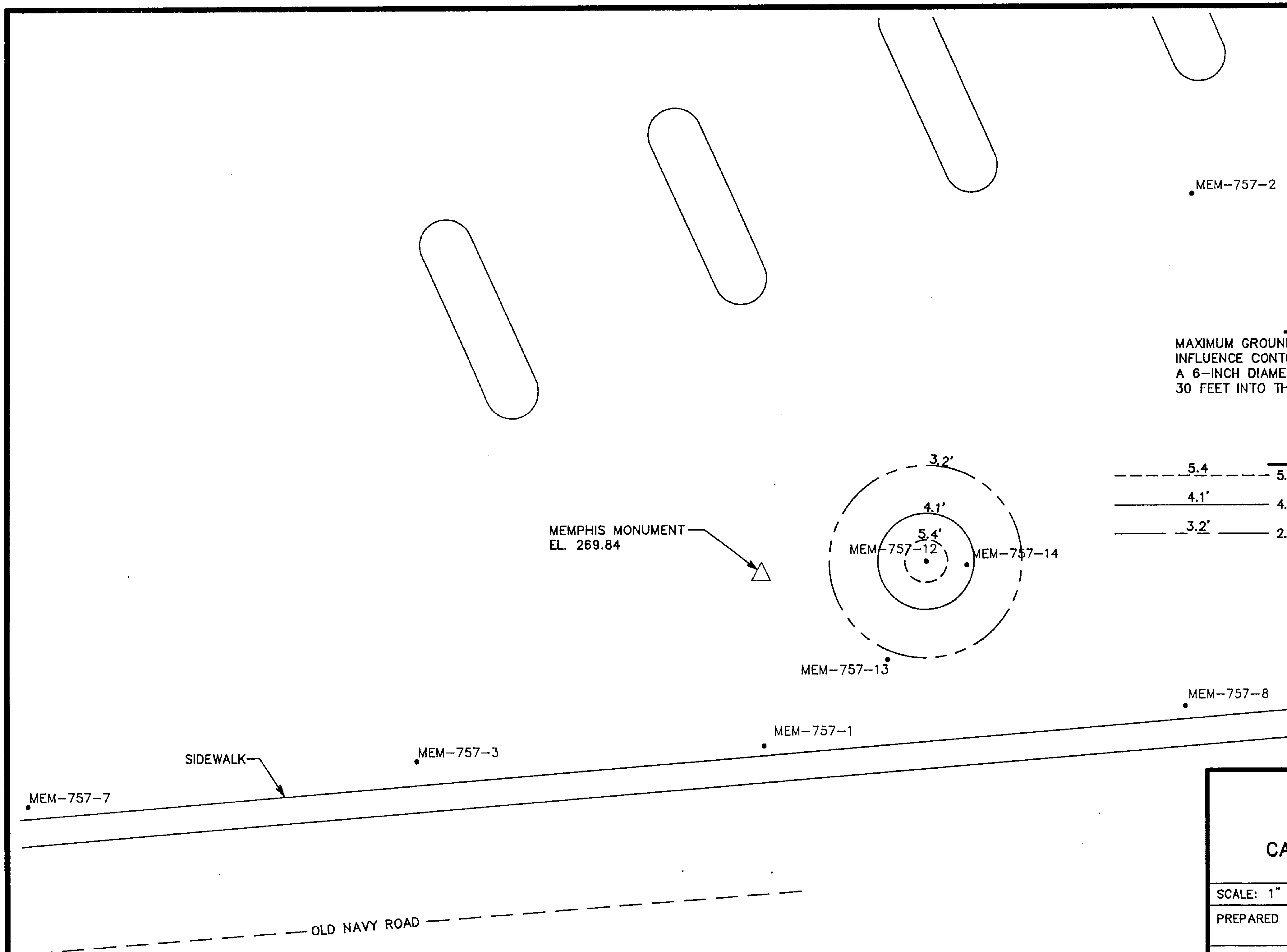

NOTE

MAXIMUM GROUND WATER DRAWDOWN/RADIUS OF INFLUENCE CONTOURS ARE CALCULATED FOR A 6-INCH DIAMETER RECOVERY WELL, SCREENED 30 FEET INTO THE SATURATED LAYER.

LEGEND

- - - 5.4 - - - 5.4' DRAWDOWN, 2' FROM RECOVERY WELL
—— 4.1' —— 4.1' DRAWDOWN, 4.5' FROM RECOVERY WELL
—— 3.2' —— 2.2' DRAWDOWN, 9.0' FROM RECOVERY WELL

VACUUM EXTRACTION PILOT TEST
NAVAL AIR STATION
MEMPHIS, TENNESSEE

FIGURE 6-7
CALCULATED GROUND WATER DRAW DOWN CONTOURS

SCALE: 1" = 10'	DR RAC	CHK	REV

PREPARED FOR: **SOUTHNAVFACENGCOM**

ERCE

PROJ: A472-007	DATE: 11/15/90	SHEET 1 OF 1

Area B, the soil depth at which highest hydrocarbon concentrations were detected, ranges 6 to 8 feet below surface grade. To adequately expose the upper 8-9 feet of soil in this area, approximately 4.0 feet of drawdown would be required. Ground water pump test results indicate that 6-inch wells, screened 30 feet into the saturated zone, would need to be spaced no more than 9 feet apart. Area B and the upgradient tip of Area C covers 37,000 ft^2 and would require approximately 525 recovery wells. This approach would target the most highly contaminated soils and incorporate ground water recovery from within the contaminant plume A.

The remaining area C would require a drawdown of approximately 2.5 feet. Ground water recovery well spacing should be no more than 14 feet apart. The remaining section of Area C covers 7,200 ft^2 and would require approximately 45 additional ground water recovery wells.

Area D as previously mentioned may be affected by abandoned underground storage tanks. Clean up of this area would not be considered until verification has been made.

6.8.3 Conclusion Petroleum hydrocarbon concentrations in soil exceed the limits established by the TDHE at depths of 10 feet below surface grade. Ground water elevations in the contaminated areas average 4 to 6 feet below grade. Calculations based on pump test data indicate that dewatering the subject area sufficiently to expose the contaminated soil layer is not a feasible option. Based on this constraint, soil remediation by vacuum extraction is not considered a viable alternative.

7.0 SUMMARY

Previous environmental studies conducted since 1985 have identified three gasoline leak/spill events at the NEX Service Station. It is estimated that 5,400 gallons of gasoline have been released at the site.

Separate field investigations performed by Pittsburgh Testing Laboratories (PTL) and Harding Lawson Associates (HLA) have identified petroleum hydrocarbon contamination within both the soil and ground water regimes at the subject site. Presently, petroleum hydrocarbon contamination at the NEX Service Station exceeds the State of Tennessee's ground water and soil cleanup criteria.

The remedial investigation performed by ERCE included four primary segments of study. The second segment determined the vertical and horizontal extent of soil contamination. The first segment initiated a quarterly ground water sampling program. In addition, ground water level measurements were monitored. Ground water analytical data collected from previous sampling events was added to the data obtained during the quarterly sampling routines. Five monitoring wells were installed outside the hydrocarbon plume based on field GC screening of soil samples. Climatological data for the test area was reviewed to correlate rainfall events with fluctuations in ground water elevations.

The third segment of study included a ground water pump test. From the test results, anticipated well capacity and ground water drawdown estimates were calculated. The fourth segment performed was a vapor extraction pump test. Field data was gathered and analyzed to determine the feasibility of vapor extraction at the subject site.

The analytical test results of 5 sampling events over a 4-year period were compiled. No distinguishable patterns in concentration fluctuations were observed. Of the 22 being monitored, 11 wells have consistently displayed non-detectable or near non-detectable concentrations of benzene during the existence of the well. Plume movement was not measurably detected.

Ground water elevations averaged 4 to 5 feet below grade. Elevations were observed to fluctuate as much as 8.7 feet but commonly changed in the 2 to 3 feet range. Based on climatological data obtained from the naval weather station, rainfall influenced ground water elevations greatest near the tank pit in the grassed area. Near the center of the hydrocarbon plume rainfall had a less noticeable effect.

To evaluate the vertical and horizontal extent of hydrocarbons in soil, 28 exploratory soil borings were advanced on site. Soil samples were obtained at 2 feet intervals utilizing a split-barrel sampler. Soil samples were analyzed for BTEX and TPH on-site with a field GC. Based on the soil sample test results, 5 monitoring wells were installed along the outer perimeter of the plume. Ground water test results of samples obtained 4 months after well installation did not reveal any evidence of plume migration. Soils encountered at the site were typically classified as silty clays and silt. Vertical soil permeabilities, determined by laboratory testing, ranged from 4.8×10^{-7} to 4.13×10^{-7} cm/s. Horizontal permeabilities ranged from 1×10^{-6} to 3.4×10^{-7} cm/s. TPH concentration contour maps were developed for soil at 2 feet intervals from 2 to 12 feet below grade. Hydrocarbon concentrations were detected across more than half of the site. The highest TPH concentrations were typically observed at the 6 to 8 feet interval near the pipe leak at monitoring well MEM-757-

2. Another area displaying high TPH concentrations was identified around the active tank pit area. A third area displaying high concentrations of TPH was near building 341 and adjacent to Old Navy Road. A review of old site plans indicate 3 UST's were abandoned in place in this area 21 years ago. It is not known if these tanks were removed during subsequent road construction activities.

A ground water pump test was performed to determine the hydraulic characteristics of the aquifer at subject site. The test results indicated that calculated transmissivities and storativities ranged from 0.003504 to 0.001933 ft^2/min. and 0.0113 to 0.00212 ft^2/min. respectively. Calculations projected 5.4 feet of drawdown at 2 feet from a 6-inch diameter well, screened 30 feet into the unconfined aquifer, pumping at a rate of 0.37 gpm.

An option considered for the remediation of soils contaminated with gasoline is vapor extraction. A series of air pump tests at high, medium, and low vacuum pressures with select observation wells closed then opened was performed. Well MEM-757-12, the same 6-inch well used for pumping in the ground water pump test, was used as a vapor extraction well. Also, well MEM-757-14, a 4-inch diameter well, was used as an extraction point in a second series of tests. Both extraction wells and the 2 nearest observation wells were equipped with well seals and ground water pumps to expose as much soil to venting as possible. Extraction well head pressures, vapor recovery flow rates, and monitoring well pressures were recorded and used to develop design variables for a remedial system, should vapor extraction be determined applicable.

Subsurface soil temperature at depths of 3.7, 7.7, and 16.5 feet below surface grade averaged 81,71, and 67°F respectively. Temperature, barometric pressure, and static pressures within the observation wells (no vacuum applied) were reviewed. No distinct pattern in fluctuations was correlated. Therefore, observation well pressure readings were not corrected.

Flow rates observed during the tests were higher than expected and required correction. Maximum sustained flow rates for the 6-inch and 4-inch diameter wells were 8.6 and 7.1 scfm at 90 and 100 inches of water yielding 4.2 and 8.6 feet radii of influences respectively. The larger radius of influence calculated for MEM-757-14 was attributed to the irregular saturated soil profile around the extraction wells.

Calculations derived from the ground water pump test indicate desaturating the soil zone, most highly concentrated with petroleum hydrocarbons, sufficiently to utilize vacuum extraction would require approximately 1,100 ground water recovery wells. Installation and maintenance costs incurred with a ground water recovery and vacuum extraction system of this complexity prevents vacuum extraction from being a practical remedial option.

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SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A1 LOG OF WELL NO. NA

Depth (ft)	MATERIAL DESCRIPTION
.2	ASPHALT
1.6	SILT GRAY & BROWN
3.2	CLAY, SILTY, GRAY
4.6	CLAY SILTY, GRAY & BROWN WET WITH PETROLEUM ODOR
5.6	CLAY, BROWN, WITH PETROLEUM ODOR
6.3	CLAY, SILTY GRAY & BROWN WITH PETROLEUM ODOR
7.3	SILT GRAY WITH PETROLEUM ODOR
10.2	SILT GRAY & BROWN WITH PETROLEUM ODOR
21.2	SILT GRAY & BROWN NO ODOR
23.2	SILT, GRAY
	TERMINATED @ 23.2

Column headings: DEPTH IN FEET (scale 5, 10, 15, 20, 25) | SYMBOL | SAMPLES (LAB) | MATERIAL DESCRIPTION | WELL CONSTRUCTION

Boring Completion Date: MAY 31, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vaccum Extraction Study and Remedial Investigation NAS Memphis, Tn July, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A2 LOG OF WELL NO. NA

DEPTH (FT)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.2	ASPHALT	
1.6	SILT GRAY & BROWN	
3.2	CLAY, SILTY, GRAY	
4.6	CLAY SILTY, GRAY & BROWN WET WITH PETROLEUM ODOR	
5.6	CLAY, BROWN, WITH PETROLEUM ODOR	
6.3	CLAY, SILTY GRAY & BROWN WITH PETROLEUM ODOR	
7.3	SILT GRAY WITH PETROLEUM ODOR	
10.2	SILT GRAY & BROWN WITH PETROLEUM ODOR	
21.2	SILT GRAY & BROWN NO ODOR	
23.2	SILT, GRAY	
	TERMINATED @ 23.2	

Depth scale: 5, 10, 15, 20, 25. Columns: DEPTH IN FEET, SYMBOL, SAMPLES (LAB).

Boring Completion Date: MAY 31, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vaccum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

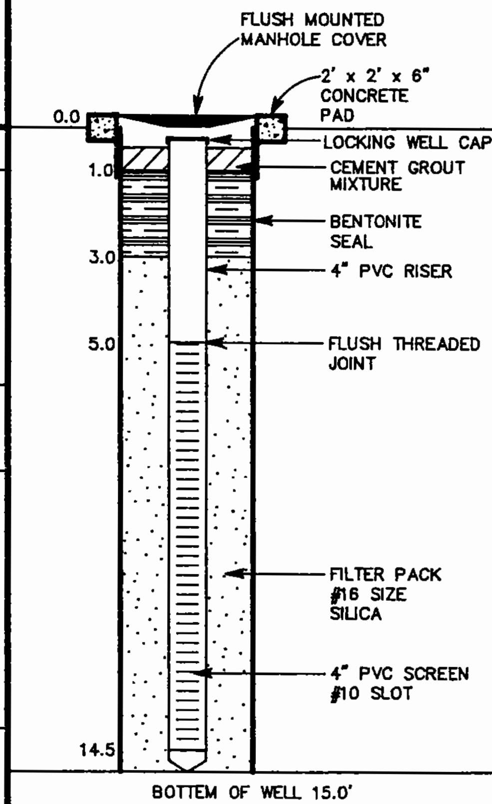
LOG OF BORING NO. A3 LOG OF WELL NO. MEM 757-17

MATERIAL DESCRIPTION

DEPTH IN FEET	MATERIAL DESCRIPTION
0.0 – 1.0	TOPSOIL
1.0 – 6.0	CLAY SILTY BROWN
6.0 – 8.0	CLAY SILTY BROWN
8.0 – 14.0	SILT GRAY BROWN
14.0 – 19.0	SILT OCCASIONAL GRAVEL
19.0 – 21.0	SILT GRAY

TERMINATED @ 21.0

WELL CONSTRUCTION



Boring Completion Date: MAY 31, 1990

Well Completion Date: JUNE 13, 1990

Well Development Date: JUNE 14, 1990

Drilling Method: AUGER

Depth to Water: ≈ 4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring / Well Log

Vacuum Extraction Study
and Remedial Investigation
NAS Memphis, Tn
November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

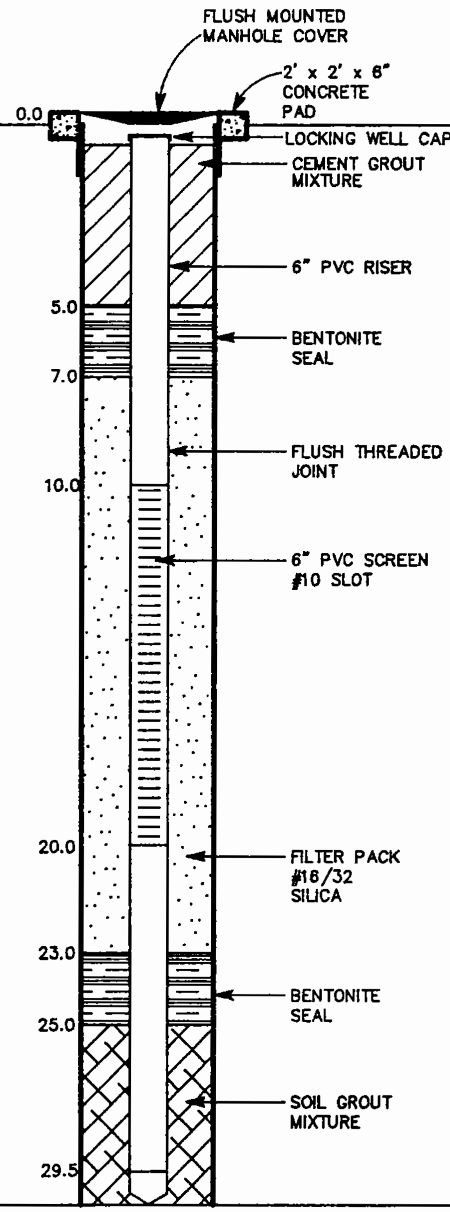
LOG OF BORING NO. A4 LOG OF WELL NO. MEM-757-12

MATERIAL DESCRIPTION

DEPTH IN FEET	MATERIAL DESCRIPTION
0.0–.3	ASPHALT
.3–1.0	GRAVEL
1.0–4.2	CLAY SILTY GRAY PETROLEUM ODOR
4.2–5.7	CLAY BROWN PETROLEUM ODOR
5.7–9.9	CLAY SILTY GRAY STRONG PETROLEUM ODOR
9.9–19.6	SILT GRAY BROWN ODOR
19.6–23.0	SILT GRAY NO ODOR
23.0–30.0	SILT CLAYEY GRAY

TERMINATED @ 30.0

WELL CONSTRUCTION



BOTTOM OF WELL 30.0'

