01.02- 10/26/94 - 00290

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT

CAMP GEIGER FUEL FARM MARINE CORPS BASE

CAMP LEJEUNE, NORTH CAROLINA

October 26, 1994

Law Engineering Job No. 475-08135-01

Law Engineering, Inc.
Raleigh, North Carolina

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

October 26, 1994

Commander
Naval Facilities Engineering Command
Atlantic Division
Norfolk, Virginia 23511-6287

Attention: Mr. Mark Barnes, Code 18215
Engineer-In-Charge

Subject: **ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT**
CAMP GEIGER FUEL FARM, MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

Dear Mr. Barnes:

In accordance with Naval Facilities Engineering Command Order for Supplies and Services Contract No. N62470-90-D-7625/0002 dated September 29, 1990, Law Engineering is pleased to present this addendum to the report of our environmental services for the above-referenced project site. The scope of our services, as described in the attached report, included drilling of three soil-test borings and collecting soil samples for chemical testing; installing three groundwater monitoring wells and collecting groundwater samples for chemical testing; performing an eight-hour aquifer test using the three newly-installed wells; and interpreting the data from the pump test to estimate the hydraulic characteristics of the aquifer.

This report is intended for the exclusive use of Naval Facilities Engineering Command, Atlantic Division. The contents should not be relied upon by any other parties without the express, written consent of Law Engineering. The findings are relevant to the dates of our site work and should not be relied upon to represent site conditions on other dates.

LAW ENGINEERING, INC.
3301 ATLANTIC AVENUE • RALEIGH, NC 27604
P. O. BOX 18288 • RALEIGH, NC 27619
(919) 876-0416 • FAX (919) 872-3253
ONE OF THE LAW COMPANIES

We appreciate the opportunity to continue to work with you and the Navy on your environmental projects. If any questions arise, please contact us at (919) 876-0416.

Sincerely,

LAW ENGINEERING, INC.

Richard A. Kolb, P.G.
Senior Geologist

W. Douglass Dixon, P.E.
Principal Engineer

RAK/WDD/rak/bro/kkc

cc: Mark Spangler
Kathy Molino

01.02 - 10/26/94 - 00290

TABLE OF CONTENTS

TABLES

DRAWINGS

DRAWINGS CONTINUED

APPENDICES

1.0 INTRODUCTION

1.1 Purpose of the Investigation

On September 29, 1990, the Commander of the Atlantic Division Naval Facilities Engineering Command (LANTDIV) in Norfolk, Virginia, contracted with Law Companies Group, Inc. to perform a Comprehensive Site Assessment (CSA) at the Camp Geiger Fuel Farm, Marine Corps Base (MCB), Camp Lejeune, North Carolina (Drawing 1.1). The purpose of the investigation was 1) to identify the presence, magnitude and extent of possible free-product accumulation and groundwater contamination and 2) to assess potential exposure to subsurface contaminants resulting from the release(s) of petroleum fuels. As stated in Law Engineering's CSA Workplan dated July 25, 1991, the objective of the investigation was to provide sufficient data to meet the requirements of Sections 280.63 and 280.65 of 40 CFR Part 280, Federal Technical Standards for Underground Storage Tanks and Sections .0704 and .0706 of Title 15A, Chapter 2, Subchapter 2N, North Carolina Criteria and Standards Applicable to Underground Storage Tanks.

The assessment activities presented in the CSA Workplan were completed and a report, entitled "Final Report, Underground Fuel Investigation, Comprehensive Site Assessment", was issued to the Commander of the Atlantic Division, Naval Engineering Facilities Command on February 8, 1992. Based upon the results of the initial assessment, it was determined that additional assessment was necessary to fully characterize the southern extent of petroleum contamination resulting from the underground fuel release and that performing an aquifer pumping test was necessary to estimate the hydraulic characteristics of the surficial aquifer.

1.2 Scope of Work

Authorization to proceed with the investigation was granted by the Commander of LANTDIV of Norfolk, Virginia, via Addendum to Contract/Purchase Order No. N62470-90-D-7625/0002. As outlined in the contract, the scope of work included preparing a health and safety plan, advancing three soil borings, installing three monitoring wells, collecting and analyzing soil and groundwater samples, performing an eight-hour pumping test of the surficial aquifer, preparing an addendum to our report of investigation, and presenting our data and conclusions. Specific methods employed while performing the project activities are described in this report, which presents a summary of the additional assessment activities performed during October and November 1992.

2.0 SUBSURFACE CONTAMINATION ASSESSMENT

2.1 Installation of the Monitoring Wells

Law Engineering performed field activities on October 28 and 29, 1992, which consisted of advancing three soil borings. One of these borings was subsequently used to install pumping well 28 (PW-28). The remaining two borings were used to install monitoring wells 26 (MW-26) and MW-27, used as observation wells during the pumping test. The locations of these wells are shown on Drawing 3.1. The numbers of the drawings included in this addendum report correspond with those in our February 1992 report.

Law Engineering accomplished all drilling using hollow-stem augers and techniques described in ASTM D-1452. We steam-cleaned our down-hole drilling equipment prior to work at each drilling location. We used augers with an inside diameter of 6.25 inches for drilling each boring. The site geologist collected soil samples from each of the soil borings for field classification, headspace testing and chemical testing. We generally obtained soil samples for field classification at depths of 0 to 1.5 feet, 1.5 to 3 feet, 3 to 4.5 feet and on 5-foot centers thereafter to boring termination. We collected these soil samples with a split-spoon sampler 24 inches long and with an inside diameter of 1.375 inches (outside diameter of 2 inches). We obtained each soil sample by continually dropping a 140-pound hammer for 30 inches, until the sampler was driven 18 inches into the substrate. We performed split-spoon sampling in general accordance with ASTM D-1586 and recorded on the field boring log the number of blows required to drive the sampler each 6-inch increment. After donning laboratory-grade gloves, we placed representative portions of each sample in two, pre-labeled plastic bags and sealed each bag for subsequent headspace testing.

The site geologist examined in the field the soil sample collected at each interval using visual/manual techniques described in ASTM D-2487 and ASTM D-2488. We classified the soil in general accordance with the United Soil Classification System. We have included a record of each test boring in Appendix A.

We collected one soil sample from the boring for the pumping well to test for grain-size distribution. We used the data from this test in calculations to estimate the hydraulic conductivity of the surficial aquifer. The results of this grain-size test are included in Appendix B.

The specifications for each soil boring included decontaminating the drilling equipment with a pressurized steam-cleaning unit, emplacing a silica-sand filter pack and a bentonite seal above the filter pack and grouting the well above the bentonite seal with a cement/bentonite slurry, and developing the well through low-yield pumping. Development water was discharged to the oil/water separator which is located east of the fuel farm, as directed by activity personnel.

The screened intervals of the two observation wells are constructed of Schedule 40 PVC with an inside diameter of two inches. The screened interval of the pumping well is constructed of Schedule 40 PVC with an inside diameter of four inches. The risers for each of the three wells are constructed of Schedule 80 PVC. Each of the wells constructed by Law Engineering has a lockable cap and is protected by a flush-mount cover constructed of steel. Details for installing the monitoring wells are included in Appendix C. Upon installation, each well was developed through low-yield pumping. In Table 3.1, we have summarized the approximate volumes of water removed during well development and our observations of turbidity of the development water. The numbers of the tables included in this report correspond with those in our February 1992 report.

2.2 Assessment of Soil Contamination

2.2.1 Scanning Procedures

Law Engineering monitored all soil-investigation activities with an organic vapor analyzer (OVA) manufactured by Foxboro (Model 128) which had been calibrated using methane. We used the OVA to qualitatively measure total volatile organics in

the borehole, in ambient air, and in the individual soil samples. Values recorded with the OVA are qualitative and are not directly comparable to actual laboratory analytical results. However, the OVA is useful in providing a relative indication of the presence of volatile organics in soil samples.