Boring Completion Date: MAY 31, 1990
Well Completion Date: JUNE 1, 1990
Well Development Date: JUNE 2, 1990
Drilling Method: AUGER
Depth to Water: ≈ 4.0'

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

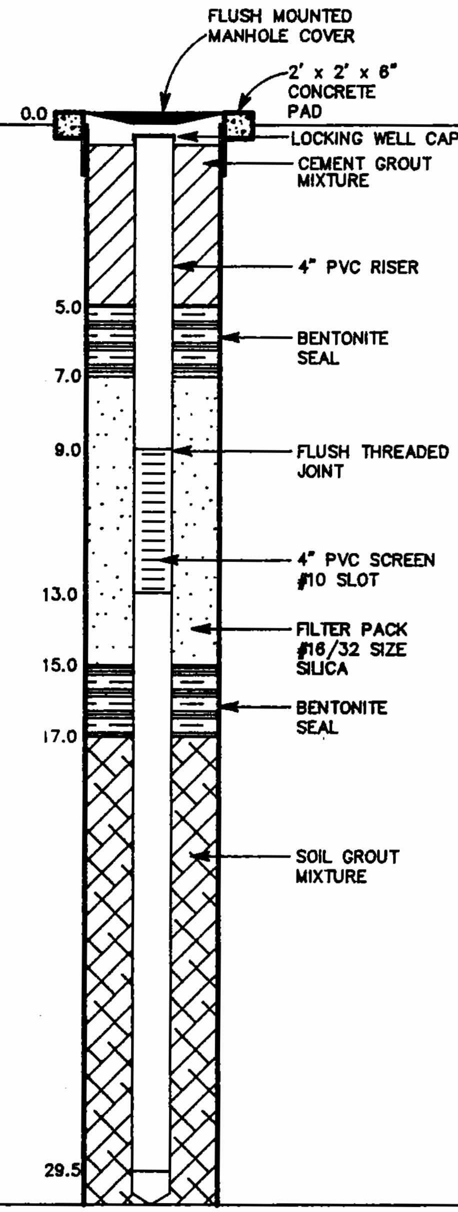
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A5 LOG OF WELL NO. MEM-757-13

DEPTH IN FEET	MATERIAL DESCRIPTION
0.0–.2	ASPHALT
.2–1.0	GRAVEL
1.0–5.0	CLAY SILTY GRAY WITH PETROLEUM ODOR
5.0–10.1	SILT GRAY PETROLEUM ODOR
10.1–20.0	SILT GRAY BROWN NO ODOR
20.0–30.0	SILTY CLAYEY GRAY NO ODOR
30.0	TERMINATED @ 30.0

WELL CONSTRUCTION



Boring Completion Date: JUNE 1, 1990

Well Completion Date: JUNE 1, 1990

Well Development Date: JUNE 2, 1990

Drilling Method: AUGER

Depth to Water: ≈ 4.0'

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring / Well Log

Vacuum Extraction Study
and Remedial Investigation
NAS Memphis, Tn
November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A6 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.2			ASPHALT	
.5			GRAVEL	
5.8			CLAY SILTY GRAY NO ODOR	
6.5			CLAY SILTY BROWN	
19.5			SILT GRAY–BROWN	
21.0			SILT CLAYEY GRAY	
			TERMINATED ● 21.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 4, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation Nas Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A7 LOG OF WELL NO. MEM-757-14

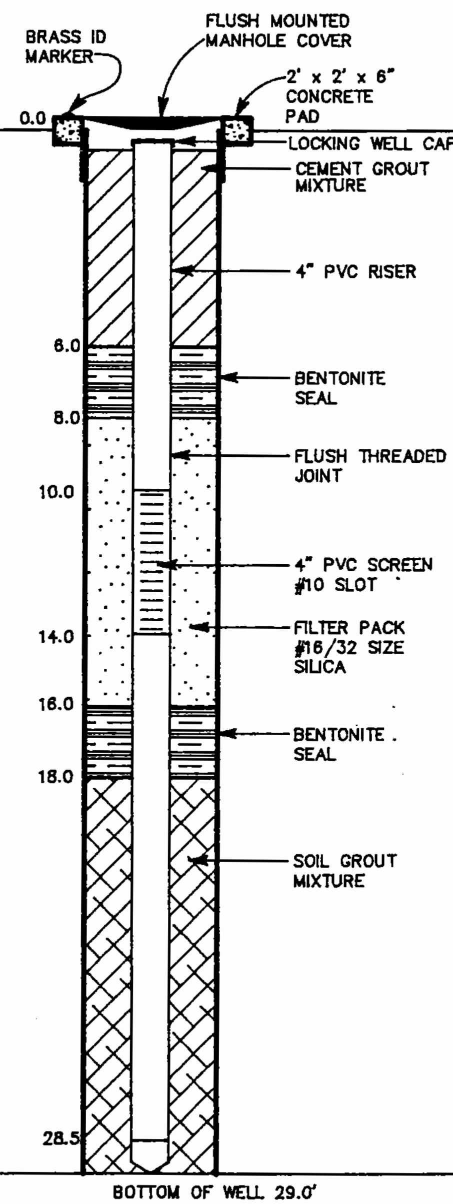
MATERIAL DESCRIPTION

Depth in feet (bottom)	Material Description
.3	ASPHALT
.5	GRAVEL
6.5	CLAY SILTY GRAY PETROLEUM ODOR
10.1	SILT GRAY PETROLEUM ODOR
13.0	SILT GRAY BROWN PETROLEUM ODOR
19.0	SILT GRAY BROWN NO ODOR
29.0	SILT GRAY

TERMINATED @ 29.0

Columns: DEPTH IN FEET (5, 10, 15, 20, 25, 30) | SYMBOL | SAMPLES (LAB)

WELL CONSTRUCTION



BOTTOM OF WELL 29.0'

Boring Completion Date: JUNE 4, 1990
Well Completion Date: JUNE 4, 1990
Well Development Date: JUNE 4, 1990
Drilling Method: AUGER
Depth to Water: ≈4.0'

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A8 LOG OF WELL NO. N/A

DEPTH IN FEET	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.2	ASPHALT	
.5	GRAVEL	
1.6	CLAY SILTY GRAY	
6.0	SILT CLAYEY BLUE GRAY PETROLEUM ODOR	
8.0	SILT CLAYEY BLUE GRAY TO BROWN STRONG PETROLEUM ODOR	
10.0	SILT GRAY–BROWN STRONG PETROLEUM ODOR	
12.0	SILT GRAY–BROWN TO BROWN SLIGHT PETROLEUM ODOR	
18.5	SILT GRAY–BROWN TO BROWN NO ODOR	
21.0	SILT GRAY	
	TERMINATED @ 21.0	

Depth scale: 5, 10, 15, 20, 25. Columns: SYMBOL, SAMPLES (LAB).

Boring Completion Date: JUNE 4, 1990

Well Completion Date: N/A

Well Development Date: N/A

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A9 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.2			ASPHALT	
.5			GRAVEL	
1.0			CLAY, GRAVEL GRAY	
3.0			CLAY SILTY GRAY	
5.0			CLAY SILTY BLUE-GREEN SLIGHT PETROLEUM ODOR	
7.0			CLAY SILTY BLUE-GREEN STRONG PETROLEUM ODOR	
9.2			SILT CLAYEY GRAY-BROWN TO BROWN SLIGHT PETROLEUM ODOR	
19.3			SILT GRAY-BROWN	
25.0			SILT GRAY	
			TERMINATED @ 25.0	

Boring Completion Date: JUNE 4, 1990

Well Completion Date: N/A

Well Development Date: N/A

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A10 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.3			TOPSOIL CLAY SILTY BROWN	
2.3–6.0	▼		SILT CLAYEY BROWN-GRAY	
6.0–10.0			SILT CLAYEY BROWN-GRAY	
10.0–14.0			SILT CLAYEY BROWN-GRAY	
14.0–21.0			SILT BROWN-GRAY	
21.0			TERMINATED @ 21.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 5, 1990

Well Completion Date: N/A

Well Development Date: N/A

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A11 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY BROWN (2.0)	
2.0–4.7	▼		SILT CLAYEY BROWN (4.7)	
4.7–8.0			SILT CLAYEY BROWN-GRAY (8.0)	
8.0–18.1			SILT BROWN-GRAY PETROLEUM ODOR (18.1)	
18.1–24.0			SILT GRAY PETROLEUM ODOR (24.0)	
24.0–26.0			SILT DARK GRAY (26.0)	
			TERMINATED @ 26.0	

Boring Completion Date: JUNE 5, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈ 4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A12 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY BROWN (2.0)	
2.0–4.0			SILT CLAYEY BROWN (4.0)	
4.0–8.0			SILT CLAYEY BROWN-GRAY (8.0)	
8.0–10.0			SILT CLAYEY BROWN-GRAY (10.0)	
10.0–14.0			SLT CLAYEY BROWN-GRAY (14.0)	
14.0–26.0			SILT GRAY (26.0)	
			TERMINATED @ 26.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 5, 1990	Boring Diameter: 6.25"
Well Completion Date: N/A	Ground Elevation:
Well Development Date: N/A	Top of Casing Elevation:
Drilling Method: AUGER	Driller: A. DAVIS
Depth to Water: ≈ 4.0	Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A13 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY BROWN	
2.0–4.0			SILT CLAYEY BROWN	
4.0–6.0 (5)			SILT CLAYEY BROWN-GRAY	
6.0–8.0			SILT CLAYEY BROWN-GRAY PETROLEUM ODOR	
8.0–10.0 (10)			SILT BROWN-GRAY PETROLEUM ODOR	
10.0–12.0			SILT BROWN-GRAY NO ODOR	
12.0–19.7 (15)			SILT GRAY-BROWN	
19.7–21.0 (20)			SILT GRAY	
			TERMINATED @ 21.0	
25				

Boring Completion Date: JUNE 5, 1990

Well Completion Date: N/A

Well Development Date: N/A

Drilling Method: AUGER

Depth to Water: ≈ 4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation
NAS Memphis, Tn
November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

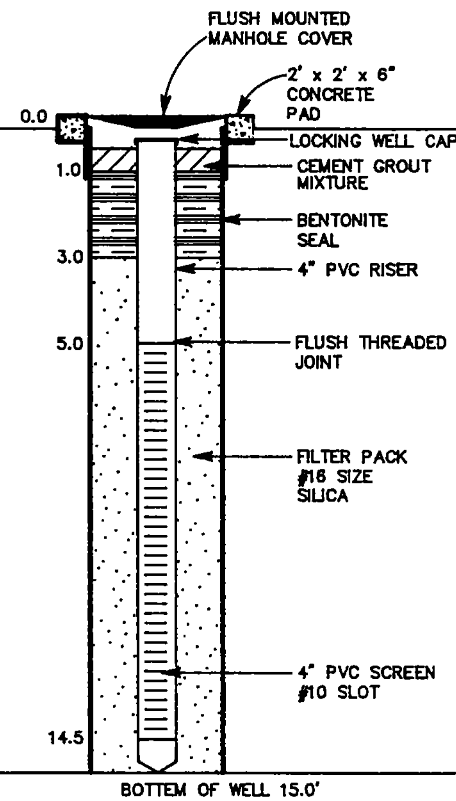
LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A14 LOG OF WELL NO. MEM 757-16

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION
0.0–1.0			TOPSOIL CLAY SILTY BROWN
1.0–3.1			CLAY SILTY BROWN
3.1–6.0			SILT CLAYEY BROWN-GRAY
6.0–8.0			SILT BROWN-GRAY
8.0–18.2			SILT BROWN-GRAY
18.2–21.0			SILT GRAY
21.0			TERMINATED @ 21.0

Depth scale: 5, 10, 15, 20, 25

WELL CONSTRUCTION



Boring Completion Date: JUNE 5, 1990

Well Completion Date: JUNE 13, 1990

Well Development Date: JUNE 14, 1990

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring / Well Log

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A15 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3			ASPHALT	
.5			GRAVEL	
1.0			SILT CLAYEY GRAY PETROLEUM ODOR	
3.0			SILT CLAYEY GRAY PETROLEUM ODOR	
7.0			SILT CLAYEY GRAY PETROLEUM ODOR	
9.0			SILT CLAYEY BROWN-GRAY PETROLEUM ODOR	
18.0			SILT CLAYEY BROWN-GRAY SLIGHT PETROLEUM ODOR	
20.0			SILT GRAY	
			TERMINATED @ 20.0	

Boring Completion Date: JUNE 5, 1990

Well Completion Date: N/A

Well Development Date: N/A

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

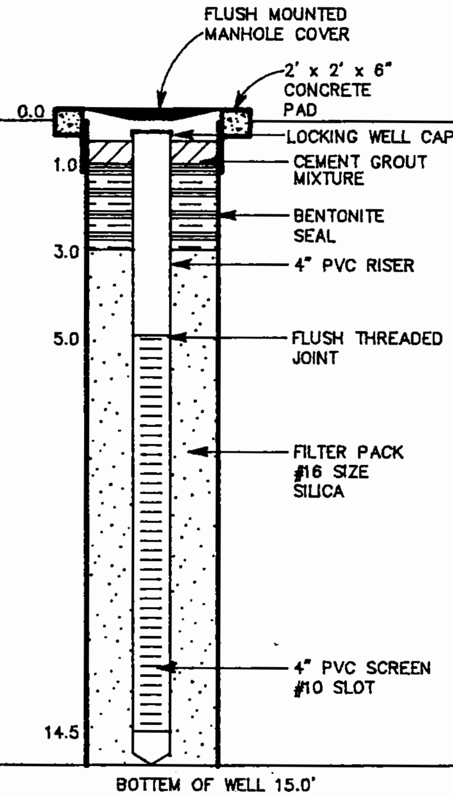
LOG OF BORING NO. A16 LOG OF WELL NO. MEM 757-15

MATERIAL DESCRIPTION

Depth (ft)	Material Description
.3	ASPHALT
.5	GRAVEL
1.0	SILT CLAYEY GRAY
7.0	SILT CLAYEY GRAY-BROWN
9.0	SILT CLAYEY GRAY-BROWN
15.0	SILT CLAYEY GRAY-BROWN
21.0	SILT GRAY

TERMINATED @ 21.0

WELL CONSTRUCTION



Boring Completion Date: JUNE 5, 1990

Well Completion Date: JUNE 13, 1990

Well Development Date: JUNE 14, 1990

Drilling Method: AUGER

Depth to Water: ≈4.0

Boring Diameter: 6.25"

Ground Elevation:

Top of Casing Elevation:

Driller: A. DAVIS

Logged by: C. RUTHERFORD

Soil Boring / Well Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A17 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3			ASPHALT	
.5			GRAVEL	
1.0			CLAY SILTY REDDISH-BROWN	
5.7			SILT CLAYEY GRAY, PETROLEUM ODOR	
13.0			SILT BROWN AND GRAY, PETROLEUM ODOR	
18.0			SILT BROWN-GRAY NO ODOR	
20.0			SILT GRAY	
			TERMINATED @ 20.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 6, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation
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November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A18 LOG OF WELL NO. N/A

DEPTH IN FEET	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3	ASPHALT	
.5	GRAVEL	
1.0	CLAY SILTY REDDISH-BROWN	
3.0	SILT CLAYEY GRAY, PETROLEUM ODOR	
9.0	SILT CLAYEY GRAY-BROWN, PETROLEUM ODOR	
11.0	SILT GRAY-BROWN SLIGHT PETROLEUM ODOR	
18.0	SILT GRAY-BROWN NO ODOR	
20.0	SILT GRAY	
	TERMINATED @ 20.0	

Columns: DEPTH IN FEET (5, 10, 15, 20, 25), SYMBOL, SAMPLES (LAB)

Boring Completion Date: JUNE 6, 1990	Boring Diameter: 6.25"
Well Completion Date: N/A	Ground Elevation:
Well Development Date: N/A	Top of Casing Elevation:
Drilling Method: AUGER	Driller: A. DAVIS
Depth to Water: ≈4.0	Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A19 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3			ASPHALT	
.5			GRAVEL	
1.0			SILT CLAYEY GRAY SLIGHT PETROLEUM ODOR	
3.0			SILT CLAYEY GRAY PETROLEUM ODOR	
5.0	▼		SILT CLAYEY GRAY-BROWN PETROLEUM ODOR	
7.0			SILT CLAYEY GRAY-BROWN STRONG PETROLEUM ODOR	
9.0			SILT CLAYEY GRAY-BROWN STRONG PETROLEUM ODOR	
18.0			SILT CLAYEY GRAY-BROWN NO ODOR	
20.0			SILT GRAY	
			TERMINATED @ 20.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 6, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈ 4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A20 LOG OF WELL NO. N/A

DEPTH IN FEET	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3	ASPHALT	
.5	GRAVEL	
1.0	SILT CLAYEY DARK GRAY STRONG PETROLEUM ODOR	
3.0	SILT CLAYEY DARK GRAY STRONG PETROLEUM ODOR	
7.4	SILT CLAYEY GRAY STRONG PETROLEUM ODOR	
9.0	SILT GRAY-BROWN PETROLEUM ODOR	
19.3	SILT GRAY-BROWN NO ODOR	
20.0	SILT CLAYEY GRAY	
	TERMINATED @ 20.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 7, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A21 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
			.3 ASPHALT	
			.5 GRAVEL	
			SILT CLAY BLACK	
			1.0	
			SILT CLAYEY BLACK	
			4.1	
5			SILT CLAYEY BROWN–GRAY	
			7.9	
10				
			SILT CLAYEY BROWN–GRAY	
15				
			18.0	
			TERMINATED @ 18.0	
20				
25				

Boring Completion Date: JUNE 07, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study
and Remedial Investigation
NAS Memphis, Tn
November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A22 LOG OF WELL NO. N/A

DEPTH IN FEET	MATERIAL DESCRIPTION	WELL CONSTRUCTION
.3	ASPHALT	
.5	GRAVEL	
1.0	SILT CLAY DARK GRAY ODOR	
3.0	SILT CLAYEY DARK GRAY PETROLEUM ODOR	
5.0	SILT CLAYEY DARK GRAY SLIGHT ODOR	
8.5	SILT CLAYEY DARK GRAY SLIGHT ODOR	
18.0	SILT BROWN AND GRAY WET	
	TERMINATED @ 18.0	

Boring Completion Date: JUNE 07, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A23 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY BROWN	
2.0–4.0			SILT CLAYEY BROWN	
4.0–6.0			SILT CLAYEY BROWN	
6.0–15.7			SILT CLAY GRAY-BROWN	
15.7–22.0			SILT GRAY WET	
22.0			TERMINATED @ 22.0	

Boring Completion Date: JUNE 8, 1990
Boring Diameter: 6.25"
Well Completion Date: N/A
Ground Elevation:
Well Development Date: N/A
Top of Casing Elevation:
Drilling Method: AUGER
Driller: A. DAVIS
Depth to Water: ≈4.0
Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation
NAS Memphis, Tn
November, 1990

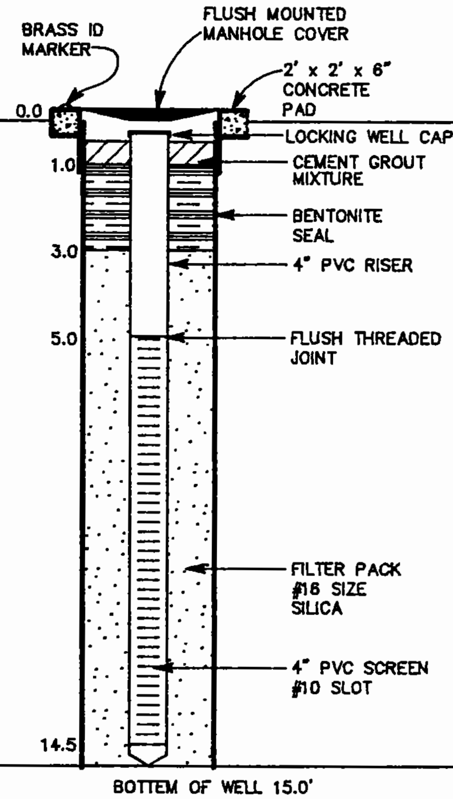
SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A24 LOG OF WELL NO. MEM-757-18

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION
0.0–2.0			TOPSOIL CLAY SILTY BROWN
2.0–4.0			SILT CLAYEY BROWN
4.0–6.0			SILT CLAYEY GRAY WET
6.0–17.0			SILT GRAY-BROWN
17.0			TERMINATED @ 17.0

WELL CONSTRUCTION



Boring Completion Date: JUNE 8, 1990
Well Completion Date: JUNE 13, 1990
Well Development Date: JUNE 14, 1990
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A25 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY WITH GRAVEL BROWN	
2.0–4.0	▼ (water at 4.0)		SILT CLAYEY BROWN	
4.0–17.0			SILT CLAYEY GRAY–BROWN	
17.0			TERMINATED @ 17.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 08, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring Log

Vacuum Extraction Study and Remedial Investigation NAS Memphis, Tn November, 1990

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A26 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY WITH GRAVEL BROWN	
2.0–4.0			SILT CLAYEY DARK BROWN	
4.0–6.0			SILT CLAYEY DARK BROWN-GRAY	
6.0–17.0			SILT BROWN--GRAY	
17.0			TERMINATED @ 17.0	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 11, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈ 4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A27 LOG OF WELL NO. N/A

DEPTH IN FEET	SYMBOL	SAMPLES (LAB)	MATERIAL DESCRIPTION	WELL CONSTRUCTION
0–2.0			TOPSOIL CLAY SILTY BROWN-GRAY (2.0)	
2.0–6.0	▼ (≈4.0)		SILT CLAYEY BROWN-GRAY (6.0)	
6.0–8.0			SILT CLAYEY BROWN-GRAY (8.0)	
8.0–10.0			SILT CLAYEY BROWN-GRAY (10.0)	
10			TERMINATED @ 10.0 ENCOUNTERED UNDERGROUND CONDUITS	

Depth scale: 5, 10, 15, 20, 25

Boring Completion Date: JUNE 11, 1990
Well Completion Date: N/A
Well Development Date: N/A
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMMAND
GROUNDWATER MONITORING WELL INSTALLATION REPORT

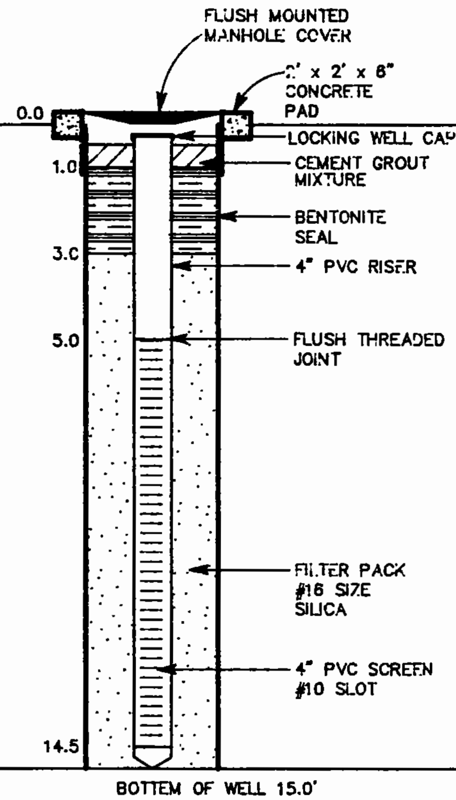
LOCATION NAVY EXCHANGE SERVICE STATION

LOG OF BORING NO. A28 LOG OF WELL NO. MEM-757-19

MATERIAL DESCRIPTION

DEPTH IN FEET	MATERIAL DESCRIPTION
0.0–2.0	TOPSOIL CLAY SILTY BROWN
2.0–5.3	SILT CLAYEY BROWN-GRAY
5.3–17.0	SILT BROWN-GRAY
17.0	TERMINATED @ 17.0

WELL CONSTRUCTION



Boring Completion Date: JUNE 11, 1990
Well Completion Date: JUNE 13, 1990
Well Development Date: JUNE 14, 1990
Drilling Method: AUGER
Depth to Water: ≈4.0

Boring Diameter: 6.25"
Ground Elevation:
Top of Casing Elevation:
Driller: A. DAVIS
Logged by: C. RUTHERFORD

Soil Boring / Well Log

Vacuum Extraction Study and Remedial Investigation
NAS Memphis, Tn
November, 1990

Professional Service Industries, Inc.

Vertical Permeability

Shelby Tube A7 7'-9' $k = 4.83 \times 10^{-7}$ cm/s LL = 46, PI = 25

Shelby Tube A5 14-16 $k = 4.13 \times 10^{-7}$ cm/s LL = 34, PI = 9

Horizontal Permeability

Shelby Tube A7 7'-9' $k = 1.0 \times 10^{-6}$ cm/s

Shelby Tube A5 14-16 $k = 3.4 \times 10^{-7}$ cm/s

Organic Content

Sample A7 ,Depth 3'-5' Organic Content = 0.9%

Bulk Density

Sample A7 ,Depth 5'-7' Dry Density = 108 pcf

Sample A5 ,Depth 14'-16' Dry Density = 101 pcf

Total Porosity

Sample A7 ,Depth 5'-7'
N = 44.3%
V_s = 55.7%
V_w = 36.0%
V_a = 8.3%

Sample A5 ,Depth 14'-16'
N = 40.7%
V_s = 59.3%
V_w = 38.3%
V_a = 2.4%

Moisture Content

Sample A5 ,Depth 14'-16' mc = 24%

Sample A7 3'- 5" mc = 22%

Sample A& 3'- 5' mc = 26%

Sample A7 5'-7' mc = 25%

Particle Size

Sample A7 ,Depth 5'-7' (see distribution curve)

Resistivity/Conductivity

Sample A7 ,Depth 3'-5' (c) 0.6 mmho/cm

7'-9' (r) 3300 ohm-cm

pH

Sample A7 ,Depth 3'-5' 7.2

4161 Ridgemoor Avenue • Memphis, TN 38118 • Phone: 901/365-1802

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
05/31/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A1/10.2-12.2	820	1000	440	180	7400
A1/8.2-10.2	40000	80000	13000	4000	380000
A1/6.2-8.2	120000	160000	19000	5400	800000
A1/4.2-6.2	23000	40000	21000	6200	200000
A1/14.2-16.2	<2	6	<2	<3	26
A1/21.2-23.2	<0.5	<0.6	<0.6	<0.7	<0.5
A2/4.5-6.5	290000	137000	68000	20000	860000
A2/6.5-8.5	1400	<40	<50	<60	3500
A2/15-17'	160	120	45	<1	590
A2/20-20.4	1200	670	670	270	4700
A2/20.4-20.8	33	25	20	<3	100
A2/2.5-4.5	21000	28000	25000	7200	150000
A1/2.2-4.2	480	460	280	<60	3200
A1/0.2-2.2	1400	320	<50	<60	3500
A1/12.2-14.2	75	90	40	<6	590
A3/2.0-4.0	<0.8	<0.9	<1	<1	<0.8
A4/5.0-7.0	175000	240000	35000	11000	1700000
A3/6.0-8.0	12	20	6	<1	86
A3/19-21'	<0.7	2	<0.8	<1	3
A2/8.5-10.5	530	<20	<24	<30	1700
A4/13-15'	8800	13500	6200	1900	89000
A4/23-25'	<4	<4	<5	<6	<4
A4/9-11'	3400	2200	1000	<60	17000

Analyzed by: S. Evans
Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
05/31/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A2/10.5-12.5	<4	<4	<5	<6	<4
A3/4-6'	<0.8	<0.9	<1	<1	<0.8
A3/8-10'	<0.5	<0.6	<0.6	<0.7	<0.5
A3/14-16'	2	3	<0.5	<0.6	6
A4/19-20'	<2	<2	<2	<3	<2
A4/11-13'	1100	<60	<60	<70	3100

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
AIR	<0.2	<0.2	<0.2	<0.3	<0.2
AIR	<0.2	<0.2	<0.2	<0.3	<0.2
Tank 1	<2	<150	11	<3	400
HS/A1	4500	7500	4500	2200	41000
HS/A2	8800	2400	9300	<60	39000
HS/A3	<2	<2	<2	<3	<2

Analyzed by: S. Evans
Proofed by:

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB\#1-90-448-0
06/01/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A4/1-3'	1600	1900	980	110	6600
A4/3-5'	1200	1500	1000	110	6600
A4/7-9'	90000	150000	33000	12000	930000
A5/2-4'	4600	6100	4200	1500	18000
A5/4.0-4.5	1300	1500	870	220	5400
A5/7-9'	2200	460	620	80	9100
A5/9-11'	2900	210	200	27	9900
A5/11-13'	50	14	5	<2	170
A5/16-18'	10	7	2	<0.7	50
A5/23-25'	0.4	0.4	<0.4	<0.5	0.8
A5/28-30'	38	34	12	4	170

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
HS/A4	22000	8100	5300	1400	71000
AIR	3	2	0.8	<0.3	25

Analyzed by: S. Evans
Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0

06/04/90

CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A6/0.5-2.5	<0.4	<0.4	<0.4	<0.6	13
A6/2.5-4.5	<0.4	<0.4	<0.4	<0.6	0.9
A6/4.5-6.5	<0.4	<0.4	<0.4	<0.6	8
A6/6.5-8.5	0.7	<0.4	<0.4	<0.6	0.7
A6/8.5-10.5	0.4	0.3	<0.3	<0.4	0.7
A6/14.5-16.5	1	1	<0.2	<0.3	2
A6/19-21'	1	0.2	<0.2	<0.3	1
A7/1-3'	8100	8800	4300	1700	35000
A7/3-5'	2200	2700	690	190	5300
A7/5-7'	200000	330000	75000	29000	2000000
A7/7-9'	9900	7200	3000	710	66000
A7/9-11'	22000	23000	14000	2000	180000
A7/11-13'	2100	110	40	<40	6900
A7/18-20'	<0.9	<0.8	<0.8	<1	<0.9
A7/23-25'	14	12	2	1	90
A7/28-30'	3	2	0.8	0.3	14

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
HS/A5	4600	1500	780	210	20000
HS/A6	<0.2	<0.2	<0.2	<0.3	<0.2
MEM757-1	63000	69000	33000	14000	340000
AIR	<0.2	<0.2	<0.2	<0.3	<0.2
AIR	0.7	1	<0.2	<0.3	15

Analyzed by: S. Evans

Checked by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/05/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A8/0-2'	7700	11000	4300	1500	60000
A8/2-4'	1100	1000	360	160	5900
A8/4-6'	88000	140000	27000	9100	780000
A8/6-8'	75000	150000	40000	15000	890000
A8/8-10'	2700	1800	1000	240	26000
A8/10-12'	80	<30	<30	<40	740
A8/12-14'	130	100	60	5	1300
A8/14-16'	<2	<2	<2	<2	6
A8/19-21'	<0.5	<0.5	<0.4	<0.6	2
A9/1-3'	220	120	<20	<20	1100
A9/3-5'	110000	190000	47000	17000	1100000
A9/5-7'	110000	210000	51000	19000	1100000
A9/7-9'	2100	800	1000	50	20000
A9/9-11'	50	40	30	4	540
A9/11-13'	4	2	<0.4	<0.5	14
A9/18-20'	<0.4	0.7	<0.4	<0.5	7
A9/23-25'	1	<0.4	<0.4	<0.5	2
A9-A/5'	5000	5300	850	<2	34000

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
2"#1-7'	100000	210000	59000	22000	1100000
2"#2-7'	140000	280000	50000	17000	1400000
COM STK PL	15000	17000	13000	4700	170000
AIR	0.4	<0.2	<0.2	<0.2	0.4
AIR	0.5	<0.2	<0.2	<0.2	1

Analyzed by: S. Evans
Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-O
06/06/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A11/0-2'	<0.4	<0.4	<0.3	<0.4	<0.4
A11/2-4'	<0.4	<0.4	<0.3	<0.4	<0.4
A11/4-6'	<0.4	<0.4	<0.3	<0.4	1
A11/6-8'	34000	46000	29000	11000	270000
A11/8-10'	19000	21000	13000	4800	140000
A11/10-12'	34000	36000	22000	7600	280000
A11/12-14'	6000	2000	2600	180	31000
A11/14-16'	1900	<25	1300	<30	9400
A11/19-21'	140	9	38	5	540
A11/24-26'	80	4	<0.8	<1	200
A11/29-31'	80	3	<0.3	<0.5	200
A10/0-2'	<1	<0.9	<0.8	<1	<1
A10/2-4'	<0.4	<0.4	<0.3	<0.5	3
A10/4-6'	<0.4	<0.4	<0.3	<0.5	<0.4
A10/6-8'	<0.4	<0.4	<0.3	<0.5	2
A10/8-10'	<0.4	<0.4	<0.3	<0.5	<0.4
A10/14-16'	96000	48000	11000	5700	310000
A10/19-21'	7400	1500	70	45	21000
A12/0-2'	30	20	3	1	180
A12/2-4'	1	<0.4	<0.4	<0.6	4
A12/4-6'	<0.5	<0.4	<0.4	<0.6	1

Analyzed by: S. Evans
Proofed by: L. Lapdarder

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/06/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A12/6-8'	<0.4	<0.4	<0.3	<0.5	2
A12/8-10'	<0.4	<0.4	<0.3	<0.5	2
A12/14-16'	<1	<0.9	<0.8	<1	<1
A12/19-21'	<0.4	<0.4	<0.3	<0.5	3
A13/0-2'	<0.4	<0.4	<0.3	<0.5	1
A13/2-4'	<0.4	<0.4	<0.3	<0.5	0.8
A13/4-6'	<0.4	<0.4	<0.3	<0.5	<0.4
A13/6-8'	15000	12000	11000	3300	71000
A13/8-10'	7500	6900	3000	1800	56000
A13/10-12'	3100	2000	460	60	19000
A13/12-14'	500	150	<3	<5	1900
A13/19-21'	100	<0.9	<0.8	<1	150
A14/0-2'	2	1	<0.4	<0.6	18
A14/2-4'	0.6	<0.4	<0.4	<0.6	5
A14/4-6'	0.6	<0.4	<0.3	<0.5	3
A14/6-8'	0.6	0.9	<0.3	<0.5	20
A14/8-10'	<1	<0.9	<0.8	<1	30
A14/14-16'	1	1	<0.3	<0.5	30
A14/19-21'	0.6	<0.4	<0.3	<0.5	6
A15/1-3'	2800	<36	190	<40	12000
A15/3-5'	74000	86000	35000	<40	480000

Analyzed by: S. Evans
Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0

06/06/90

CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A15/5-7'	43000	52000	20000	7100	320000
A15/7-9'	27000	33000	19000	8200	230000
A15/9-11'	2100	450	380	<40	6200
A15/11-13'	550	<4	<3	<4	1900
A15/18-20'	2	<0.9	<0.8	<1	2
A16/1-3'	<0.4	<0.4	<0.3	<0.5	11
A16/3-5'	0.8	<0.4	<0.3	<0.5	0.8
A16/5-7'	3	<0.7	<0.7	<0.9	3
A16/7-9'	2	<0.4	<0.3	<0.5	2
A16/14-16'	0.5	<0.4	<0.3	<0.5	1
A16/19-21'	1	<0.4	<0.3	<0.5	2

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
HS/A13	6500	120	1400	230	30000
WS-01	18000	5800	1400	380	57000
AIR	0.4	0.6	<0.2	<0.2	1