2.2.2 Collection of Soil Samples

We collected soil samples from each boring for headspace testing and laboratory chemical analysis according to the following procedure:

- Drive the decontaminated split-spoon sampler to the desired depth interval.

- Retrieve and immediately open the split-spoon sampler. Quickly remove portions of sample aliquots from the split-spoon sampler and place the sample into two, pre-labeled, airtight plastic bags. Carefully execute sample handling in an effort to reduce the loss of the volatile organics. Seal and place the bags in a warm location.

- After approximately 10 minutes, test the headspace gas in one of the two bags with the OVA and record the peak value. This procedure was conducted for the soil sample collected at each sample-depth interval.

- From the soil samples collected from each boring, two samples were targeted for chemical testing. For those samples, the paired sample was transferred to a laboratory-supplied glass container, placed into a cooler, packed on ice and shipped to the laboratory for chemical analysis. Law Engineering maintained

custody of the samples until shipment. Chain of custody forms are included in Appendix D.

2.2.3 Results of the Soil Sampling

A summary of headspace testing is presented in Table 4.1. Volatile organics were not detected in the boreholes for MW-26 and MW-27. Volatile organics were detected in excess of the equipment detection limit of 0.2 parts per million (ppm) in samples collected from the borehole for PW-28 at depths below the water table.

We have presented a summary of laboratory analyses of the soil samples collected from MW-26, MW-27 and PW-28 in Table 4.2. Copies of the laboratory test reports are included in Appendix E. The selected soil samples were tested for total petroleum hydrocarbons (TPH) using EPA Methods 3550 (semi-volatiles) and 5030 (volatiles). The laboratory did not detect TPH in the soil samples collected from these three wells.

We have modified two of our isopleth maps (Drawings 4.3 and 4.3.1) to include the locations of MW-26, MW-27 and PW-28. TPH was not detected in the soil samples from these three wells; therefore, the contours on these isopleth maps did not change from those in our February 1992 report.

2.3 Assessment of Groundwater Contamination

2.3.1 Procedures for Sampling the Monitoring Wells

Law Engineering installed three wells during the investigation to complement the 25 wells installed during previous investigations. Prior to sampling each of the three,

newly-installed wells, Law Engineering measured and recorded the depth to groundwater using an electronic, water-level probe. We recorded the data collected and observations made on the Monitoring Well and Sampling Field Data Worksheets (Appendix E). Groundwater elevations relative to sea level for the newly-installed wells are shown on the Monitoring Well Casing and Water Elevation Worksheet (Appendix F).

Law Engineering evacuated the newly-installed wells prior to collecting groundwater samples to remove stagnant water from the well casing and sand pack. We performed this task in an effort to collect samples representative of the water quality in the surficial aquifer. To evacuate the observation wells, we used decontaminated, Teflon bailers attached to new nylon cord; to evacuate the pumping well, we used an Arch Well Development Pump. We measured and recorded specific conductance, pH, and water temperature throughout the evacuation process. We generally evacuated the wells of at least three standing well volumes and until indicator parameters had stabilized.

Prior to sampling the wells, Law Engineering personnel donned laboratory-grade gloves. We collected the water samples and immediately decanted the samples from the bailer into pre-labeled sample containers. We sealed the containers, stored the containers in a chilled cooler, and maintained custody of the samples until shipment at the end of the day.

2.3.2 Results of the Groundwater Sampling

We have presented a summary of laboratory analyses of the groundwater samples collected from all of the monitoring wells, including MW-26, MW-27 and PW-28, in

Table 4.4. Copies of the laboratory test reports are included in Appendix H. We tested the groundwater samples from MW-26, MW-27 and PW-28 for purgeable aromatic hydrocarbons by EPA Method 602, modified to include total xylenes and methyl tertiary butyl ether (MTBE). The laboratory did not detect constituents of petroleum hydrocarbons in the groundwater samples from MW-27 and PW-28. In the sample from MW-26, the laboratory detected total xylenes at a concentration of 1 µg/L and MTBE at a concentration of 12 µg/L. The North Carolina Groundwater Quality Standard for total xylenes is 400 µg/L and for MTBE is 50 µg/L. Therefore, the concentrations of these constituents in MW-26 are below the state standards.

We have modified six isopleth maps from the February 1992 report (Drawings 4.7, 4.7.1 through 4.7.4 and 4.13) to include the locations of MW-26, MW-27 and PW-28. Benzene, toluene and ethylbenzene were not detected in the groundwater samples from these three wells; therefore, we did not change the contours for these constituents on the isopleth maps (Drawings 4.7.1, 4.7.2 and 4.7.3, respectively). We also did not change the contours of the isopleth maps of total xylenes concentrations (Drawing 4.7.4) and combined BTEX concentrations (Drawing 4.7). Since the concentration of 1 µg/L of total xylenes detected by the laboratory in the groundwater sample from MW-26 is the same as the laboratory detection limit, it is possible that this concentration is a result of laboratory-induced contamination or handling of the samples during shipment.

Law Engineering documented MTBE at concentrations below the State Standard of 50 µg/L in the groundwater sample from MW-26 and in the water collected during the pumping test performed on PW-28. MW-26 and PW-28 are hydraulically upgradient of the contaminant source at the Tank Farm; therefore, the MTBE documented in the

groundwater from these wells is possibly not related to activities at the Tank Farm. As we documented in our previous report, we also could not identify a likely source for the MTBE detected in the sample collected from MW-9, which is located west of the Tank Farm and of MW-26/PW-28. Because of the isolated occurrence of MTBE in several of the wells and no discernible pattern of contaminant migration, we are unable to offer an explanation as to other sources of MTBE.

3.0 SITE HYDROGEOLOGY

3.1 Eight-Hour Pumping Test

Law Engineering conducted an eight-hour pumping test during November 1992 at PW-28 to determine the performance characteristics of the well and to estimate the hydraulic parameters of the aquifer. Yield and drawdown were recorded so that the specific capacity of the well could be calculated. These data give a measure of the productive capacity of the well and provide information needed for the selection of appropriately sized pumping equipment which may be necessary during the corrective action phase of the project. The pumping test also provided data from which to determine the transmissivity and storativity of the surrounding aquifer in order to predict the size and shape of capture zones produced during pumping of individual or multiple extraction wells.

3.1.1 Pumping-Test Procedures

Prior to the actual pumping test, PW-28 was pumped for approximately one hour to determine the approximate well yield. This "pre-test" data was necessary to select

the proper size pump and to establish the pumping rate to be used during the test.

During the pumping test, the groundwater pumped from PW-28 was stored in a tanker. The laboratory tested a water sample collected from this tanker for purgeable aromatics by EPA Method 602, modified to include total xylenes and MTBE. The discharged water was transported off the site by P&W Oil Company, which is storing the water for future disposal.