Analyzed by: S. Evans

Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/07/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A17/1-3'	830	280	160	<40	8100
A17/3-5'	<40	<30	<30	<40	480
A17/5-7'	13000	27000	8700	3400	160000
A17/7-9'	24000	46000	12000	4500	270000
A17/9-11'	15000	29000	7600	2800	190000
A17/11-13'	1700	2400	700	130	22000
A17/19-21'	650	800	560	300	7800
A18/1-3'	2400	2100	430	40	38000
A18/3-5'	21000	45000	12000	4600	240000
A18/5-7'	28000	59000	16000	6200	350000
A18/7-9'	22000	43000	14000	5000	290000
A18/9-11'	3700	3100	890	210	37000
A18/11-13'	1600	910	370	60	15000
A18/19-21'	<2	<2	<2	<2	<2
A19/1-3'	6	<2	<2	<2	8
A19/3-5'	10000	13000	21000	6800	100000
A19/5-7'	450000	230000	110000	49000	15000000
A19/7-9'	11000	3200	4800	530	43000
A19/9-11'	180	<20	<20	<20	630
A19/11-13'	2	<2	<2	<2	20

Analyzed by: S. Evans
Proofed by: L. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/07/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A19/18-20'	1	<0.7	<0.6	<0.8	1
A20/1-3'	1100	50	240	<30	3000
A20/3-5'	36000	84000	41000	17000	370000
A20/5-7'	23000	37000	24000	7900	270000
A20/7-9'	4	<2	<2	<2	30
A20/9-11'	1	<0.8	<0.8	<1	6
A20/11-13'	1	1	<0.4	<0.5	2
A20/18-20'	0.8	<0.3	<0.3	<0.4	0.8
A21/1-3'	<0.4	<0.3	<0.3	<0.4	<0.4
A21/5-7'	<0.4	<0.3	<0.3	<0.4	0.4
A21/16-18'	2	<0.3	<0.3	<0.4	2
A21/9-11'	<0.4	<0.3	<0.3	<0.4	<0.4
A21/16-18'	2	<0.3	<0.3	<0.4	2

SAMPLE	BENZENE ug/L	TOLUENE ug/L	ETHYL BENZENE ug/L	XYLENES ug/L	TPH ug/L
AIR	6	3	1	0.4	18

Analyzed by: S. Evans
Proofed by: L. Laplander

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/08/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A22/1-3'	60	<3	<3	<4	770
A22/3-5'	40	<3	<3	<4	430
A22/5-7'	<2	<1	<1	<2	40
A22/7-9'	<0.8	<0.7	<0.7	<0.9	5
A22/9-11'	<0.5	<0.5	<0.5	<0.6	2
A22/16-18'	<0.4	<0.4	<0.4	<0.4	5
A23/0-2'	<0.4	<0.4	<0.4	<0.4	0.7
A23/2-4'	<0.4	<0.4	<0.4	<0.4	0.4
A23/4-6'	<0.4	<0.4	<0.4	<0.4	<0.4
A23/6-8'	<0.4	<0.4	<0.4	<0.4	<0.4
A23/8-10'	<0.4	<0.4	<0.4	<0.4	<0.4
A23/15-17'	<0.4	<0.4	<0.4	<0.4	<0.4
A23/20-22'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/0-2'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/2-4'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/4-6'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/6-8'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/8-10'	<0.4	<0.4	<0.4	<0.4	<0.4
A24/15-17'	<0.3	<0.3	<0.3	<0.4	<0.3
A25/0-2'	<0.4	<0.4	<0.4	<0.4	3
A25/2-4'	0.5	<0.4	<0.4	<0.4	5

Analyzed by: S. Evans
Proofed by: S. Laplander

Tracer Research Corporation

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/08/90
CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A25/4-6'	<0.4	<0.4	<0.4	<0.4	5
A25/6-8'	<0.3	<0.3	<0.3	<0.4	4
A25/8-10'	<0.3	<0.3	<0.3	<0.4	3
A25/15-17'	<0.3	<0.3	<0.3	<0.4	3

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
BB-1	<0.06	<0.06	<0.06	<0.06	<0.06
WELL-1	24000	21000	1000	<6	250000

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Proofed by: L. Haplander

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/09/90
CONDENSED DATA

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
AIR	0.05	0.07	<0.4	<0.3	0.7
W-1	21000	23000	2400	330	135000
W-2	24000	29000	4100	780	250000
W-3	22000	22000	2300	380	220000
W-4	21000	27000	3600	670	230000
W-5	23000	27000	4200	790	260000
W-6	24000	28000	4000	760	280000
W-7	19000	18000	4700	1000	250000
W-8	18000	16000	3800	740	230000
W-9	18000	17000	3500	700	210000
W-10	24000	28000	5500	1100	240000
W-11	21000	19000	4700	1000	230000
W-12	22000	26000	3700	770	220000
W-13	21000	27000	5200	1100	260000
W-14	18000	16000	4300	960	200000
W-15	19000	18000	4500	970	190000
W-16	21000	23000	5300	1200	210000
W-17	21000	20000	4500	1000	220000
W-18	21000	25000	4500	950	220000
W-19	17000	16000	4400	980	190000
W-20	25000	31000	6000	1300	250000
W-21	19000	19000	4800	1100	210000
W-22	24000	31000	6100	1300	300000
AIR	0.6	0.3	0.2	<0.03	2

Analyzed by: S. Evans
Proofed by: L. Laplander

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ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0

06/11/90

CONDENSED DATA

SAMPLE	BENZENE ug/kg	TOLUENE ug/kg	ETHYL BENZENE ug/kg	XYLENES ug/kg	TPH ug/kg
A26/0-2'	<0.4	<0.4	<0.4	<0.5	<0.4
A26/2-4'	0.8	<0.4	<0.4	<0.5	0.8
A26/4-6'	4	<0.4	<0.4	<0.5	4
A26/6-8'	0.6	<0.4	<0.4	<0.5	0.6
A26/8-10'	6	<0.4	<0.4	<0.5	6
A26/15-17'	1	<0.4	<0.4	<0.5	2
A27/0-2'	1	0.8	<0.4	<0.5	4
A27/2-4'	4	<0.4	<0.4	<0.5	6
A27/4-6'	1	0.9	<0.4	<0.5	5
A27/6-8'	1	<0.4	<0.4	<0.5	1
A27/8-10'	0.9	<0.4	<0.4	<0.5	3
A28/0-2'	8	2	<0.3	<0.4	90
A28/2-4'	8	2	<0.3	<0.4	100
A28/4-6'	8	2	<0.3	<0.4	90
A28/6-8'	6	2	<0.3	<0.4	60
A28/8-10'	5	2	<0.3	<0.4	80
A28/15-17'	5	2	<0.3	<0.4	50

Analyzed by: S. Evans

Proofed by: L. Kaplander

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/11/90
CONDENSED DATA

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
W-23	23000	28000	5200	1200	280000
HS/A27	4	<0.2	<0.2	<0.3	5
HS/A23	<0.4	<0.4	<0.4	<0.5	<0.4
HS/A24	<0.4	<0.4	<0.4	<0.5	<0.4
W-24	30000	31000	9900	2300	310000
HS/A28	4	1	<0.3	<0.4	40
W-25	26000	26000	7500	1700	250000
HS/A8	33000	36000	23000	10000	260000
HS/A9	31000	41000	26000	11000	240000
HS/A18	93000	180000	50000	20000	1200000
W-26	22000	22000	7400	1700	200000
HS/A20	15000	20000	30000	13000	133000
HS/A22	<4	<3	<3	<4	120
HS/A16	<2	<2	<1	<2	8
AIR	0.04	<0.03	<0.04	<0.03	0.2
AIR	0.2	<0.03	<0.04	<0.03	0.2

Analyzed by: S. Evans
Proofed by: L. Laplander

ERC ENVIRONMENTAL/NAVAL AIR STATION/MEMPHIS-MILLINGTON, TENNESSEE JOB#1-90-448-0
06/12/90
CONDENSED DATA

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	TPH ug/l
AIR	0.3	0.4	0.2	<0.03	1
DISCHARGE	<0.8	<0.8	<1	<1	<0.8
W-27	25000	23000	5400	1300	250000
W-28	28000	28000	6800	1400	270000
EXT WELL	20000	15000	7400	2500	56000
W-29	24000	25000	7000	1600	240000
W-30	26000	28000	7400	1700	26000
AIR	0.8	0.6	<0.04	<0.03	4
06/13/90					
AIR	0.08	0.09	<0.03	<0.03	0.2
W-31	22000	24000	7000	1800	220000
W-32	27000	28000	7700	2000	270000
W-33	21000	22000	6000	1500	210000
AIR	<0.03	<0.03	<0.03	<0.03	0.05

Analyzed by: S. Evans
Proofed by: L. Laplander

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Client: THE EDGE GROUP
05145

Lab I.D.#: 90-2602-1
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-1 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	10	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-2
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-2 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	4	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-3
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-3 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	17	1
XYLENE	PPB	BDL	2

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-4
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-4 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	17	1
XYLENE	PPB	BDL	2

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-5
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-5 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	840	10
ETHYL BENZENE	PPB	150	10
TOLUENE	PPB	220	10
XYLENE	PPB	720	20

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Lab I.D.#: 90-2602-6
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-6 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	31	1
XYLENE	PPB	BDL	2

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-7
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-7 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	120	10
ETHYL BENZENE	PPB	BDL	10
TOLUENE	PPB	BDL	10
XYLENE	PPB	80	20

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-8
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0509-8 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	130	10
ETHYL BENZENE	PPB	BDL	10
TOLUENE	PPB	BDL	10
XYLENE	PPB	BDL	20

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Lab I.D.#: 90-2602-9
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-1   Sample Date: 05/09-10   Time: VARIOUS

BETX   BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	3600	100
ETHYL BENZENE	PPB	100	10
TOLUENE	PPB	500	10
XYLENE	PPB	650	20

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Lab I.D.#: 90-2602-10
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-2 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	926000	10000
ETHYL BENZENE	PPB	25000	10000
TOLUENE	PPB	115000	10000
XYLENE	PPB	80000	10000

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-11
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-3 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	830	10
ETHYL BENZENE	PPB	100	10
TOLUENE	PPB	350	10
XYLENE	PPB	410	20

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-12
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-4 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	1500	10
ETHYL BENZENE	PPB	140	10
TOLUENE	PPB	450	10
XYLENE	PPB	570	20

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-13
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-5 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	830	10
ETHYL BENZENE	PPB	230	10
TOLUENE	PPB	50	10
XYLENE	PPB	260	20

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-14
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-6 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	700	10
ETHYL BENZENE	PPB	40	10
TOLUENE	PPB	360	10
XYLENE	PPB	450	20

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Client: THE EDGE GROUP
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Lab I.D.#: 90-2602-15
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-7 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	250	10
ETHYL BENZENE	PPB	1200	100
TOLUENE	PPB	2200	100
XYLENE	PPB	13000	200

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Client: THE EDGE GROUP
05145

Lab I.D.#: 90-2602-16
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-8 Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	520	10
ETHYL BENZENE	PPB	107	10
TOLUENE	PPB	570	10
XYLENE	PPB	1250	20

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Client: THE EDGE GROUP
05145

Lab I.D.#: 90-2602-17
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0510-9   Sample Date: 05/09-10   Time: VARIOUS

BETX   BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	490	10
ETHYL BENZENE	PPB	70	10
TOLUENE	PPB	540	10
XYLENE	PPB	1170	20

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Client: THE EDGE GROUP
05145

Lab I.D.#: 90-2602-18
Order Date: 05/11/90
Sampled By: B.D./C.R.

Sample Site: NAS MEMPHIS, TN
Sample Type: WATER

Sample ID.: TRIP BLANK Sample Date: 05/09-10 Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-1
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0615-1
Sample Date: 06/15/90
Time: 1200

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-2
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0615-2 Sample Date: 06/15/90 Time: 1200

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-3
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0615-3 Sample Date: 06/15/90 Time: 1200

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-4
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0615-4 Sample Date: 06/15/90 Time: 1200

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-5
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: GROUNDWATER

Sample ID.: 0615-5 Sample Date: 06/15/90 Time: 1200

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
05145

Lab I.D.#: 90-3404-6
Order Date: 06/19/90
Sampled By: C RUTHERFORD

Sample Site: MEMPHIS, TN
Sample Type: WATER

Sample ID.: TRIP BLANK   Sample Date: 06/15/90   Time: 1200

BETX   BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	1
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-1
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 109901 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE, ETHYLBENZENE, TOLUENE, XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE
Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-2
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 109904 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE, ETHYLBENZENE, TOLUENE, XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-3
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 109906 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	7	5
XYLENE	PPB	BDL	2

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Client:	E R C E-NASHVILLE	Lab I.D.#:	90-6209A-4
		Order Date:	10/13/90
Project Number:	A472-007	Sampled By:	B.D. / E.D.
Project Name:	NEX MEMPHIS		
Sample Site:	NEX MEMPHIS		
Sample Type:	GROUNDWATER		

Sample ID.: 1010904 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-5
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1010906 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-6
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1010908 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-7
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 10109010 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-8
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10109012 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	3	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	9	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-9
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 10109014 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-10
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1011902 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-11
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1011904 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-12
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1011906 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	600	100
ETHYL BENZENE	PPB	1350	10
TOLUENE	PPB	60	50
XYLENE	PPB	630	20

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Client: E R C E-NASHVILLE
Lab I.D.#: 90-6209A-13
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1011908 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	5	1
ETHYL BENZENE	PPB	3	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	3	2

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Client: E R C E-NASHVILLE
Lab I.D.#: 90-6209A-14
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10119010 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	200	100
ETHYL BENZENE	PPB	1100	100
TOLUENE	PPB	1200	500
XYLENE	PPB	9500	200

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Client: E R C E-NASHVILLE
Lab I.D.#: 90-6209A-15
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10119012 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	5100	100
ETHYL BENZENE	PPB	1100	100
TOLUENE	PPB	1900	500
XYLENE	PPB	4700	200

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-16
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10119014 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	5800	100
ETHYL BENZENE	PPB	400	100
TOLUENE	PPB	2900	500
XYLENE	PPB	2700	200

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-17
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10119016 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	430	10
ETHYL BENZENE	PPB	140	10
TOLUENE	PPB	BDL	50
XYLENE	PPB	50	20

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Client: E R C E-NASHVILLE
Lab I.D.#: 90-6209A-18
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10119018 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE, ETHYLBENZENE, TOLUENE, XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	190	10
ETHYL BENZENE	PPB	160	10
TOLUENE	PPB	BDL	50
XYLENE	PPB	360	20

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Client: E R C E-NASHVILLE

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-19
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 1012903 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	6500	100
ETHYL BENZENE	PPB	700	100
TOLUENE	PPB	2100	500
XYLENE	PPB	2000	200

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Client: E R C E-NASHVILLE
Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-20
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 1012905 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	21000	1000
ETHYL BENZENE	PPB	2000	1000
TOLUENE	PPB	14000	5000
XYLENE	PPB	11000	2000

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-21
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 1012907 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	6100	100
ETHYL BENZENE	PPB	500	100
TOLUENE	PPB	800	500
XYLENE	PPB	1500	200

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Client: E R C E-NASHVILLE

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Lab I.D.#: 90-6209A-22
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Sample ID.: 1012909 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	11000	1000
ETHYL BENZENE	PPB	BDL	1000
TOLUENE	PPB	6000	5000
XYLENE	PPB	6000	2000

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-23
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: 10129011 Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	11000	1000
ETHYL BENZENE	PPB	1300	1000
TOLUENE	PPB	4000	5000
XYLENE	PPB	5000	2000

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Client: E R C E-NASHVILLE

Lab I.D.#: 90-6209A-24
Order Date: 10/13/90
Sampled By: B.D. / E.D.

Project Number: A472-007
Project Name: NEX MEMPHIS
Sample Site: NEX MEMPHIS
Sample Type: GROUNDWATER

Sample ID.: TRIP Sample Date: VARIOUS Time: VARIOUS

BETX BENZENE,ETHYLBENZENE,TOLUENE,XYLENE

Parameter	Units	Result	Detection Limit
BENZENE	PPB	BDL	1
ETHYL BENZENE	PPB	BDL	1
TOLUENE	PPB	BDL	5
XYLENE	PPB	BDL	2

end of report

DATE	TIME	WELL #		VACUUM (in H2O)	FLOW (vel) (fps)	APPROX FLOW (rate) (scfm)	TEMP (degree F)
				TEST RUN			
5-9-90	9:51						
	11:20	EXT	12	120			
	11:24		1	0.96			
	11:29		3	0			
	11:31		7	0			
	11:33		8	0.04			
	11:35	EXT	12	98			
	11:35	EXT	12				85.1
	11:37	T1,T2,T3					67.8,70.5.78.4
	11:48		1	1.35			
	11:49		13	1.4			
	11:50		14	2.5			
	11:51		142	nr			
	11:52	EXT	12	98			
	11:58		3	1.1			
	11:59		7	0.035			
	12:01		8	0.03			
				HIGH CLOSED			
	20:24	EXT	12				77.5
	20:26	T1.T2,T3					67.6.70.5.77.5
	20:32		14	2.3			
	20:32		13	1.25			
	20:34		142	0.06			
	20:35	EXHAUST			*550*		
	20:36		1	1.4			
	20:38		3	0.39			
	20:39		7	0.04			
	20:41		8	0.09			
	20:56	EXT	12	94			
	20:57	T1.T2,T3					67.2.70.1.78.2
	21:00		13	1.8			
	21:00		14	3.6			
	21:03		142	0.07			
	21:04		1	1.7			
	21:05	EXHAUST			*600*		
	21:06		3	0.67			
	21:07		7	0.06			
	21:09		8	0.08			
	21:10		2	0.08			
	21:24	EXT	12	93			
	21:24		14	4.25			
	21:25		13	2			
	21:28		142	0.14			
	21:29		1	1.9			
	21:31		3	0.79			
	21:32		7	0.04			
	21:34		8	0.08			
	21:35	EXHAUST			*600*		
	21:36		2	1.6			
	21:40		84	0			
	21:42	EXT	12	93			
	21:42	T1.T2,T3					67.2,70.1.78.2

	21:54	EXT	12	93		
	21:55		14	4.7		
	21:56		13	2.2		
	21:58		142	0.11		
	21:59		1	2		
	22:00		3	0.84		
	22:01		7	0.03		
	22:02		8	0.08		
	22:03		2	2.75		
	22:05	EXHAUST			*600*	
	22:27	EXT	12	94		
	22:28		14	5.3		
	22:29		13	2.3		
	22:31		142	0		
	22:32		1	2.15		
	22:33		3	0.93		
	22:34		7	0.035		
	22:35	EXHAUST			*500*	
	22:36		8	0.06		
	22:36		2	2		
	22:38		B4	0		
	22:38	BAROMETER				
	22:40	EXHAUST				72.8
	22:42	T1.T2.T3				67.1.69.8.78.2
	22:43	PAVEMENT				80.4
	23:05	EXHAUST			*500*	
	23:12	EXT	12	95		
	23:12		14	5.1		
	23:13		13	2.35		
	23:18		142	0.13		
	23:13		1	2.2		
	23:19		3	0.95		
	23:20		7	0.03		
	23:22		8	0.06		
	23:16		2	2.1		
	23:22	BAROMETER				
	23:35	EXHAUST			*500*	
	23:45	EXT	12			72.3
	23:46	T1.T2.T3				67.1.69.9./8.2
	23:46	PAVEMENT				80.2
	23:50		14	5.9		
	23:50		13	2.5		
	23:51		1	2.25		
	23:52		3	1		
	23:53		2	2.15		
	23:55		7	0.02		
	23:56		142	0.065		
	23:59		8	0.07		
2-10-90	00:05	EXHAUST			*400*	
	00:35	EXT	12	96		
	00:35	EXHAUST			*375*	
	00:36		14	5.9		
	00:36		13	2.4		
	00:37		1	2.15		
	00:38		3	0.95		
	00:40		7	0.035		

00:43		8	0.07			
00:38		2	2.2			
00:41		142	0.09			
00:45	EXT	12	97			
00:46	T1,T2,T3					67.1,69.9,78.2
1:05	EXHAUST			*400*		
1:33		14	5.8			
1:33	EXT	12	98			
1:33		13	2.4			
1:34		1	2.3			
1:35		3	1			
1:35		2	2.3			
1:35	EXHAUST			*375*		
1:37		142	0.06			
1:38		7	0.04			
1:39		8	0.06			
2:05	EXHAUST			*325*		
2:23	EXT	12	99			
2:23		14	4.6			
2:24		13	2.2			
2:25		1	2			
2:26		3	1			
2:27		2	2.25			
2:32		142	0.125			
2:33		7	0.035			
2:35		8	0.05			
2:35	EXHAUST			*325*		
2:36	EXT	12				71.7
2:36	T1.T2,T3					67.1.69.9.78.4
2:37	ASPHALT					76.1
2:38	BAROMETER					
3:05	EXHAUST			*300*		
3:07		14	4.65			
3:07		13	2.15			
3:08		1	1.9			
3:08		3	1			
3:09		2	2.3			
3:11		142	0.145			
3:12		8	0.055			
3:13		7	0.04			
3:14	EXT	12	100			

MEDIUM CLOSED

3:22	EXT	12	60			
3:23		14	3.4			
3:23		13	1.5			
3:24		1	1.4			
3:24		2	2.2			
3:25		142	0.16			
3:25	EXHAUST			190.6	9.36	
3:28		3	1			
3:29		7	0.035			
3:30		8	0.05			
3:35	EXHAUST			190.6	9.36	
3:36	EXT	12	60			
3:36		14	3.15			
3:36		13	1.5			

3:37		1	1.45			
3:37		3	1			
3:37		2	2.2			
3:39		142	0.18			
3:40		8	0.04			
3:42		7	0.05			
3:44		B4	0			
3:45	BAROMETER					
3:50	AMBIENT					77
3:58		14	2.85			
3:58		13	1.95			
3:59		1	1.25			
3:59		3	0.9			
4:00		2	2.1			
4:04		7	0.06			
4:01		142	0.13			
4:02		8	0.045			
4:05	EXT	12	60			
4:05	EXHAUST			190.6	9.36	
4:35	EXHAUST			190.6	9.36	
4:36		14	0.8			
4:36		13	1.4			
4:37		1	1.25			
4:37		2	2.1			
4:38		142	0.1			
4:39		8	0.05			
4:43		3	1			
4:41		7	0.05			
5:08	EXT	12	60			
5:10		14	2.7			
5:12		13	1.35			
5:13		1	1.25			
5:14		3	1			
5:15	EXHAUST			190.6	9.36	
5:17		142	0.13			
5:22		7	0.03			
5:26		9	0.04			
5:27		2	2.1			
5:29	BAROMETER					
		LOW CLOSED				
5:34	EXT	12	15			
5:35	EXHAUST			104.6	5.13	
5:42	EXT	12				74.4
5:42	T1,T2,T3					67.2,70.1,78.8
5:43	ASPHALT					75.7
5:43	AMBIENT					73.4
5:45		14	1.9			
5:46		13	0.77			
5:48		142	0.14			
5:49		8	0.01			
5:50		1	0.67			
5:51		3	0.97			
5:53		7	0.03			
5:54		6	0.04			
5:56		2	1.9			
6:17		14	1.4			

	6:18		142	0.14			
	6:19		13	0.72			
	6:20		8	0.04			
	6:22		1	0.68			
	6:23		3	0.95			
	6:24		7	0.02			
	6:25		2	1.75			
	6:30	EXT	12	25			
	6:31	EXHAUST			104.6	5.13	
	6:47		14	1.3			
	6:48		2	1.9			
	6:50		8	0.04			
	6:51		142	0.12			
	6:52		13	1.61			
	6:53		1	0.66			
	6:54		3	0.95			
	6:56		7	0.02			
	7:22		14	1.35			
	7:22		2	1.95			
	7:25		8	0.025			
	7:26		142	0.095			
	7:27		13	0.715			
	7:28		1	0.68			
	7:30		3	0.97			
	7:31		7	0.025			
	7:33		B4	-0.005			
	7:35	EXHAUST			104.6	5.13	
	7:37	BAROMETER				1	
	7:38	EXT	12	25			
	7:38	AMBIENT					77.6
	7:38	EXT	12				78.8
	7:39	T1.T2,T3					67.1,69.9,78.8
	8:01		14	1.4			
	8:01		2	1.9			
	8:03		8	0.055			
	8:04		142	0.1			
	8:05		13	0.7			
	8:06		1	0.635			
	8:08		3	0.97			
	8:09		7	0.03			
	8:15	SHUT DOWN					

HIGH CLOSED

6-11-90	9:31	EXT	12	100			
	9:32		14	1.9			
	9:32		13	0.9			
	9:34		142	0			
	9:35		1	1			
	9:35	EXT	12	96			
	9:37		3	0.08			
	9:38		7	0			
	9:39		8	0.03			
	9:41		2	-0.02			
	9:42		B4	0			
	9:48	EXHAUST			296	14.53	99.1
	9:48	AMBIENT					82
	9:56	EXT	12	91			

9:57		14	2.5			
9:57		13	1.2			
9:57		1	1.2			
9:59		3	0.2			
9:59		142	0			
10:00		8	0.02			
10:03		7	0.04			
10:06		2	0.22			
10:07		11	0.05			
10:10	EXT	12				80.2
10:11	T1,T2,T3					66.9,69.9,79.3
10:50		14	2.8			
10:51		13	1.4			
10:51		1	1.3			
10:52	EXT	12	90			
10:53		11	0.04			
10:54		8	0.03			
10:55		142	-0.06			
10:56		3	0.13			
10:57		7	0.015			
10:58		2	0.51			
11:56		14	3			
11:56		13	1.4			
11:56		1	1.4			
11:59		11	0.07			
12:00		8	0.02			
12:01		142	-0.02			
12:02		3	-0.6			
12:04		7	0.04			
12:05		2	0.67			
12:12		84	0.035			
12:16	BLOWER					150
12:16	EXHAUST			296	14.53	113.9
12:17	ASPHALT					115.5
12:18	EXT	12	90			
12:18	EXT	12				83.1
12:18	T1,T2,T3					66.7,70.1,79.8
16:13	EXHAUST			296	14.53	109
16:16	EXT	12				84.9
16:16	ASPHALT					110.1
16:16	T1,T2,T3					67.1,70.1,80
16:29	EXT	12	90			
16:29		14	3.4			
16:29		13	1.6			
16:29		1	1.4			
16:31		2	1			
16:32		11	0.04			
16:35		8	0.04			
16:34		84	0.02			
16:36		142	-0.14			
16:37		3	-0.2			
16:38		7	0.03			
16:50	UNCAPPED WELLS 1.2					
	HIGH OPEN					
16:53		14	3.25			
16:53		13	1.5			

	17:26	14	3.3			
	17:26	13	1.5			
	17:41	EXHAUST		340	16.69	
	17:50	1		80		
	17:50	2		ND		
	17:53	14	3.3			
	17:53	13	1.5			
	17:55	EXT 12	90			
	18:12	EXHAUST		320	15.71	107.9
	18:14	PAVEMENT				99.1
	18:14	EXT 12				82.6
	18:14	T1,T2,T3				67.8,70.8,80.7
	18:14	AMBIENT				85.4
	18:14	BAROMETER				
	18:20	14	3.35			
	18:20	13	1.5			
	18:22	142	0.01			
	18:25	8	0.02			
	18:23	11	0.05			
	18:24	B4	0.03			
	18:28	7	0.02			
	18:26	3	0.2			
	18:30	1		64		
	18:30	2		ND		
	22:12	BLOWER				160.1
	22:12	EXHAUST		287	14.09	106.3
	22:12	AMBIENT				75.5
	22:12	EXT 12	92			73
	22:12	T1,T2,T3				67.2,70.5,80.1
	22:12	PAVEMENT				89.2
	22:16	14	3.1			
	22:16	13	1.5			
	22:16	B4	0.01			
	22:16	11	0.02			
	22:16	8	0.02			
	22:16	142	0.4			
	22:16	3	0.42			
	22:46	13	1.4			
	22:46	EXT 12	92			
	23:05	EXHAUST	160	335	16.44	
		MEDIUM OPEN				
	23:10	EXHAUST	60	277	13.6	
6-12-90	00:20	AMBIENT				69.9
	00:20	PAVEMENT				85.6
	00:20	EXHAUST				92.4
	00:20	EXT 12				71.9
	00:20	T1,T2,T3				67.2,70.5,80.2
	00:30	14	2.2			
	00:30	13	1.1			
	00:30	EXT 12	61			
	00:30	142	0.3			
	00:30	B4	0			
	00:30	11	0			
	00:30	8	0.025			
	00:30	3	0.49			
	00:30	7	0.02			

00:30		1		51		
00:30		2		ND		
00:51	EXHAUST			248	12.17	88.7
00:51	BLOWER					130.2
3:58	EXT	12	60			
3:58		14	2.15			
3:58		13	1			
4:00		142	0.27			
4:02		B4	0.025			
4:03		11	0.04			
4:05		8	0.03			
4:07		3	0.85			
4:08		7	0.02			
4:12		1		43		
4:14		2		ND		
4:20	EXHAUST			219	10.75	87.8
4:26	PAVEMENT					79.1
4:27	AMBIENT					66
4:31	T1,T2,T3					66.5,69.9,79.7
4:37	BLOWER					138.2
4:55	EXT	12	60			
4:55		14	2.15			
4:55		13	1			
4:55		142	0.28			
4:55		3	0.87			
4:55		1	50			
4:55		2	ND			
		LOW OPEN				
5:12	EXT	12	30			
5:12		14	1.25			
5:12		13	0.5			
5:12		142	0.29			
5:12		1		21		
5:12		2		ND		
5:12	EXHAUST			162	7.95	75.9
5:12	BLOWER					116.7
5:42	EXT	12	30			
5:44		14	1.25			
5:45		13	0.5			
5:45		142	0.35			
5:46		B4	0.01			
5:48		11	0.04			
5:52		8	0.03			
5:55		3	0.9			
5:59		7	0.01			
6:11	EXHAUST			167	8.2	73.5
6:01		13	0.63			
6:07		1		15		
6:07		2		ND		
6:14	AMBIENT					66.7
6:14	PAVEMENT					78.8
6:40	EXT	12	30			
6:40		14	1.25			
6:40		13	0.6			
6:40		B4	0.02			
6:40		11	0.02			

6:40		8	0.01			
6:52		142	0.33			
6:54		3	0.92			
6:56		7	0.02			
7:00	EXHAUST			162	7.95	75.9
6:58	AMBIENT					68.9
7:00	SHUT DOWN					
7:01		14	0.3			
7:02		13	0.07			
7:03		142	0.27			
7:07		14	0.045			
7:08		13	0.07			
7:10		142	0.255			
7:17		142	0.26			
7:20		1		ND		
7:20		2		ND		
7:21	EXHAUST			ND		71.6
7:25	EXT	12	73.9			
7:26		142	0.2			
7:38		13	0			
7:39		142	0.15			
7:40		14	0.1			

HIGH CLOSED

WENT TO	EXT	14	4in WELL			
10:33	EXT	14	90			
10:38		12	1.2			
10:39		141	0.74			
10:40		13	0.56			
10:38		8	0			
10:41		142	-0.02			
10:42		1	0.55			
10:43		3	-0.05			
10:44		7	0.04			
10:45		11	0.05			
10:47		84	0.01			
10:49		2	0.34			
10:56	EXHAUST			171	8.39	100
10:59	EXT	14	85			
11:06	EXT	14	84			
11:07		12	1.35			
11:08		13	0.88			
11:10		142	0.83			
11:11		11	0.02			
11:13		8	0.03			
11:14		1	0.62			
11:15		3	-0.02			
11:16		7	0.02			
11:18		2	0.52			
11:58	EXHAUST			171	8.39	108.8
12:13		13	0.8			
12:12	EXT	14	80			
12:15		12	1.75			
12:18		11	0.03			
12:20		8	0.02			
12:22		141	1			
12:22		142	-0.17			

12:24		1	0.75			
12:25		3	-0.11			
12:26		7	0.02			
12:17		2	0.65			
12:53	EXHAUST			171	8.39	109.7
12:55	EXT	14				90.1
12:55	EXT	14	80			
12:55	T1,T2,T3					66.7,70.1,80.2
12:55		13	0.8			
12:58		141	-0.13			
13:05		12	1.9			
13:01		B4	0.01			
13:03		11	0.04			
13:04		8	0.02			
13:08		142	1.1			
13:07		1	0.78			
13:09		3	-0.2			
13:10		7	0.02			
13:00		2	0.75			
13:51	EXHAUST			200	9.82	109.7
13:54		12	1.9			
13:55		13	0.9			
13:53	EXT	14	80			
13:57		142	-0.13			
13:54		141	1.2			
13:58		2	0.75			
13:58		11	0.05			
14:00		8	0.02			
14:01		1	0.62			
14:02		3	-0.2			
14:03		7	0.02			
14:08	ASPHALT					127.2
14:05	AMBIENT					90.1
RAISED VACUUM						
14:10	EXT	14	100			
14:10	EXHAUST			215	10.55	
14:52		12	2.7			
14:53		13	1.3			
14:54	EXT	14	100			
14:54	T1,T2,T3					66.9,70.[illegible],80.[illegible]
14:54	EXT	14				89.6
14:55		142	0			
15:05		141	1.5			
14:59		2	1			
15:01		B4	0.03			
15:03		11	0.06			
15:04		8	0.02			
15:02		1	1.1			
15:07		3	0			
15:08		7	0.04			
15:08	AMBIENT					90.5
15:09	ASPHALT					122.8
15:15	EXHAUST			239	11.73	109.4
16:05		12	3			
16:06		13	1.2			
16:06	EXT	14	100			

16:12		142	-0.03			
16:09		141	1.6			
16:07		2	1			
16:14		11	0.04			
16:14		8	0.02			
16:08		1	1			
16:17		3	-0.23			
16:18		7	0.02			
16:50	EXHAUST			287	14.09	109.7
16:55		12	3.6			
16:57		13	1.4			
16:58	EXT	14	100			
16:58	EXT	14				87.6
17:06	T1,T2,T3					67.2,71,81.5
17:06		142	-0.02			
16:59		141	1.7			
17:00		2	1.2			
17:03		B4	0.04			
17:04		11	0.07			
17:05		8	0.03			
17:10		1	1.2			
17:08		3	-0.16			
17:09		7	0.02			
			MEDIUM CLOSED			
17:14	EXT	14	50			
17:14		12	2.4			
17:14		141	1.4			
17:14		13	1			
17:15		1	0.9			
17:16		2	1.2			
17:17		142	-0.03			
17:18		11	0.04			
17:19		8	0.02			
17:19		3	-0.21			
17:20		7	0.05			
17:42	EXT	14	49			
17:42		12	2.3			
17:42		141	1.2			
17:42		13	0.85			
17:45		142	0			
17:46		1	0.65			
17:47		64	0			
17:49		11	0.02			
17:49		8	0.02			
17:50		1	0.14			
17:51		3	-0.18			
17:52		7	0.03			
17:54	AMBIENT					91
17:54	PAVEMENT					107
17:54	T1.T2.T3					67.8,71.81.3
17:54	EXHAUST			171	8.39	101.1
21:28		12	1.8			
21:30		13	0.67			
21:31	EXT	14	50			
21:33		141	1			
21:37		142	0.33			

	21:38		B4	0.63			
	21:39		11	0.03			
	21:40		8	0.02			
	21:41		1	0.75			
	21:42		3	0.22			
	21:43		7	0.02			
6-13-90	4:45	EXT	14	51.5			
	5:36		12	1.2			
	5:37		13	0.5			
	5:39		13	0.57			
	5:40		141	0.84			
	5:43		142	0.36			
	5:45		1	0.58			
	5:47		B4	0.02			
	5:49		11	0.03			
	5:51		8	0.02			
	5:53		3	0.81			
	5:55		7	0.03			
	5:57		1	0.64			
	5:59		142	0.36			
	6:01		2	0.62			
	6:03		12	1.7			
	6:06		13	0.76			
	6:07	EXT	14	55			
	6:14		141	1.1			
	6:09		142	0.37			
	6:18	AMBIENT					71.7
	6:18	PAVEMENT					79.8
	6:18	EXT	14				74.1
	6:18	T1,T2,T3					66.9,70.3,80.[illegible]
	6:18	EXHAUST			191	8.88	86
	6:53		142	0.34			
	6:54		12	0.85			
	6:55	EXT	14	50.5			
	6:57		12	2.1			
	6:57		141	1.15			
	7:00		2	0.77			
	7:46		12	2.13			
	7:46	EXT	14	50.5			
	7:47		141	1.2			
	7:50		13	0.97			
	7:52		142	0.12			
	7:54		B4	0.035			
	7:57		11	0.04			
	7:58		8	0.05			
	8:00		1	0.83			
	8:02		3	0.82			
	8:04		7	0.04			
	8:04		2	0.65			
	8:07	AMBIENT					77.3
	8:07	PAVEMENT					87.8
	8:07	EXHAUST			191	9.38	95.3