The eight-hour pumping test was conducted on November 4, 1992. During the test, a constant pumping rate of approximately 4.1 gallons per minute was maintained and the drawdown in each of the surrounding observation wells -- MW-22S, MW-26 and MW-27 -- was measured and recorded at appropriate time intervals. These data are summarized in Appendix I. As summarized, after eight hours of pumping PW-28, approximately 2,360 gallons of groundwater were extracted and drawdowns were as follows:

Observation Well	Distance from PW-28	Drawdown
MW-22S	113 feet	0.08 feet
MW-26	32 feet	0.22 feet
MW-27	88 feet	0.01 feet

3.1.2 Estimating Aquifer Parameters

The data collected during the pumping test were used to calculate the storativity and transmissivity of the surrounding aquifer. These determinations were made by using

type curve matching, time-downdown method, and the In-Situ computer software, TS-Match Theis Curve Automated Matching Program. TS-Match uses relative least-squares and the Newton-Raphson iterative method to solve the Theis solution, where:

$$s = \frac{Q}{\pi T} \int_u^{\infty} \frac{e^{-u}}{u}\, du,$$

where:
s = drawdown
Q = pumping rate, in gpm
T = Transmissivity, in gpd/ft
u = $(r^2S)/(4Tt)$, where
r = radial distance, in feet, from the pumped well to the observation well,
S = storage coefficient, and
t = time

The TS-Match program makes the following assumptions:

- the production rate is constant.
- the aquifer is homogeneous, non-leaky, and there is no recharge.
- the aquifer has very large areal extent. If this is not the case, a mechanism has been provided to ignore data which the user considers are strongly influenced by the limited extent of the aquifer.
- water removed from storage is discharged instantaneously with decline in head (i.e., no delayed-yield effects).
- for analyzing production well data, skin (well loss) = 0.
- for analyzing production well data, wellbore storage is not accounted for. However, a mechanism has been provided to ignore data that may be influenced by wellbore storage.

In addition, the data were also analyzed manually by the type-curve matching method and the manual time-drawdown method to confirm the solution presented by TS-Match. We also analyzed grain-size distribution data from well PW-28 to estimate hydraulic conductivity. The field data and calculations are presented in Appendix I. The Type-curve matching, TS-Match, time-drawdown and grain size distribution solutions are as follows:

SUMMARY OF AQUIFER PARAMETER ESTIMATIONS

AQUIFER PARAMETER	WELL NUMBER		
	MW-22S	MW-26	PW-28
I. Transmissivity (ft^2/day) by:			
a) Type Curve Matching	3064	1570	
b) Time-Drawdown	3911	1026	
c) Theis Curve Matching (Computer Program)	4226	988	
II. Specific Storage by:			
a) Type Curve Matching	0.003	0.008	
b) Time-Drawdown	0.001	0.006	
c) Theis Curve Matching	0.0015	0.011	
III. Hydraulic Conductivity (3) (ft/day) by:			
a) Type Curve Matching	139	71	
b) Time-Drawdown	177	47	
c) Theis Curve Matching	192	45	
d) Grain-Size Analysis	(4)	(4)	99

NOTES:

(1) MW-22 and MW-26 were used as observation wells for the pumping test.
(2) PW-28 was the well on which the pumping test was performed.
(3) Aquifer thickness is 22 feet, estimated from boring records in February 7, 1992, report.
(4) Grain-size distribution analysis not performed on soil samples from these wells.

From this data, average hydraulic conductivity values would be 169 ft/day for MW-22S, and 54 ft/day for MW-26. The hydraulic conductivity value from grain-size analysis for well PW-28, which is 99 ft/day, falls between these two other values. All three conductivity values fall within the same order of magnitude. The differences between the values may be explained by local heterogeneities in the soil matrix of the aquifer. A regional average of approximately 110 ft/day may be used for hydraulic conductivity in the surficial aquifer beneath the Fuel Farm area.

Similarly, average specific storage calculated from the pumping test ranges from 10^{-3} to 10^{-2}. Specific storage values associated with well MW-26 are higher than those associated with MW-22. The differences may be explained by local heterogeneities in the soil matrix of the aquifer.

4.0 PROCEDURES FOR QUALITY CONTROL

4.1 Decontaminating Equipment

The CSA Workplan details the quality-control procedures followed for handling and decontaminating equipment in the field. Using the procedures described in the

Workplan, we decontaminated our drilling equipment adjacent to the oil/water separator, which is located east of the Fuel Farm.

4.2 Collecting, Handling and Shipping Samples

The CSA Workplan details the quality-control procedures followed for collecting, handling and shipping samples. We utilized rinse blanks and trip blanks as quality-control measures to provide checks on the integrity and quality of our groundwater sampling program.

Law Engineering submitted an equipment rinse blank to the laboratory to evaluate the procedures we used for decontaminating the Teflon bailers. Law Engineering also submitted a trip blank to the laboratory to check the integrity of the sample containers, to determine if contaminants may have entered the sample containers during shipment to and from the job site, and to check for laboratory-induced contamination. Each of the blanks was analyzed for purgeable aromatics. The two blank samples did not contain contaminant levels above the laboratory detection limit. Although, our procedures for bailer decontamination were generally successful in eliminating the introduction of contaminants through the sampling equipment, it is possible that the 1 μg/L of total xylenes documented in the groundwater sample from

MW-26 may have resulted from incomplete decontamination of the bailer used to sample that well or from laboratory-induced contamination.

5.0 REFERENCES

Freeze, R. Allan and Cherry, John A., Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1979.

North Carolina Administrative Code, Title 15, Subchapter 2L, Classification and Water Quality Standards Applicable to the Groundwaters of North Carolina, North Carolina Environmental Management Commission, Raleigh, North Carolina, August 4, 1989.

Walton, W.C., Practical Aspects of Groundwater Modeling, 2nd Edition, 1984.

Water-Vel, Hydrologic Modeling Division, In-Situ, Inc., Laramie, Wyoming, Version 2.2, July 1989.

TABLES

TABLE 3.1
SUMMARY OF DEVELOPMENT OF MONITORING WELLS

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT
CAMP GEIGER FUEL FARM
CAMP LEJEUNE,NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

MONITORING WELL IDENTIFICATION NUMBER	FINAL TURBIDITY (SUBJECTIVE)*	APPROXIMATE VOLUME OF WATER REMOVED (GAL.)
MW-26	2	13.5
MW-27	2	20
PW-28	1	120

Note:

* (1) Clear; (2) Slight; (3) Moderate; (4) High

TABLE 4.1
SUMMARY OF HEADSPACE TESTING

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

SAMPLE LOCATION	SAMPLE DEPTH (ft.)	OVA READING	SAMPLE SELECTED FOR LABORATORY ANALYSIS
MW-26	0 - 1.5	Not Detected (ND)	
	1.5 - 3	ND	*
	3 - 4.5	ND	
	6 - 7.5	ND	*
	9.5 - 11	ND	
	14.5 - 16	ND	
MW-27	0 - 1.5	ND	
	1.5 - 3	ND	*
	3 - 4.5	ND	
	6 - 7.5	ND	*
	9.5 - 11	ND	
	14.5 - 16	ND	
PW-28	0 - 1.5	ND	
	1.5 - 3	ND	
	3 - 4.5	ND	*
	6 - 7.5	ND	
	9.5 - 11	ND	*
	14.5 - 16	20	
	19.5 - 21	28	

TABLE 4.2
SUMMARY OF LABORATORY ANALYSES OF SOIL SAMPLES

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT
CAMP GEIGER AREA FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

SAMPLE LOCATION	SAMPLE DEPTH (ft)	TOTAL PETROLEUM HYDROCARBONS	
		VOLATILES (mg/kg)	SEMI-VOLATILES (mg/kg)
MW-26	1.5-3	N.D.	N.D.
MW-26	6-7.5	N.D.	N.D.
MW-27	1.5-3	N.D.	N.D.
MW-27	6-7.5	N.D.	N.D.
PW-28	3-4.5	N.D.	N.D.
PW-28	9.5-11	N.D.	N.D.

KEY TO SYMBOLS FOR TABLE 4.4

SUMMARY OF LABORATORY ANALYSES

* Numerical standard has not been established; substances not allowed in detectable concentrations.

N.D. = Not detected: see laboratory reports for applicable detection limits.

- = Sample not analyzed for this parameter.