LOW CLOSED

8:18	EXT	14	25
8:19		12	1.15
8:22		141	0.66

8:24		13	0.5			
8:25		142	0.09			
8:27		1	0.45			
8:33	EXHAUST			105	5.4	90.6
8:33	EXT	14	25			
8:46		142	0.15			
8:52		141	0.68			
8:53		13	0.47			
8:54		12	0.98			
8:55		1	0.44			
HIGH CLOSED						
9:02	EXT	14	90			
9:04		12	3.9			
9:05		141	1.95			
9:05		13	1.5			
9:06		1	1.35			
9:07		142	0.025			
9:09		8	0.02			
9:11		3	0.67			
9:14		2	1.25			
10:24	EXT	14	91			
10:24		12	2			
10:24		13	0.95			
10:24		141	1.3			
10:26		2	0.87			
10:27		13	0.95			
10:27		142	-0.03			
10:29		8	0.02			
10:30		1	0.9			
10:31		3	0.49			
10:32	AMBIENT					90.8
10:32	ASPHALT					106.1
10:32	EXT	14				85.4
10:32	T1.T2.T3					67.6.70.8.81.5
10:32	EXHAUST			191	9.38	111.7
10:40		12	0.95			
10:43		12	0.73			
10:46	EXHAUST					110.1
HIGH OPEN						
10:50	EXT	14	91			
10:51	EXHAUST			191	9.38	
11:17	EXHAUST			191	9.38	
11:20		1		9		
12:49	EXT	14	91			
12:49		12	1.7			
12:49		141	1.1			
12:50		13	0.83			
12:51		142	0.02			
12:52		8	0.01			
12:53		3	0.28			
12:53		1		21		
12:53		2		ND		
12:53	EXHAUST			191	9.38	114.4
13:40	EXT	14	90			
13:43		142	-0.08			
13:46		8	0.03			

13:47	12	2.5			
13:48	141	1.4			
13:48	13	1.05			
13:51	AMBIENT				91.5
13:51	PAVEMENT				114.2
13:51	T1,T2,T3,				68,71.6,82.4
13:51	EXT 14				88.3
13:51	1		-21		
13:51	EXHAUST		191	9.38	114.8
MEDIUM OPEN					
13:59	EXT 14	50			
13:59	EXT 14				93.3
13:59	T1,T2,T3				68.1,71.4,82.4
14:00	13	0.64			
14:10	EXHAUST		95	4.66	104.3
14:12	13	0.44			
14:13	12	1			
14:14	141	0.93			
14:25	2		<10		
15:30	12	1.6			
15:33	13	0.69			
15:30	EXT 14	50			
15:32	141	0.93			
15:35	EXHAUST		167	8.2	102.7
15:36	2		<10		
15:39	1		<10		
16:00	12	1.65			
15:57	13	0.72			
15:56	EXT 14	50			
15:58	141	0.97			
16:20	12	1.7			
16:22	13	0.77			
16:20	EXT 14	50			
16:20	EXT 14				92.4
16:20	T1,T2.T3				67.8,71.81.8
16:21	141	0.99			
16:24	EXHAUST				102.5
LOW OPEN					
16:25	STEP DOWN	19			
16:26	12	1.1			
16:27	13	0.5			
16:25	EXT 14	25			
16:28	141	0.63			
16:30	EXHAUST		105	5.15	102.5
16:31	1,2		ND		
16:53	12	1			
16:55	13	0.42			
16:56	EXT 14	25			
16:56	EXT 14				92.4
16:56	T1,T2,T3				68,71.6,82.4
16:57	141	0.6			
17:01	EXHAUST		124	6.09	96.6
17:04	1,2		ND		
17:06	AMBIENT				91.7
17:06	ASPHALT				10.9
-14-90 6:18	12	1.2			

	8:20	141	0.8			
	8:21	13	0.54			
	8:21	AMBIENT				84.7
	8:21	ASPHALT				92.3
	8:21	EXT 14		25		84.3
	8:21	T1,T2,T3				67.8,71.2,82.2
	8:21	EXHAUST		143	7.02	96.2

CLOSED STATIC MONTITORING

6-15-90	10:00	12	-0.02	
	10:00	13	-0.09	
	10:00	14	-0.06	
	10:00	141	0	
	10:00	142	-0.02	
	10:00	11	0.02	
	10:00	8	0.03	
	10:00	1	0	
	10:00	3	0.02	
	10:00	7	-0.03	
	10:00	2	0	
	10:00	AMBIENT		82.7
	10:00	ASPHALT		93.5
	10:00	T1,T2,T3		68,71.7,83.3
	12:30	12	-0.05	
	12:30	14	-0.01	
	12:30	13	0.02	
	12:30	141	-0.12	
	12:30	142	-0.38	
	12:30	11	-0.01	
	12:30	8	-0.02	
	12:30	1	0	
	12:30	3	0.22	
	12:30	7	-0.03	
	12:30	2	-0.14	
	12:30	AMBIENT		90.6
	12:30	ASPHALT		107
	12:30	T1,T2,T3		68,71.9,83.3
	15:30	12	[illegible]	
	15:30	13	[illegible]	
	15:30	14	-0.1	
	15:30	141	[illegible]	
	15:30	142	-0.14	
	15:30	11	0.02	
	15:30	8	0.04	
	15:30	1	0	
	15:30	3	-0.25	
	15:30	7	0.04	
	15:30	2	-0.13	
	15:30	AMBIENT		89.7
	15:30	ASPHALT		99
	15:30	T1,T2,T3		66.1,71.9,83.3
	18:50	12	0.01	
	18:50	13	-0.14	
	18:50	14	-0.02	
	18:50	141	0.02	
	18:50	142	0.1	
	18:50	11	0.01	

	18:50	8	0.04	
	18:50	1	0	
	18:50	3	-0.7	
	18:50	7	0	
	18:50	2	0	
	18:50	AMBIENT		66.3
	18:50	ASPHALT		96
	18:50	T1,T2,T3		68.3,72.5,63.8
	19:00	OPENED WELLS		
	19:00	CLOSED WELLS		
	OPENED THEN RECLOSED FOR STATIC MONITORING			
6-16-90	2:00	12	0	
	2:00	14	-0.01	
	2:00	13	-0.12	
	2:00	141	0.03	
	2:00	142	0.22	
	2:00	11	0.01	
	2:00	8	0.04	
	2:00	1	0.02	
	2:00	3	0	
	2:00	7	0.03	
	2:00	2	0.52	
	2:00	AMBIENT		82.9
	2:00	ASPHALT		96
	2:00	T1,T2,T3		68,71.9.83.3
	5:00	12	0	
	5:00	13	-0.02	
	5:00	14	-0.11	
	5:00	141	0.02	
	5:00	142	0.05	
	5:00	11	0	
	5:00	8	0.04	
	5:00	1	0.01	
	5:00	3	0.02	
	5:00	7	0	
	5:00	2	0.5	
	5:00	AMBIENT		71.1
	5:00	ASPHALT		76.1
	5:00	T1,T2,T3		67.7,71.8,81.6
	8:00	12	0	
	8:00	13	-0.02	
	8:00	14	0	
	8:00	141	0.05	
	8:00	142	0.13	
	8:00	11	0.03	
	8:00	8	0.05	
	8:00	1	0.02	
	8:00	3	0.39	
	8:00	7	0.04	
	8:00	2	0.85	
	8:00	AMBIENT		90.6
	8:00	ASPHALT		88.3
	8:00	T1,T2,T3		67.9,71.9.83.3
	10:30	12	0	
	10:30	13	0.01	
	10:30	14	-0.03	

10:30	141	0.01	
10:30	142	0.01	
10:30	11	0.06	
10:30	8	0.03	
10:30	1	0.02	
10:30	3	0.01	
10:30	7	0.02	
10:30	2	0.74	
10:30	AMBIENT		88.7
10:30	ASPHALT		104.3
10:30	T1,T2,T3		68.1,72.1,83.3
12:15	12	-0.01	
12:15	13	-0.02	
12:15	14	-0.02	
12:15	141	0	
12:15	1423	-0.03	
12:15	11	0.02	
12:15	8	0.03	
12:15	1	0	
12:15	3	-0.16	
12:15	7	0.03	
12:15	2	0.75	
12:15	AMBIENT		91.5
12:15	ASPHALT		119.5
12:15	T1,T2,T3		68,71.9,83.3

APR 1990
MEMPHIS, TN
FCWOS MEMPHIS
2496 WINCHESTER RD., 5TH FLOOR

ISSN 0198-4837

LOCAL CLIMATOLOGICAL DATA

Monthly Summary

INTERNATIONAL AIRPORT

A 2 1990
MEMPHIS, TN

LATITUDE 35° 03'N LONGITUDE 90° 00'W ELEVATION (GROUND) 258 FEET TIME ZONE CENTRAL 13893

DATE 1	TEMPERATURE °F MAXIMUM 2	MINIMUM 3	AVERAGE 4	DEPARTURE FROM NORMAL 5	AVERAGE DEW POINT 6	DEGREE DAYS BASE 65°F HEATING (SEASON BEGINS WITH JUL) 7A	COOLING (SEASON BEGINS WITH JAN) 7B	WEATHER TYPES 1 FOG 2 HEAVY FOG 3 THUNDERSTORM 4 ICE PELLETS 5 HAIL 6 GLAZE 7 DUSTSTORM 8 SMOKE, HAZE 9 BLOWING SNOW 8	SNOW ICE PELLETS OR ICE ON GROUND AT 0600 INCHES 9	PRECIPITATION WATER EQUIVALENT (INCHES) 10	SNOW, ICE PELLETS (INCHES) 11	AVERAGE STATION PRESSURE IN INCHES ELEV. 284 FEET ABOVE M.S.L. 12	WIND (M.P.H.) RESULTANT DIR. 13	RESULTANT SPEED 14	AVERAGE SPEED 15	PEAK GUST SPEED 16	PEAK GUST DIRECTION 17	FASTEST 1-MIN SPEED 18	FASTEST 1-MIN DIRECTION 19	SUNSHINE MINUTES 20	PERCENT OF TOTAL POSSIBLE 21	SKY COVER (TENTHS) SUNRISE TO SUNSET 22	MIDNIGHT TO MIDNIGHT 23
01	79	51	65	7	57	0	0	1	0	0.00	0.0	29.650	25	3.6	5.4	14	W	12	29			6	5
02	65	46	56	-2	36	9	0		0	0.00	0.0	29.710	34	11.2	13.0	28	N	20	36			5	4
03	60	39	50	-8	35	15	0		0	0.00	0.0	29.760	35	6.8	8.2	18	N	15	02			0	0
04	72	41	57	-2	38	8	0		0	0.00	0.0	29.580	23	4.8	6.8	18	W	13	24			0	1
05	75	49	62	3	41	3	0	1	0	0.70	0.0	29.590	03	6.1	8.3	16	NE	15	04			5	6
06	51	35	43*	-16	33	22	0	1	0	0.41	0.0	29.770	02	9.6	10.5	25	N	16	35			8	6
07	58	31*	45	-15	24	20	0		0	0.00	0.0	29.980	03	4.6	5.8	20	N	14	36			0	0
08	66	33	50	-10	26	15	0		0	0.00	0.0	30.000	12	5.1	6.0	16	E	14	08			8	7
09	70	50	60	-1	37	5	0		0	0.00	0.0	29.870	18	8.0	8.8	23	S	17	20			10	10
10	69	50	60	-1	53	5	0	1 3	0	0.21	0.0	29.690	26	6.4	15.6	32	NW	23	23			9	10
11	61	40	51	-10	34	14	0		0	0.00	0.0	29.940	33	9.9	10.3	24	NW	16	36			2	2
12	60	38	49	-13	27	16	0		0	0.00	0.0	30.010	01	3.4	6.5	14	N	9	32			1	2
13	70	41	56	-6	36	9	0		0	0.00	0.0	29.900	16	6.9	9.2	23	SE	16	15			10	8
14	66	49	58	-4	52	7	0	1	0	0.11	0.0	29.760	12	0.5	6.9	14	N	12	02			9	7
15	69	42	56	-7	48	9	0	2	0	T	0.0	29.720	12	1.3	3.9	13	W	10	25			10	8
16	80	54	67	4	52	0	2		0	0.00	0.0	29.640	18	6.9	8.4	21	S	17	20			9	9
17	70	43	57	-6	45	8	0	1 3	0	1.10	0.0	29.820	03	9.3	11.9	30	N	21	02			9	7
18	62	41	52	-12	32	13	0		0	0.00	0.0	30.010	04	9.3	9.6	22	NE	16	04			8	7
19	75	53	64	0	51	1	0	8	0	0.00	0.0	29.955	15	8.8	10.0	18	S	14	15			10	10
20	79	60	70	6	60	0	5	1 3 5	0	0.74	T	29.910	18	9.3	10.1	31	SW	16	16			9	9
21	77	62	70	6	63	0	5	1 3	0	0.61	0.0	29.830	25	5.1	6.2	31	W	25	28			9	7
22	86	58	72	7	61	0	7	1	0	0.00	0.0	29.740	14	0.7	3.9	12	SE	10	12			3	3
23	86	62	74	9	63	0	9		0	0.00	0.0	29.680	17	5.3	6.0	14	S	10	14			10	6
24	88*	67	78*	13	64	0	13	3 8	0	0.80	0.0	29.700	17	7.2	8.0	37	S	23	17			7	7
25	85	66	76	10	61	0	11		0	0.00	0.0	29.760	16	8.2	8.6	16	SE	13	14			6	5
26	85	65	75	9	56	0	10		0	0.00	0.0	29.660	16	9.7	10.1	21	S	16	17			1	1
27	81	62	72	6	61	0	7	1 3	0	1.65	0.0	29.460	17	6.9	9.9	23	SE	16	14			10	8
28	71	54	63	-3	52	2	0	1	0	0.60	0.0	29.385	24	8.5	11.1	35	SW	21	26			7	6
29	82	56	69	2	61	0	4		0	0.00	0.0	29.420	18	10.3	10.7	23	S	17	20			8	5
30	80	69	75	8	68	0	10	1 8	0	T	0.0	29.610	25	1.7	6.1	22	S	16	20			9	8
	SUM	SUM				TOTAL	TOTAL	NUMBER OF DAYS		TOTAL	TOTAL	FOR THE MONTH:								TOTAL	% FOR MONTH	SUM	SUM
	2178	1507				181	63			6.93	T	29.750	17	1.3	8.5	37	S	25	28			198	174
	AVG.	AVG.	AVG.	DEP.	AVG.	DEP.	DEP.	PRECIPITATION		DEP.						DATE: 24		DATE: 21		POSSIBLE		AVG	AVG
	72.6	50.2	61.4	-1.2	47.4	55	29	≥ .01 INCH	10	1.16												6.6	5.8

NUMBER OF DAYS				SEASON TO DATE			
MAXIMUM TEMP.		MINIMUM TEMP.		TOTAL	TOTAL	SNOW, ICE PELLETS ≥ 1.0 INCH	0
≥ 90°	≤ 32°	≤ 32°	≤ 0°	2797	117	THUNDERSTORMS	6
0	0	1	0	DEP.	DEP.	HEAVY FOG	1
				-385	43	CLEAR 7 PARTLY CLOUDY 6 CLOUDY 17	

GREATEST IN 24 HOURS AND DATES				GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE	
PRECIPITATION		SNOW, ICE PELLETS			
2.25	27-28	trace	20	0	

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.
T TRACE AMOUNT.
+ ALSO ON EARLIER DATE(S).
HEAVY FOG: VISIBILITY 1/4 MILE OR LESS.
BLANK ENTRIES DENOTE MISSING OR UNREPORTED DATA.

DATA IN COLS 6 AND 12-15 ARE BASED ON 21 OR MORE OBSERVATIONS AT HOURLY INTERVALS. RESULTANT WIND IS THE VECTOR SUM OF WIND SPEEDS AND DIRECTIONS DIVIDED BY THE NUMBER OF OBSERVATIONS. COLS 16 & 17: PEAK GUST - HIGHEST INSTANTANEOUS WIND SPEED. ONE OF TWO WIND SPEEDS IS GIVEN UNDER COLS 18 & 19: FASTEST MILE - HIGHEST RECORDED SPEED FOR WHICH A MILE OF WIND PASSES STATION (DIRECTION IN COMPASS POINTS). FASTEST OBSERVED ONE MINUTE WIND - HIGHEST ONE MINUTE SPEED (DIRECTION IN TENS OF DEGREES). ERRORS WILL BE CORRECTED IN SUBSEQUENT PUBLICATIONS.

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC DATA CENTER.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER ASHEVILLE NORTH CAROLINA

Kenneth D Hadeen
DIRECTOR
NATIONAL CLIMATIC DATA CENTER

MAR 1990
MEMPHIS, TN
FCWOS MEMPHIS
2496 WINCHESTER RD., 5TH FLOOR

ISSN 0198-4837

LOCAL CLIMATOLOGICAL DATA
Monthly Summary

INTERNATIONAL AIRPORT

LATITUDE 35° 03'N LONGITUDE 90° 00'W ELEVATION (GROUND) 258 FEET TIME ZONE CENTRAL 13893

MEMPHIS, TN R 1990

DATE 1	TEMPERATURE °F: MAXIMUM 2	MINIMUM 3	AVERAGE 4	DEPARTURE FROM NORMAL 5	AVERAGE DEW POINT 6	DEGREE DAYS BASE 65°F: HEATING (SEASON BEGINS WITH JUL) 7A	COOLING (SEASON BEGINS WITH JAN) 7B	WEATHER TYPES (1 FOG, 2 HEAVY FOG, 3 THUNDERSTORM, 4 ICE PELLETS, 5 HAIL, 6 GLAZE, 7 DUSTSTORM, 8 SMOKE, HAZE, 9 BLOWING SNOW) 8	SNOW ICE PELLETS OR ICE ON GROUND AT 0600 INCHES 9	PRECIPITATION: WATER EQUIVALENT (INCHES) 10	SNOW, ICE PELLETS (INCHES) 11	AVERAGE STATION PRESSURE IN INCHES ELEV. 284 FEET ABOVE M.S.L. 12	WIND (M.P.H.): RESULTANT DIR. 13	RESULTANT SPEED 14	AVERAGE SPEED 15	PEAK GUST SPEED 16	PEAK GUST DIRECTION 17	FASTEST 1-MIN SPEED 18	FASTEST 1-MIN DIRECTION 19	SUNSHINE: MINUTES 20	PERCENT OF TOTAL POSSIBLE 21	SKY COVER (TENTHS): SUNRISE TO SUNSET 22	MIDNIGHT TO MIDNIGHT 23
01	42	38	40*	-7	37	25	0	1	0	0.21	0.0	30.000	03	9.8	9.9	23	NE	15	04			10	10
02	52	33	43	-4	35	22	0		0	0.05	0.0	29.750	01	5.9	6.5	17	N	14	36			10	8
03	63	30	47	0	33	18	0		0	0.00	0.0	29.780	33	3.3	4.3	17	NW	13	35			0	0
04	64	34	49	1	30	16	0		0	0.00	0.0	29.860	08	1.5	2.3	12	NW	9	11			0	0
05	71	37	54	6	37	11	0		0	0.00	0.0	29.855	18	3.5	4.3	21	SW	12	23			4	4
06	74	48	61	13	40	4	0		0	0.00	0.0	29.895	12	7.7	8.2	18	SE	15	15			10	10
07	64	54	59	10	51	6	0	1	0	1.19	0.0	29.970	09	7.4	8.8	23	SE	17	12			10	10
08	65	51	58	9	55	7	0	1 3	0	1.27	0.0	29.900	15	10.2	13.6	44	SE	28	14			10	10
09	74	58	66	17	63	0	1	1	0	T	0.0	29.890	20	8.1	9.1	22	SW	14	22			10	9
10	76	62	69	19	64	0	4	1	0	0.02	0.0	29.860	18	7.7	8.3	18	S	12	21			9	7
11	77	62	70	20	60	0	5		0	T	0.0	29.810	18	10.7	11.4	26	S	20	17			9	8
12	73	63	68	18	63	0	3	1	0	0.05	0.0	29.860	17	9.7	10.0	21	S	15	17			10	10
13	82*	63	73*	22	60	0	8		0	0.00	0.0	29.750	17	9.6	10.2	23	S	16	18			9	8
14	77	64	71	20	58	0	6		0	T	0.0	29.460	16	15.5	16.1	33	SE	23	14			10	10
15	73	49	61	10	51	4	0	1 3	0	1.35	0.0	29.570	21	6.7	9.6	37	S	23	21			10	10
16	62	43	53	2	45	12	0		0	0.00	0.0	29.650	23	1.8	3.0	10	W	9	20			10	7
17	66	43	55	5	39	10	0		0	0.00	0.0	29.710	28	5.5	7.7	21	W	15	25			[illegible]	[illegible]
18	70	39	55	3	41	10	0		0	0.00	0.0	29.810	18	3.0	6.9	28	N	20	36			[illegible]	[illegible]
19	49	35	42	-11	28	22	0	1	0	0.05	0.0	30.060	35	11.4	12.4	26	N	20	36			[illegible]	6
20	53	30*	42	-11	24	23	0		0	0.00	0.0	30.140	02	3.6	6.0	16	NE	12	03			0	0
21	66	32	49	-4	31	16	0		0	0.00	0.0	29.950	19	6.8	7.0	16	S	13	19			7	6
22	71	52	62	8	47	3	0		0	0.00	0.0	29.840	21	10.4	10.9	29	SW	20	23			4	4
23	66	49	58	4	45	7	0		0	0.00	0.0	29.980	02	10.4	11.1	21	NE	17	04			4	4
24	49	36	43	-11	35	22	0	1	0	0.15	0.0	30.020	02	10.9	11.3	21	NE	16	04			10	10
25	46	35	41	-14	33	24	0		0	T	0.0	30.110	01	8.1	8.3	16	N	14	33			10	10
26	48	36	42	-13	36	23	0	1	0	0.20	0.0	30.120	01	5.4	6.0	13	N	12	03			10	8
27	62	33	48	-8	32	17	0	1	0	0.00	0.0	30.020	05	5.3	5.9	14	NE	10	04			10	7
28	56	47	52	-4	45	13	0	1	0	0.25	0.0	29.820	13	6.4	7.3	13	SE	12	13			10	10
29	69	56	63	7	58	2	0	1	0	0.05	0.0	29.660	14	8.6	9.4	20	S	13	12			10	10
30	66	58	62	5	59	3	0	2	0	0.80	0.0	29.540	16	1.7	10.2	22	W	16	26			10	10
31	74	56	65	8	56	0	0	•	0	0.00	0.0	29.680	35	3.8	5.2	16	NW	9	33			7	6
	SUM 2000	SUM 1426				TOTAL 321	TOTAL 27	NUMBER OF DAYS		TOTAL 5.65	TOTAL 0.0	29.850	14	1.7	8.4	44	SE	28	14	TOTAL	% FOR MONTH	SUM 234	SUM 217
	AVG. 64.5	AVG. 46.0	AVG. 55.3	DEP. 3.6	AVG. 44.9	DEP. -112	DEP. 7	PRECIPITATION ≥ .01 INCH 13		DEP. 0.31						DATE: 8		DATE: 8		POSSIBLE		AVG. 7.5	AVG. 7.0

NUMBER OF DAYS				SEASON TO DATE			GREATEST IN 24 HOURS AND DATES				GREATEST DEPTH ON GROUND OF SNOW, ICE PELLETS OR ICE AND DATE
MAXIMUM TEMP.		MINIMUM TEMP.		TOTAL	TOTAL	SNOW, ICE PELLETS ≥ 1.0 INCH 0	PRECIPITATION		SNOW, ICE PELLETS		
≥ 90°	≤ 32°	≤ 32°	≤ 0°	2614	34	THUNDERSTORMS 2	2.45	07-08	0.0		0
0	0	3	0	DEP. -440	DEP. 14	HEAVY FOG 1					
						CLEAR 5 PARTLY CLOUDY 6 CLOUDY 20					

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.
T TRACE AMOUNT.
• ALSO ON EARLIER DATE(S).
HEAVY FOG: VISIBILITY 1/4 MILE OR LESS.
BLANK ENTRIES DENOTE MISSING OR UNREPORTED DATA.

DATA IN COLS 6 AND 12-15 ARE BASED ON 21 OR MORE OBSERVATIONS AT HOURLY INTERVALS. RESULTANT WIND IS THE VECTOR SUM OF WIND SPEEDS AND DIRECTIONS DIVIDED BY THE NUMBER OF OBSERVATIONS. COLS 16 & 17: PEAK GUST - HIGHEST INSTANTANEOUS WIND SPEED. ONE OF TWO WIND SPEEDS IS GIVEN UNDER COLS 18 & 19: FASTEST MILE - HIGHEST RECORDED SPEED FOR WHICH A MILE OF WIND PASSES STATION (DIRECTION IN COMPASS POINTS). FASTEST OBSERVED ONE MINUTE WIND - HIGHEST ONE MINUTE SPEED (DIRECTION IN TENS OF DEGREES). ERRORS WILL BE CORRECTED IN SUBSEQUENT PUBLICATIONS.

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC DATA CENTER.

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER ASHEVILLE NORTH CAROLINA

PRECIPITATION (inches)

MEMPHIS, TENNESSEE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1960	3.	3.08	4.20	3.65	4.20	5.34	1.30	7.84	4.05	4.11	3.62	4.30	49.43
1961	0	6.89	7.13	4.65	4.40	1.49	3.97	1.71	0.66	1.28	8.06	8.56	49.64
1962	4.19	4.22	4.80	3.62	0.84	5.71	3.94	4.18	5.28	2.57	2.31	1.35	43.01
1963	1.28	2.91	6.17	5.60	3.77	4.33	4.38	2.15	2.06	T	2.72	3.31	38.68
1964	3.73	3.50	7.34	11.03	3.28	1.39	6.14	5.76	2.74	2.21	2.59	7.97	57.68
1965	4.79	6.78	5.35	2.05	7.42	0.98	1.60	3.98	7.38	0.54	0.75	1.17	42.79
1966	2.84	6.88	1.50	5.42	5.69	0.52	2.18	4.28	3.23	1.92	1.57	5.21	41.24
1967	2.23	2.33	4.65	4.46	6.38	1.70	6.01	5.17	1.86	2.38	1.90	7.37	46.44
1968	5.57	1.98	6.52	5.15	5.21	3.76	2.69	1.61	5.58	2.87	4.89	6.04	51.87
1969	3.14	3.20	2.63	8.29	1.34	1.60	1.92	6.62	0.90	1.24	4.19	7.05	42.12
1970	1.16	3.87	5.32	7.08	3.70	5.76	4.99	1.78	3.80	6.20	2.62	3.71	49.99
1971	2.15	7.21	3.64	2.89	3.90	3.82	2.90	6.00	3.42	0.06	1.49	6.71	44.19
1972	4.73	2.23	4.80	3.51	4.55	5.50	4.89	1.94	5.46	3.92	8.05	9.37	58.95
1973	4.62	3.62	7.63	9.44	6.23	1.00	4.49	4.88	5.06	3.37	8.49	5.35	64.18
1974	8.90	4.65	3.40	6.34	7.76	6.30	6.33	4.78	3.45	2.67	4.96	5.03	64.57
1975	4.65	5.53	12.08	4.98	8.72	2.42	2.26	2.03	2.62	2.69	7.77	2.93	58.68
1976	2.85	4.41	7.68	2.41	4.73	4.05	3.82	0.86	5.40	5.66	1.83	1.79	45.50
1977	2.57	1.99	4.13	5.42	0.83	3.38	3.41	1.62	6.43	2.02	6.01	3.39	41.20
1978	8.13	1.31	4.05	2.14	8.14	4.45	3.89	9.65	1.52	1.82	5.56	13.12	63.78
1979	5.98	5.66	6.60	11.47	7.78	4.93	3.12	5.92	4.49	2.60	7.42	4.92	70.89
1980	3.23	1.12	10.66	7.53	4.43	5.75	4.73	1.23	5.32	3.14	5.23	1.86	54.43
1981	1.38	3.66	4.98	3.67	7.06	2.93	1.71	4.21	0.61	5.83	2.12	1.84	40.00
1982	6.61	4.16	4.47	6.76	5.50	6.68	4.13	3.11	1.92	5.23	6.43	13.81	68.81
1983	2.32	2.61	3.66	8.84	9.58	3.50	3.83	0.61	1.52	2.94	9.56	8.66	57.65
1984	1.88	4.37	6.07	5.24	9.06	1.12	4.59	5.00	1.96	7.75	5.85	4.35	57.24
1985	3.78	4.10	4.96	6.51	2.23	4.55	3.50	3.50	4.03	3.36	3.87	3.27	47.66
1986	0.57	2.50	1.90	3.72	4.63	3.80	1.21	2.74	1.21	3.75	8.67	3.92	38.62
1987	1.76	5.81	3.38	3.78	2.95	3.66	2.06	4.12	2.01	1.96	10.45	11.39	53.34
1988	4.25	3.49	4.20	2.85	2.38	2.15	5.21	0.85	4.73	3.62	10.52	5.99	50.24
1989	7.91	10.51	5.50	2.13	2.36	7.20	7.55	1.43	6.08	2.37	3.65	2.20	58.89
Record Mean	4.88	4.35	5.21	5.07	4.37	3.68	3.44	3.24	2.99	2.86	4.45	4.75	49.29

See Reference Notes on Page 6B.

AVERAGE TEMPERATURE (deg. F)

MEMPHIS, TENNESSEE

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
#1960	41.9	40.8	40.2	64.8	63.5	77.8	81.8	81.6	76.1	63.8	50.8	37.2	60.4
1961	36.1	47.2	55.1	58.2	66.7	75.1	80.2	77.8	74.6	62.5	49.6	42.4	60.4
1962	36.2	50.3	47.3	58.8	76.8	77.1	81.3	80.8	73.4	65.9	50.2	39.9	61.5
1963	34.4	37.6	56.7	64.2	71.1	78.6	80.1	80.2	73.4	68.6	53.4	31.5	60.8
1964	41.1	40.2	51.7	64.0	71.9	79.3	80.6	78.6	72.9	58.9	54.4	44.3	61.5
1965	43.4	42.9	44.0	66.4	74.7	78.1	81.8	80.2	73.7	60.8	55.8	45.8	62.3
1966	34.2	42.2	52.8	60.6	67.9	76.6	84.7	76.9	70.8	58.1	53.7	41.4	60.0
1967	42.2	39.2	56.7	66.5	68.8	78.3	77.7	76.0	70.3	62.4	48.1	45.0	61.0
1968	38.9	37.3	50.9	62.7	69.7	79.5	80.8	82.0	71.3	62.2	50.9	41.7	60.7
1969	41.2	43.3	45.0	62.9	72.1	78.8	84.9	79.3	72.9	62.9	49.0	40.1	61.1
1970	35.3	41.7	48.7	65.0	72.3	77.3	79.7	81.2	77.9	61.7	49.8	46.4	61.4
1971	39.6	43.5	48.4	60.5	66.6	80.6	80.6	78.6	76.1	69.3	50.9	50.7	62.1
1972	42.3	44.7	52.2	63.1	69.7	77.5	79.4	79.7	75.9	61.4	45.5	40.0	60.9
1973	38.6	40.5	57.3	59.8	68.3	81.0	83.2	79.6	76.1	67.6	57.3	43.3	62.7
1974	45.7	45.6	58.7	61.6	72.1	74.7	82.5	79.2	68.5	62.4	53.3	45.2	62.5
1975	45.9	46.2	49.9	61.9	73.5	78.8	81.1	81.2	70.9	65.8	53.8	44.1	62.8
1976	39.5	53.8	58.5	63.6	65.6	76.4	81.5	78.9	73.0	58.9	45.5	41.9	61.5
1977	30.7	45.1	58.6	66.9	76.4	81.9	84.7	82.6	79.0	62.2	55.1	44.1	64.0
1978	32.7	35.0	50.3	66.3	70.9	79.8	83.8	80.9	77.7	62.5	57.7	44.0	61.8
1979	30.9	38.5	54.3	63.0	70.0	77.9	82.6	80.9	73.4	65.8	50.7	45.4	61.1
1980	43.2	39.5	49.4	60.9	72.5	80.9	88.8	87.2	80.5	62.7	53.3	45.9	63.8
1981	40.9	47.3	54.3	70.2	70.0	82.5	84.6	81.8	74.0	62.5	53.8	40.9	63.6
1982	36.6	40.5	55.5	58.5	74.5	78.0	85.0	82.9	73.3	63.7	53.4	49.5	62.6
1983	40.4	45.3	51.9	56.8	68.2	77.2	83.6	84.9	75.2	66.2	53.1	34.7	61.5
1984	35.9	47.6	51.1	61.0	69.5	80.9	80.9	79.8	71.9	68.4	50.9	53.8	62.6
1985	32.4	40.6	57.7	65.0	71.8	78.9	82.2	80.2	73.6	67.2	57.6	36.9	62.0
1986	41.9	48.0	55.2	64.4	72.5	81.0	86.5	79.2	79.1	64.2	51.1	42.6	63.8
1987	39.6	47.1	54.7	62.2	76.5	80.0	82.5	83.6	75.3	59.2	54.4	46.7	63.5
1988	36.8	42.2	52.3	62.8	71.8	80.3	81.6	83.7	76.3	59.1	54.6	44.9	62.2
1989	47.3	40.0	53.8	62.6	69.5	77.6	80.7	81.2	72.4	64.2	54.2	33.6	61.4
Record Mean	40.8	44.0	52.5	62.3	70.6	78.4	81.4	80.2	74.2	63.5	51.8	43.5	61.9
Max	48.8	52.4	61.5	71.6	79.8	87.4	90.2	89.1	83.5	73.6	60.9	51.5	70.8
Min	32.8	35.5	43.4	52.9	61.3	69.3	72.7	71.3	64.9	53.4	42.7	35.5	53.0

See Reference Notes on Page 6B.