TABLE 4.4 (Page 1 of 3)
SUMMARY OF LABORATORY ANALYSES
MONITORING WELL GROUND-WATER SAMPLES
SHALLOW SCREENED INTERVAL

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND COMPREHENSIVE SITE ASSESSMENT

CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

	WELL NUMBER	NC GROUND WATER STANDARD	EMW-1 (CGMW-1)	EMW-2 (CGMW-2)	EMW-3 (CGMW-3)	EMW-4 (CGMW-4)	EMW-5 (35GW-4)	EMW-6 (35GW-5)	EMW-7 (35GW-6)	MW-8S	MW-9S	MW-10S
	DATE SAMPLED		9/3/91	9/5/91	9/5/91	9/5/91	9/4/91	9/5/91	9/5/91	9/4/91	9/3/91	9/3/91
PARAMETER (ug/l)	SCREENED INTERVAL (Feet)		8.5-17.5	1.87-10.87	3.06-12.06	2.61-11.61	10.5-24.5	10.5-24.5	10.5-24.5	4.5-13.5	3.5-12.5	4.5-13.5'
BENZENE		1	ND	40	ND	13	0.4	0.3	ND	52	45	3
TOLUENE		1000	ND	12	ND	ND	ND	ND	ND	ND	ND	5
ETHYLBENZENE		29	ND	41	ND	0.7	ND	ND	ND	73	ND	7
XYLENES TOTAL		400	ND	76	ND	2	ND	ND	ND	420	4	ND
METHYL TERTIARY BUTYL ETHER (MTBE)		50	ND	ND	ND	ND	ND	3	ND	ND	46	ND
LEAD		50	14	ND	2	28	75	ND	12	5	ND	3
TRANS-1,2-DICHLOROETHENE		70	ND	ND	2	ND	0.7	ND	18	ND	ND	17
TRICHLOROETHENE		2.8	ND	ND	8	0.6	3	0.6	59	ND	ND	170
1-METHYLNAPTHALENE		*	-	-	-	-	-	-	-	450	-	-
2-METHYLNAPTHALENE		*	-	-	-	-	-	-	-	460	-	-

TABLE 4.4 (Page 2 of 3)
SUMMARY OF LABORATORY ANALYSES
MONITORING WELL GROUND-WATER SAMPLES
SHALLOW SCREENED INTERVAL

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND
COMPREHENSIVE SITE ASSESSMENT

CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

	WELL NUMBER	NC GROUND WATER STANDARD	MW-11S	MW-12S	MW-13S	MW-14S	MW-15S	MW-16S	MW-17S	MW-18S	MW-19S	MW-20S
	DATE SAMPLED		9/4/91	9/4/91	9/4/91	9/4/91	9/4/91	9/5/91	9/5/91	9/5/91	9/4/91	9/4/91
PARAMETER (ug/l)	SCREENED INTERVAL (Feet)		4.5'-13.5'	5'-14'	5.5'-14.5'	3.5'-12.5'	4.5'-13.5'	5.0'-14.0'	7.5'-16.5'	3.0'12.0'	4.5'-13.5'	3.0'-12.0'
BENZENE		1	ND	ND	ND	0.6	4	40	0.5	52	ND	140
TOLUENE		1000	ND	ND	ND	ND	ND	230	ND	ND	ND	280
ETHYLBENZENE		29	80	ND	ND	ND	3	76	ND	ND	ND	320
XYLENES TOTAL		400	170	ND	ND	ND	29	800	ND	ND	ND	830
METHYL TERTIARY BUTYL ETHER (MTBE)		50	ND	ND	ND	ND	ND	ND	1	32	ND	ND
LEAD		50	ND	16	7	2	5	6	6	9	36	ND
CHLOROFORM		0.19	ND	ND	ND	3	ND	ND	ND	ND	ND	ND
TRANS-1,2-DICHLOROETHENE		70	ND	ND	ND	44	ND	ND	ND	ND	5	ND
TRICHLOROETHENE		2.8	ND	ND	ND	110	ND	ND	0.6	ND	31	ND
1,2-DICHLOROETHANE		*	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
1,1,2,2-TETRACHLOROETHANE		*	ND	ND	ND	ND	ND	ND	ND	ND	12	ND
TETRACHLOROETHENE		*	ND	ND	ND	ND	ND	ND	ND	ND	1	ND

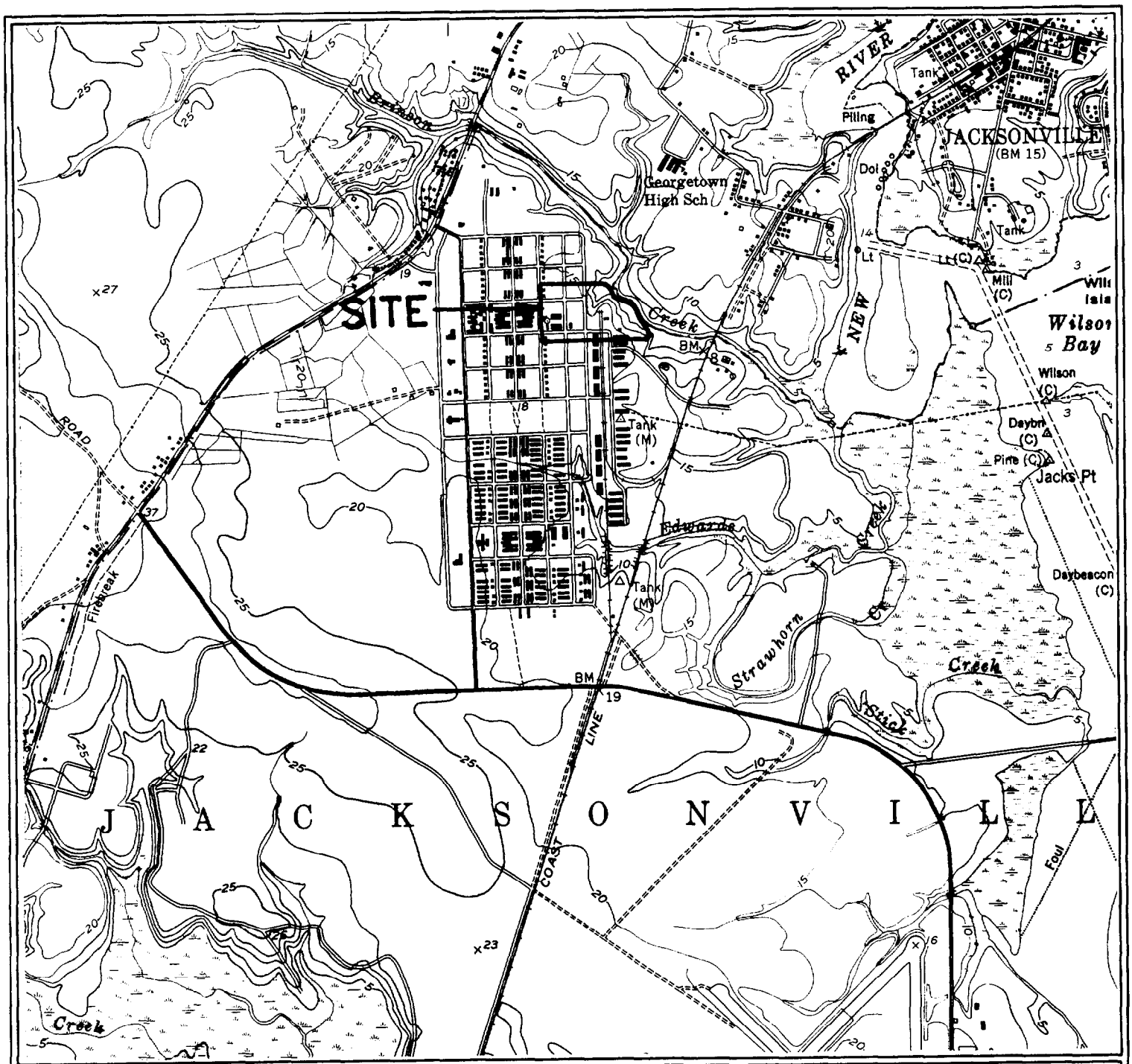
TABLE 4.4 (Page 3 of 3)
SUMMARY OF LABORATORY ANALYSES
MONITORING WELL GROUND-WATER SAMPLES
SHALLOW SCREENED INTERVAL

ADDENDUM TO REPORT OF UNDERGROUND FUEL INVESTIGATION AND 7COMPREHENSIVE SITE ASSESSMENT

CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA
LAW ENGINEERING JOB NO. 475-08135-01

	WELL NUMBER	NC GROUND WATER STANDARD	MW-21S	MW-22S	MW-23S	MW-24S	MW-25S	MW-26S (blind *duplicate* MW-14S)	MW-27S (blind *duplicate* MW-24S)	MW-26	MW-27	PW-28	POTABLE WATER
	DATE SAMPLED		9/4/91	9/4/91	9/5/91	9/5/91	9/4/91	9/4/91	9/5/91	11/04/92	11/04/92	11/04/92	10/29/92
PARAMETER (ug/l)	SCREENED INTERVAL (Feet)		4.5-13.5	5.5'-14.5'	2.5-9.5	8.5-17.5	4.5-13.5	3.5-12.5	8.5-17.5	4.5-13.5	55.5-14.5	55.5-24.5	-
BENZENE		1	220	2300	ND	11	26	0.6	12	ND	ND	ND	ND
TOLUENE		1000	ND	ND	ND	ND	160	ND	ND	ND	ND	ND	ND
ETHYLBENZENE		29	590	560	ND	10	190	ND	10	ND	ND	ND	ND
XYLENES TOTAL		400	1100	740	ND	43	500	ND	43	1.0	ND	ND	ND
METHYL TERTIARY BUTYL ETHER (MTBE)		50	ND	ND	ND	ND	ND	ND	ND	12.0	ND	ND	ND
LEAD		50	4	3	2	5	1	2	7	-	-	-	-
CHLOROFORM		0.19	ND	ND	ND	ND	ND	3	ND	-	-	-	-
TRANS-1,2-DICHLOROETHENE		70	ND	ND	ND	ND	ND	51	ND	-	-	-	-
TRICHLOROETHENE		2.8	ND	ND	0.6	ND	ND	120	ND	-	-	-	-
TRICHLOROFLUOROMETHANE		*	ND	ND	0.9	ND	ND	ND	ND	-	-	-	-
BROMODICHLOROMETHANE		*	ND	ND	ND	ND	ND	ND	ND	-	-	-	-
BROMOFORM		0.19	ND	ND	ND	ND	ND	ND	ND	-	-	-	-
DIBROMOCHLOROMETHANE		*	ND	ND	ND	ND	ND	ND	ND	-	-	-	-
ACENAPTHENE		*	-	-	-	ND	ND	ND	0.7	-	-	-	-
FLUORENE		*	-	-	-	1	ND	ND	ND	-	-	-	-
1-METHYLNAPTHALENE		*	-	-	-	64	190	ND	42	-	-	-	-
2-METHYLNAPTHALENE		*	-	-	-	63	270	ND	42	-	-	-	-
[illegible]NE		*	-	-	-	41	220	ND	31	-	-	-	-

DRAWINGS



NORTH

JACKSONVILLE SOUTH, N.C.
NW/4 NEW RIVER 15' QUADRANGLE
N3437.5—W7722.5/7.5

1952

PHOTOINSPECTED 1971
AMS 5563 III NW—SERIES V 842

CONTOUR INTERVAL 5 FEET

GRAPHIC SCALE FEET

2000 1000 0 2000 4000

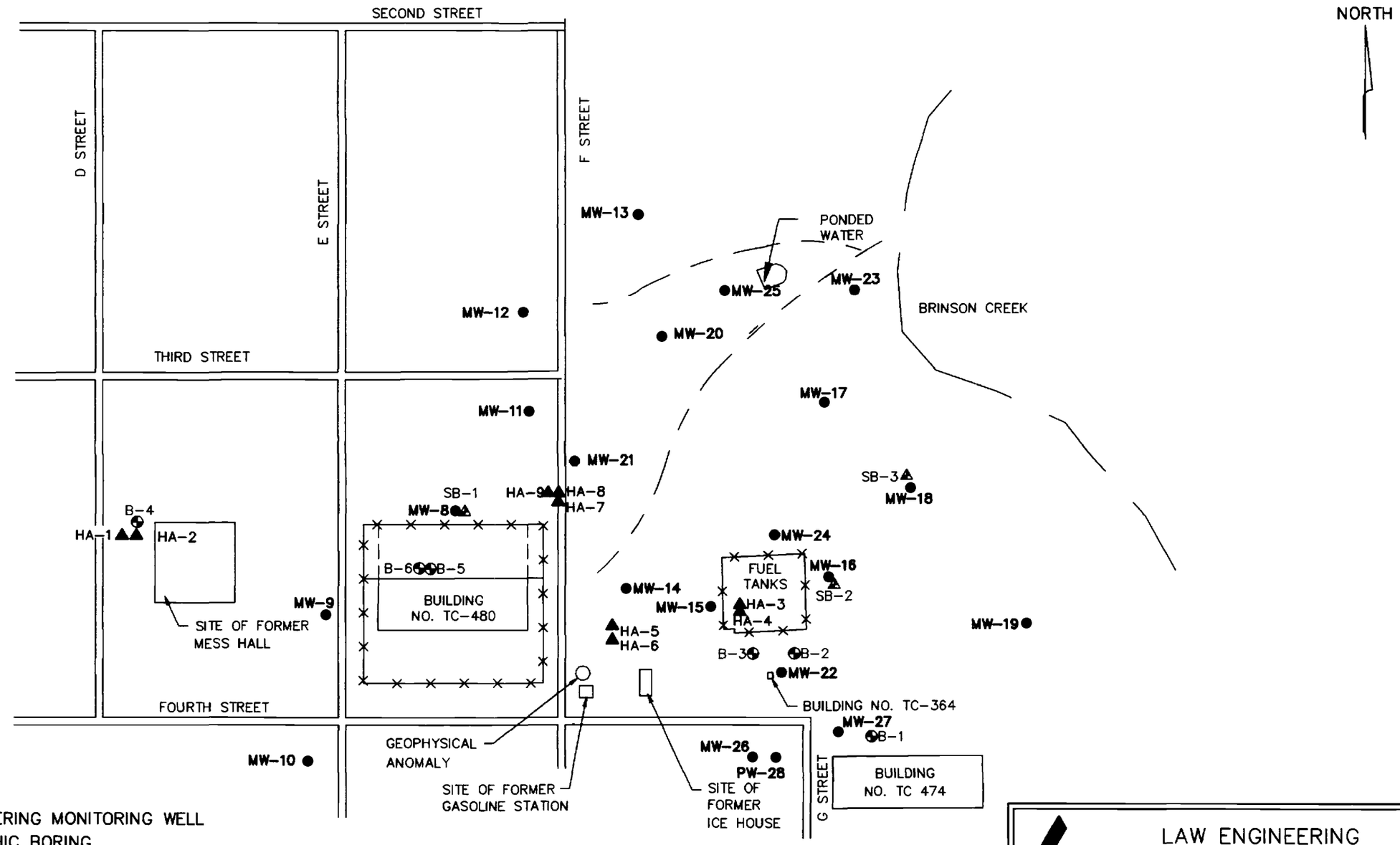
QUADRANGLE LOCATION

NOTE: SITE LOCATIONS ARE APPROXIMATE.