	29	30	31	01	02	03	04	05	06
0000	29.530	29.625	29.690	29.720	29.715	29.665	29.680	29.710	29.650
0100	29.525	29.630	29.680	29.710	29.690	29.675	29.680	29.700	29.635
0200	29.535	29.635	29.695	29.710	29.690	29.690	29.680	29.695	29.620
0300	29.550	29.635	29.690	29.700	29.690	29.710	29.680	29.705	29.635
0400	29.560	29.650	29.705	29.720	29.715	29.695	29.680	29.710	29.640
0500	29.580	29.660	29.710	29.725	29.720	29.720	29.700	29.725	29.650
0600	29.600	29.705	29.735	29.750	29.730	29.735	29.735	29.735	29.655
0700	29.620	29.670	29.730	29.750	29.720	29.740	29.755	29.740	29.645
0800	29.640	29.685	29.745	29.770	29.665	29.735	29.770	29.750	29.650
0900	29.640	29.690	29.735	29.755	29.650	29.725	29.765	29.745	29.650
1000	29.650	29.685	29.740	29.760	29.680	29.750	29.770	29.720	29.650
1100	29.650	29.685	29.735	29.745	29.690	29.755	29.765	29.705	29.650
1200	29.630	29.705	29.725	29.735	29.690	29.735	29.755	29.690	29.625
1300	29.620	29.690	29.705	29.725	29.695	29.750	29.750	29.685	29.620
1400	29.615	29.675	29.715	29.715	29.690	29.715	29.735	29.660	29.635
1500	29.590	29.695	29.715	29.700	29.690	29.705	29.730	29.635	29.620
1600	29.600	29.635	29.690	29.690	29.650	29.680	29.725	29.615	29.620
1700	29.600	29.650	29.690	29.685	29.570	29.655	29.725	29.605	29.600
1800	29.590	29.660	29.715	29.680	29.625	29.640	29.720	29.590	29.600
1900	29.580	29.665	29.720	29.685	29.645	29.635	29.720	29.595	29.585
2000	29.590	29.675	29.730	29.690	29.640	29.640	29.720	29.605	29.590
2100	29.635	29.685	29.735	29.690	29.650	29.645	29.735	29.635	29.620
2200	29.675	29.680	29.730	29.715	29.650	29.665	29.740	29.650	29.650
2300	29.665	29.685	29.730	29.705	29.650	29.665	29.735	29.650	29.665

	07	08	09	10	11	12	13	14	15
0000	29.665	29.705	29.705	29.765	29.810	29.750	29.690	29.710	29.635
0100	29.665	29.705	29.715	29.755	29.800	29.745	29.675	29.705	29.620
0200	29.665	29.705	29.720	29.760	29.805	29.745	29.665	29.700	29.620
0300	29.675	29.710	29.720	29.780	29.810	29.750	29.670	29.700	29.620
0400	29.690	29.710	29.730	29.780	29.820	29.750	29.680	29.705	29.635
0500	29.705	29.720	29.735	29.805	29.850	29.765	29.690	29.720	29.635
0600	29.715	29.715	29.735	29.815	29.860	29.780	29.715	29.735	29.640
0700	29.720	29.730	29.765	29.825	29.870	29.795	29.720	29.745	29.625
0800	29.730	29.735	29.765	29.835	29.890	29.795	29.730	29.750	29.625
0900	29.730	29.720	29.765	29.840	29.890	29.795	29.720	29.745	29.640
1000	29.730	29.720	29.735	29.845	29.880	29.780	29.720	29.735	29.635
1100	29.720	29.720	29.735	29.835	29.865	29.770	29.720	29.715	29.635
1200	29.710	29.715	29.730	29.825	29.845	29.750	29.720	29.700	29.640
1300	29.685	29.710	29.715	29.815	29.830	29.735	29.705	29.685	29.630
1400	29.670	29.690	29.725	29.805	29.810	29.720	29.705	29.655	29.610
1500	29.660	29.670	29.725	29.790	29.795	29.705	29.690	29.640	29.585
1600	29.650	29.670	29.725	29.765	29.780	29.695	29.680	29.635	29.580
1700	29.645	29.670	29.730	29.760	29.765	29.685	29.670	29.640	29.570
1800	29.650	29.655	29.735	29.770	29.755	29.680	29.670	29.620	29.580
1900	29.655	29.680	29.720	29.765	29.750	29.680	29.680	29.620	29.565
2000	29.665	29.680	29.735	29.795	29.750	29.685	29.685	29.605	29.570
2100	29.650	29.690	29.740	29.815	29.755	29.695	29.695	29.620	29.575
2200	29.660	29.700	29.755	29.820	29.765	29.700	29.695	29.625	29.590
2300	29.685	29.705	29.760	29.820	29.765	29.690	29.705	29.650	29.605

16

00	29.590
[illegible]00	29.595
0200	29.595
0300	29.605
0400	29.605
0500	29.620
0600	29.635
0700	29.640
0800	29.640
0900	29.635
1000	29.635
1100	29.635
1200	29.625
1300	29.610
1400	29.600
1500	29.590
1600	29.590
1700	29.595
1800	29.600
1900	29.600
2000	29.605
2100	29.620
2200	29.635
2300	29.625

Appendix 2 — Statement for Shipping Tickets and Invoices

Note - A Federal law (the Resource Conservation and Recovery Act (RCRA), as amended (Pub. L. 98-616)) requires owners of certain underground storage tanks to notify designated State or local agencies by May 8, 1986, of the existence of their tanks. The Tennessee Petroleum Underground Storage Tank Act (*T.C.A.* *§68—53—101 et seq.*) also contains notification requirements. Notifications for tanks brought into use after July 1, 1989 must be made 15 days in advance of installation. Consult EPA's regulations, issued on November 8, 1986 (40 CFR Part 280) and state law (*T.C.A.* *§68—53—101 et seq.*) and state regulations (Chapter 1200—1—15) to determine if you are affected by these laws and regulations.

Appendix 3

PETROLEUM CONTAMINATION CLEANUP LEVELS

GROUND WATER CLEANUP LEVEL

	BENZENE LEVEL	TOTAL PETROLEUM HYDROCARBON LEVEL
DRINKING WATER	0.005 PPM	0.100 PPM
NON—DRINKING WATER	0.070 PPM	1.0 PPM

Appendix 4

PETROLEUM CONTAMINATION CLEANUP LEVELS

SOIL PERMEABILITY	$>10^{-4}$ CM/SEC	10^{-4} TO 10^{-6} CM/SEC	$<10^{-6}$CM/SEC
SOIL CLEANUP LEVEL		B.T.X. LEVEL PPM	
DRINKING WATER	10	50	100
NON-DRINKING WATER	50	250	500

OR

TOTAL PETROLEUM HYDROCARBON CLEANUP LEVELS

SOIL PERMEABILITY	$>10^{-4}$ CM/SEC	10^{-4} TO 10^{-6} CM/SEC	$<10^{-6}$CM/SEC
SOIL CLEANUP LEVEL		T.P.H. PPM LEVEL	
DRINKING WATER	100	250	500
NON-DRINKING WATER	250	500	1000

DRAFT

EFFECTIVE

PROCEDURE TO DETERMINE THE GROUNDWATER CLASSIFICATION OF A SITE

Any aquifer or water supply which has been contaminated by a petroleum product from an underground storage tank will be classified as "NON-DRINKING WATER" if:

The ground water does not meet any of the primary or secondary drinking water standards or;

The affected aquifer provides a yield of less than one-half gallon per minute.

Unless, it is currently being used as a water supply for drinking by the citizens of the state.

The following limits have been set as primary and secondary drinking water standards as defined under Rule 1200-5-1:

A. PRIMARY STANDARDS

1.) INORGANIC CHEMICALS

INORGANIC CHEMICALS	LEVEL, PPM
ARSENIC	0.05
BARIUM	1.0
CADMIUM	0.010
CHROMIUM	0.05
FLUORIDE	4.0
LEAD	0.05
MERCURY	0.002
NITRATE (as N)	10.0
SELENIUM	0.01
SILVER	0.05

2.) ORGANIC CHEMICALS

a.) CHLORINATED HYDROCARBONS:

ENDRIN (1,2,3,4,10,10-HEXACHLORO-6, 7-EPOXY 1,3,3A,5,6,7,8,8A OCTAHYDRO-1, 4-ENDO,ENDO-5,8-DI-METHANO NAPHTHALENE)	0.0002
LINDANE (1,2,3,4,5,6-HEXACHLORO-CYCLOHEXANE, GAMMA ISOMER)	0.004
METHOXYCHLOR (1,1,1 TRICHLORO-2,2-BIS P-METHOXYPHENYL ETHANE)	0.1

TOXAPHENE ($C_{10}H_{10}CL_8$-TECHNICAL CHORINATED CAMPHENE, 67-69 PERCENT CHLORINE)	0.005

b.) CHLOROPHENOXYS:

2,4-D(2,4-DICHLOROPHENOXYACETIC ACID)	0.1
2,4,5-TP SILVEX (2,4,5-TRICHLOROPHENOXY-PROPIONIC ACID)	0.01

3.) TURBIDITY -- See attached

4.) MICROBIOLOGICAL -- See attached

5.) RADIONCULIDES -- See attached

6.) VOLATILE ORGANIC CHEMICALS (Naturally occurring)

TRICHLOROETHYLENE	0.005
CARBON TETRACHLORIDE	0.005
VINYL CHLORIDE	0.002
1,2-DICHLOROETHANE	0.005
BENZENE	0.005
1,1-DICHLOROETHYLENE	0.007
1,1,1-TRICHLOROETHANE	0.20
PARA-DICHLOROBENZENE	0.075

B.) SECONDARY STANDARDS

CHLORIDE	250
COLOR (In Color Units)	15
COPPER	1
MBAS (METHYL BLUE ACTIVE SUBSTANCE)	0.5
IRON	0.3
MANGANESE	0.05
ODOR (In Threshold Odor Number)	3
pH	6.5-8.5
SULFATE	250
TDS (TOTAL DISSOLVED SOLIDS)	500
ZINC	5
FLUORIDE	2.0

The groundater samples used for the above analyses most be from a well on the facility's property where the release occurred and which has not been contaminated by a petroleum product.

If the analyses of the groundwater meet all of the primary and secondary drinking water analyses a pump test must be performed on a well to determine the yield of the affected aquifer or water supply. This pump test should be performed on a well with an interior diameter of at least four (4) inches and a screen or open borehole length of at least twenty (20) feet below the static water level. If the well has been cased the slot size must be equal to or greater than #####. The well must be pumped at a constant rate of one-half gallon per minute for an eight (8) hour period. Data must be supplied to this Division documenting that the pump rate was maintained at a constant rate for the entire eight (8) hour pump test.

If the affected groundwater is within a confined aquifer or artesian system then the screened or open borehole section must be within that water bearing zone.

The water generated during the pump test must be properly managed if it is above the Divisions drinking water limit.

PROCEDURE TO DETERMINE THE SOIL PERMEABILITY OF A SITE

The full vertical and horizontal extent of the contaminated zone must be determined in both the soil and groundwater, to the satisfaction of the Tennessee Division of Underground Storage Tanks, before a site is eligible for a less stringent cleanup level. A soil contaminant zone is defined as the volume of soil containing greater than 10 parts per million benzene, toluene, xylene (BTX) and/or 100 parts per million total petroleum hydrocarbons (TPH), this includes material in both the saturated and unsaturated zones. A groundwater contaminant plume is defined as the volume of water containing greater than 5 parts per billion benzene and/or 100 parts per billion TPH.

Use Table 1 to determine the required number of borings.

TABLE 1

AREAL EXTENT OF SOIL CONTAMINANT ZONE (SQUARE FEET)	MAXIMUM LINEAR DISTANCE (FEET)	NUMBER OF BORINGS
LESS THAN 5,000	140	2
BETWEEN 5,000 AND 10,000	200	3
BETWEEN 10,000 AND 20,000	280	4
GREATER THAN 20,000		SITE SPECIFIC

When using Table 1, the minimum number of required borings is determined based on the areal extent of the contamination. If the maximum linear distance of the contaminant zone is greater than the corresponding linear distance in Table 1, then at least one additional boring will be required. The Division may require additional borings based on site specific conditions.

If soil contamination is contained within the unsaturated zone, two permeabilities must be determined in that boring. The first should be within the zone of contamination. The second should be in the zone directly underneath the contaminated zone. Each of these permeabilities must be determined from an undisturbed soil sample utilizing the Pressure-Chamber method in Section 2.9 of Method 9100.

If soil contamination is present at the potentiometric surface, two permeabilities must be determined in that boring. One permeability must be determined in the unsaturated zone using an undisturbed soil sample utilizing the Pressure-Chamber method in Section 2.9 of Method 9100.

The other permeability must be determined in the saturated zone using a single well test method for moderately permeable materials under unconfined conditions in Section 3.4.3 of Method 9100.

If soil contamination is encountered at the soil/bedrock interface, only one permeability will be required from that boring. This permeability must be taken directly at the soil/bedrock interface. A single well test method for moderately permeable materials under unconfined conditions in Section 3.4.3 of Method 9100 must be conducted if a saturated condition is encountered at or above the interface. The Pressure-Chamber method in Section 2.9 of Method 9100 must be used if an unsaturated condition is encountered at the interface.

Other permeability test methods may be used if they are approved by this Division prior to being implemented. If a multiple well test method is used for saturated conditions, one additional well will be necessary for the permeability testing.

If a field method is used to determine the soil permeability, a minimum of two test must be performed on each sample location. The highest permeability for a location will be applied for that location.

The highest permeability determined in any of the borings will be used to determine the appropriate clean-up level for the soils for the entire site. The site cannot be divided into different zones of permeability for different cleanup levels.

Regardless of the calculated permeability of the site, this Division reserves the right to apply a more stringent cleanup level if it is deemed necessary.

Prior to determining the permeability of a site the following information should be submitted to this Division for review and approval:

1. The permeability method(s) which will be used on the site.

2. A description of the procedure which will be used to implement the selected method(s).

3. The depths at which the permeabilites will be taken and the justification for selecting the depths.

4. If a laboratory method is used to determine the permeability of a soil, describe the following:

   The method of retrieving the soil sample;

   The method for storing and transporting the sample to the laboratory, to insure that it is undisturbed.

5. If a field method is used to determine the permeability

of a soil, describe the following:

Boring installation method;

The type and diameter of the casing, if used;

The slot size and length of screen, if used;

The type and size of annulas fill;

The location and thickness of the bentonite plug and cement grout, if used;

Well development method.

6. A site map, drawn to scale, showing the following:

   All underground utilities and structures that could alter the natural permeability of a site;

   The contaminant zone;

   The location of the borings which will be used for the permeability tests.

7. A stratigraphic cross sectional diagram, drawn to scale, showing the following:

   The location and the depth at which the permeabilities will be taken;

   The anticipated soil strata that comprise the site. This information should have been generated during the implementation of the environmental assessment;

   The vertical extent of the contaminant zone;

   The potentiometric surface.

WELL 14 - COOPER JACOB METHOD

$T = 264\,Q/\,\Delta h$

$S = 0.3\,T\,to/\,r^2$

where

T =	transmissivity in Gal/day/ft
Q =	discharge gal/min
to =	intercept where drawdown line intercepts the zero drawdown axis
r =	distance from pumping well to observation well (ft)
Δh =	change in head over 1 log cycle (ft) (read from graph)

T = 264 x .2 gal/min/1.05 ft

T = 50.2857 gal/day/ft

$S = 0.3\,T\,to/r^2$

S = 0.3x0.0503804 days x 50.2857 gal/day/ft/(.9.75)^2

S = 0.0007995

AIR PERMEABILITY

$$K = \frac{\left[\frac{Qn}{h \pi Pw}\right] \ln\left(\frac{Rw}{Rm}\right)}{\left[1 - \left(\frac{Pm}{Pw}\right)^2\right]}$$

Q corrected = 8.6 ft³/min = 4056 cm3/s

$$= \frac{\left[\frac{(4056)\left(\frac{cm^3}{s}\right)(1.8 \times 10^{-4})\left(\frac{g}{cm\text{-}s}\right)}{(304.8)\ cm\ \pi\ (7.867 \times 10^{-5})\left(\frac{g}{cm\text{-}s^2}\right)}\right] \ln\left(\frac{7.62\ cm}{114.3\ cm}\right)}{\left[1 - \left(\frac{1.001 \times 10^{6}\left(\frac{g}{cm\text{-}s^2}\right)}{7.867 \times 10^{5}\left(\frac{g}{cm\text{-}s^2}\right)}\right)^2\right]}$$

n = 1.8 x 10-4 g/cm-s

h = 304.8 cm

Rw = 3 in = 7.62 cm

Rm = 3.75 ft. = 114.3 cm (Extraction well 12 to monitoring well 14)

$$Pw = 1.01 \times 10^{6}\left(\frac{g}{cm\text{-}s^2}\right) - [90''(2480.6)]$$

$$= 7.867 \times 10^{5}\left(\frac{g}{cm\text{-}s^2}\right)$$

$$Pm = 1.01 \times 10^{-6}\left(\frac{g}{cm\text{-}s^2}\right) - [3.6''\ (2480.6)]$$

$$= 1.001 \times 10^{6}\left(\frac{g}{cm\text{-}s^2}\right)$$

$K = 4.2 \times 10^{-9}$ cm2

EFFECTIVE RADIUS OF INFLUENCE

$$Rie = \frac{Q}{2 \pi v h}$$

Q corrected = 8.6 ft^3/min @ 90" H_20 at well head

V = 3.281 x 10^{-2} ft/min.
h = 10 ft.

$$Rie = \frac{8.6 \ ft^3/min}{2 \pi (3.281 \times 10^{-2}) \ ft/min \ (10) \ ft.}$$

= 4.2 ft

SOIL VAPOR PARTITIONING COEFFICIENT

$$S_{VP} = \frac{Cg}{Cs \ bd}$$

$$= \frac{(230) \ mg/L}{(1700) \ mg/kg \ (1.68) \ kg/L}$$

= 0.081

Cg = 230 mg/L (average soil gas VOC concentration)

Cs = 1700 mg/kg (VOC concentration in soil from boring A7, 5'-7' below surface grade)

bd = 1.68 kg/L

REQUIRED NUMBER OF PORE VOLUMES

$$N = \frac{\ln (C^*s/Cs)}{\ln (1 - Svp)}$$

$C^*s = 250$ mg/kg (assumed VOC target concentration in soil)

$Cs = 1{,}700$ mg/kg (VOC concentration detected in soil)

$Svp = 0.081$

$$= \frac{\ln \dfrac{250 \text{ mg/kg}}{1700 \text{ mg/kg}}}{\ln (1-0.081)}$$

$$= \underline{\underline{22.7}}$$

TIME REQUIRED TO REDUCE SOIL CONCENTRATIONS

$$t = \frac{Rie^2 \pi N h\, ap}{Q}$$

$Rie = 4.2$ ft

$N = 22.7$

$h = 10$ ft

$ap = 0.083$

$Q = 8.6$ ft^3/min

$$= \frac{(4.2)^2 \text{ ft}^2 \pi (22.7) (10) \text{ ft} (0.083)}{8.6 \text{ ft}^3\text{/min}}$$

$$= \underline{\underline{121.4 \text{ min}}}$$

which is low, indicating at least one pore volume of air from outside of the plume was not allowed to pass across the soil mass.