LAW ENGINEERING
RALEIGH, NORTH CAROLINA

TOPOGRAPHIC SITE MAP
UNDERGROUND FUEL INVESTIGATION
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: DEC. 1992
DFT CHECK: LCP	SCALE: 1:24000
ENG CHECK: JAP	JOB: 475-08135-01
APPROVAL: RAL	DWG: 1.1



J6014Z21

LEGEND

- FENCE
- ●MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- ▲SB-1 LOCATION OF STRATIGRAPHIC BORING
- ⊕B-1 LOCATION OF SOIL BORING
- ▲HA-1 LOCATION OF HAND-AUGER BORING

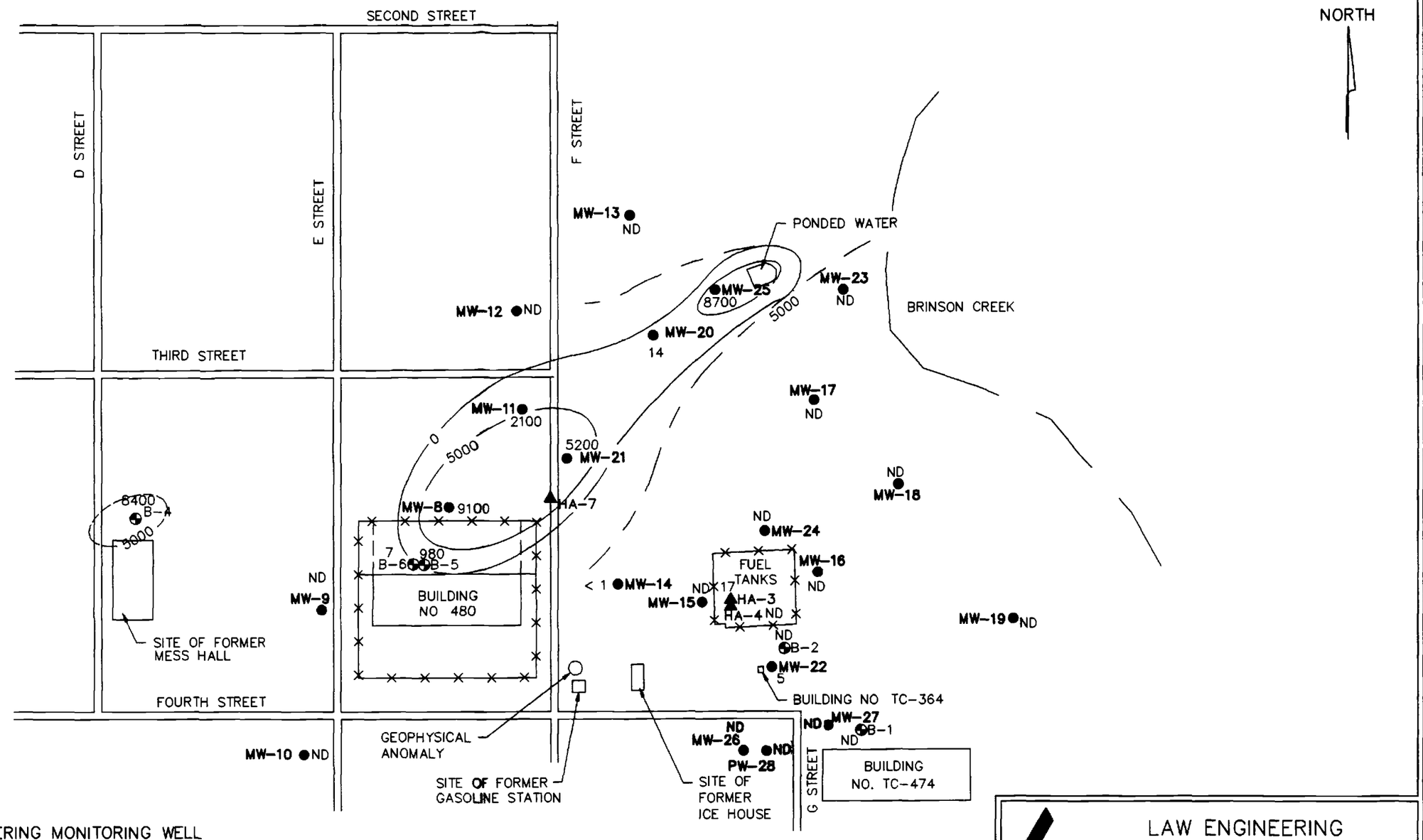
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

LOCATION OF SOIL BORINGS
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: DEC. 1992
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK:	JOB: 475-08135-01
APPROVAL:	DWG: 3.1

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91: USGS JACKSONVILLE SOUTH, N.C.

00390B01Z



LEGEND

—×—×—	FENCE
●MW-1	LOCATION OF LAW ENGINEERING MONITORING WELL
⊕B-1	LOCATION OF SOIL BORING
▲HA-1	LOCATION OF HAND-AUGER BORING
— — —	TRANSITORY STREAM
—— ——	PERENNIAL STREAM
8400	CONCENTRATION OF TPH IN ug/L
ND	NONE DETECTED

NOTE CONTOUR INTERVAL 5000 ug/L

J6014Z17

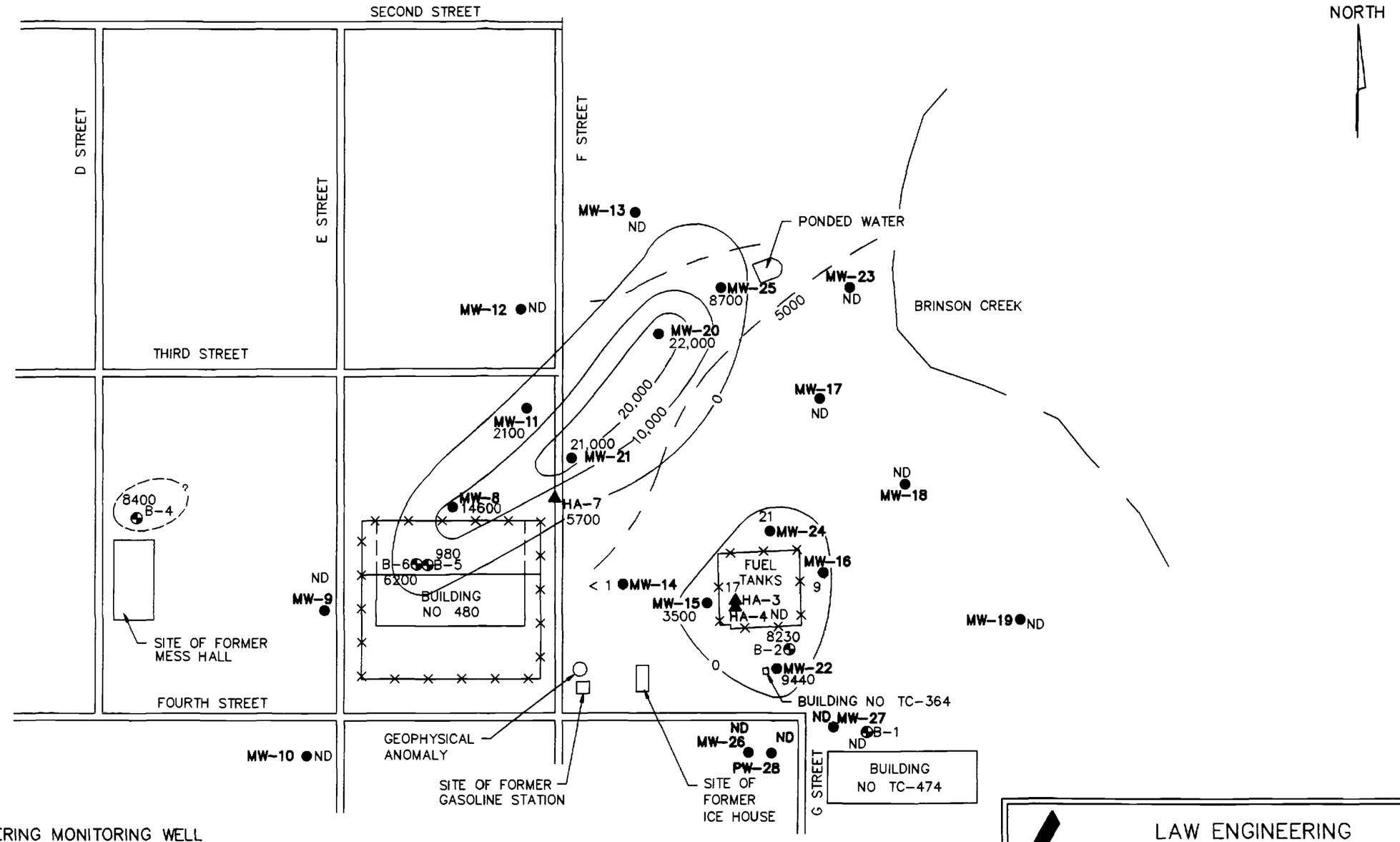
00290B:2Z

LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP – TPH CONCENTRATIONS
COMBINED VOLATILES AND SEMI-VOLATILES
SOIL SAMPLES ABOVE THE WATER TABLE
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: NOV. 1991
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK: BAP	JOB: J47590-6014
APPROVAL:	DWG: 4.3

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91: USGS JACKSONVILLE SOUTH, N.C.



LEGEND

- FENCE
- ●MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- ⊕B-1 LOCATION OF SOIL BORING
- ▲HA-1 LOCATION OF HAND-AUGER BORING
- TRANSITORY STREAM
- PERENNIAL STREAM
- 8400 CONCENTRATION OF TPH IN mg/kg
- ND NONE DETECTED

CONTOUR INTERVAL 10,000 mg/kg

J6014809

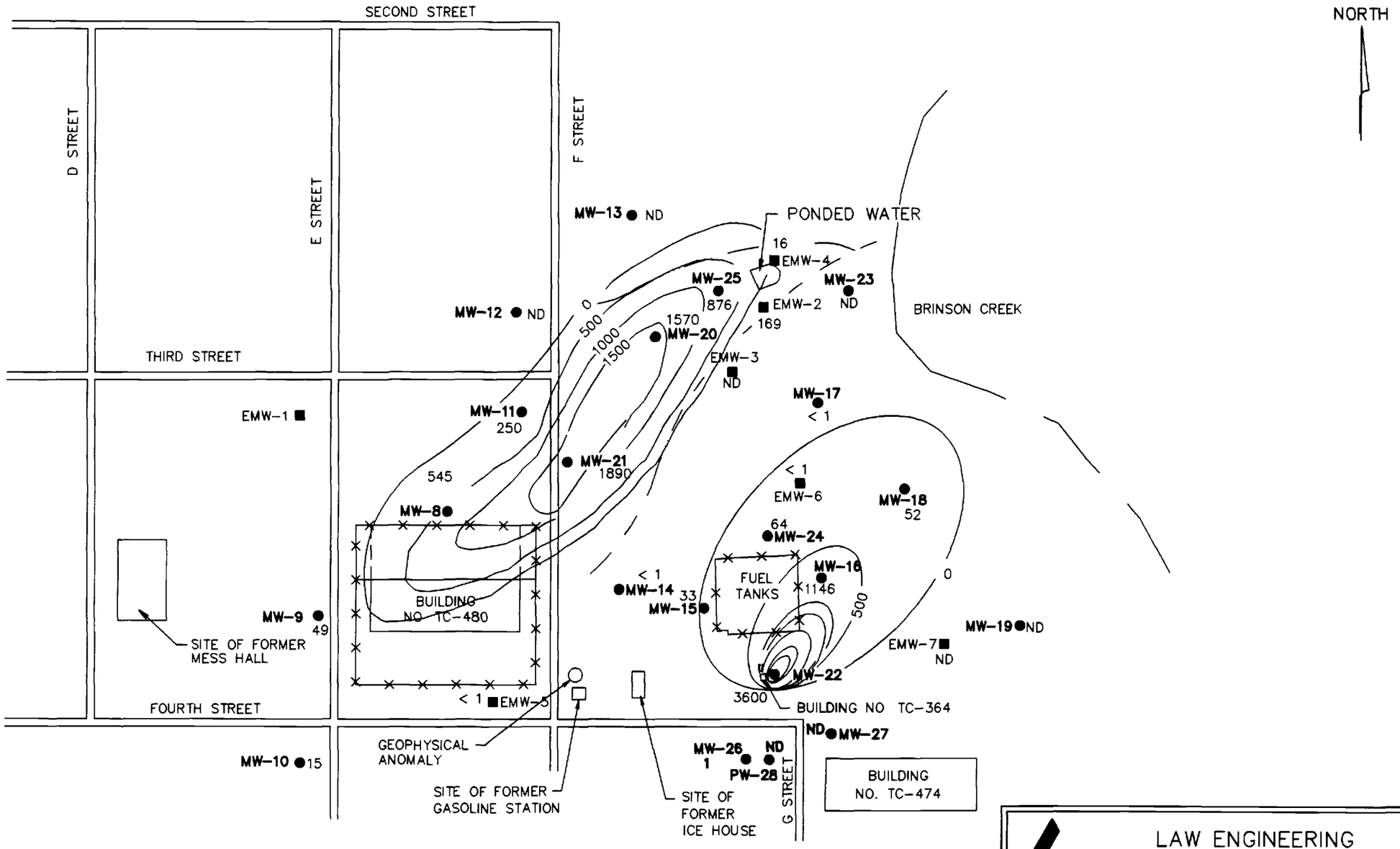
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP – TPH CONCENTRATIONS COMBINED VOLATILES AND SEMI-VOLATILES SOIL SAMPLES WITH HIGHEST TPH CONCENTRATIONS CAMP GEIGER FUEL FARM CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: FEB. 1992
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK:	JOB: J47590-6014
APPROVAL:	DWG: 4.3.1

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91: USGS JACKSONVILLE SOUTH, N.C.

00290 B03



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 8905 BTEX CONCENTRATION IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

CONTOUR INTERVAL = 500 ug/L

J6014Z19

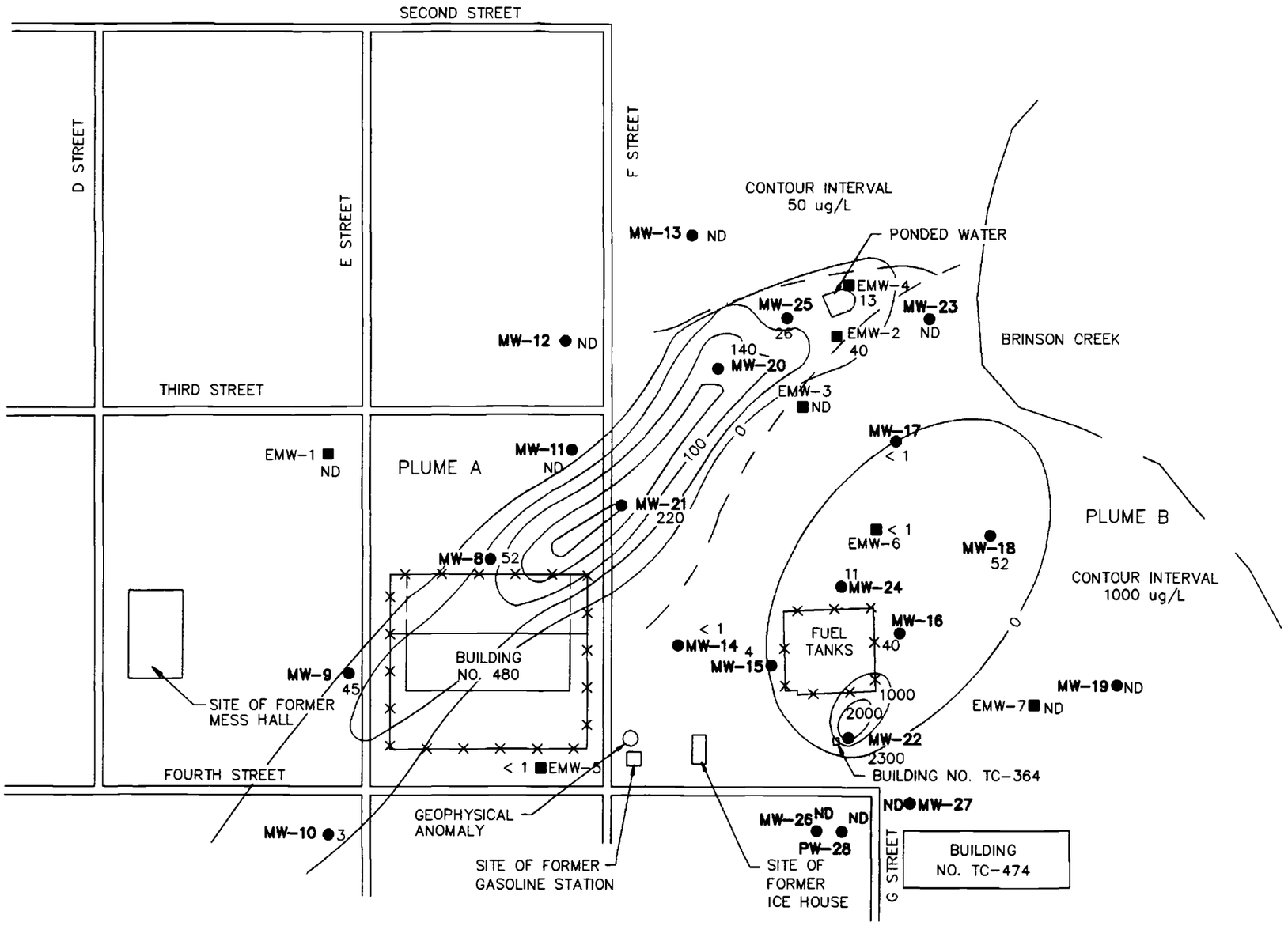
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP – COMBINED BTEX CONCENTRATIONS
WATER SAMPLES FROM SHALLOW SCREENED INTERVAL
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: NOV. 1991
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK: EJP	JOB: J47590-6014
APPROVAL: WADSWORTH	DWG: 4.7

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

00370B04Z



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 8905 BENZENE CONCENTRATION IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

PLUME A CONTOUR INTERVAL 50 ug/L
PLUME B CONTOUR INTERVAL 1000 ug/L

J6014805

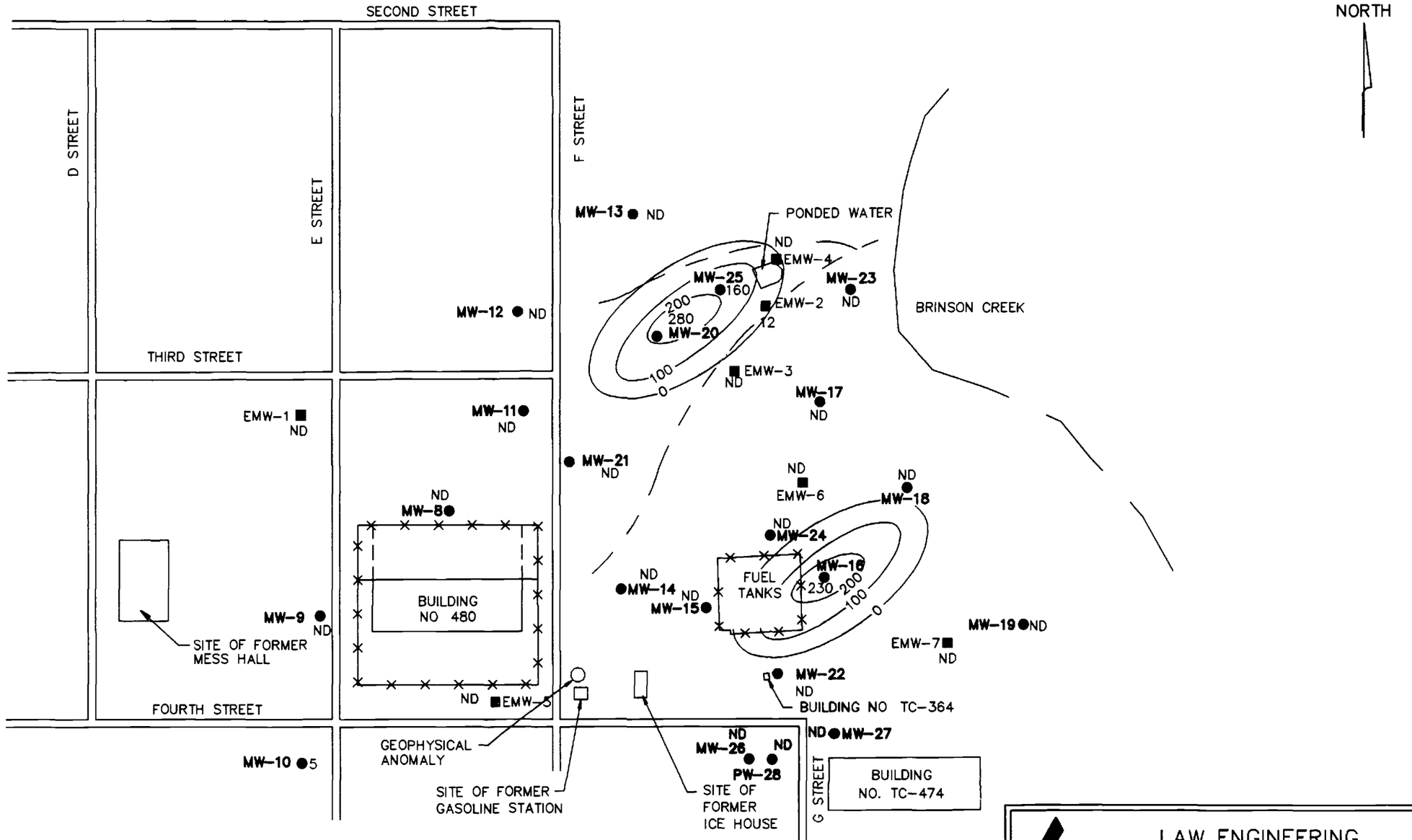
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP – BENZENE CONCENTRATIONS WATER SAMPLES FROM SHALLOW SCREENED INTERVAL CAMP GEIGER FUEL FARM CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: FEB. 1992
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK:	JOB: J47590-6014
APPROVAL:	DWG: 4.7.1

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

00290B05Z



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 8905 TOLUENE CONCENTRATION IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

CONTOUR INTERVAL = 100 ug/L

J6014B06

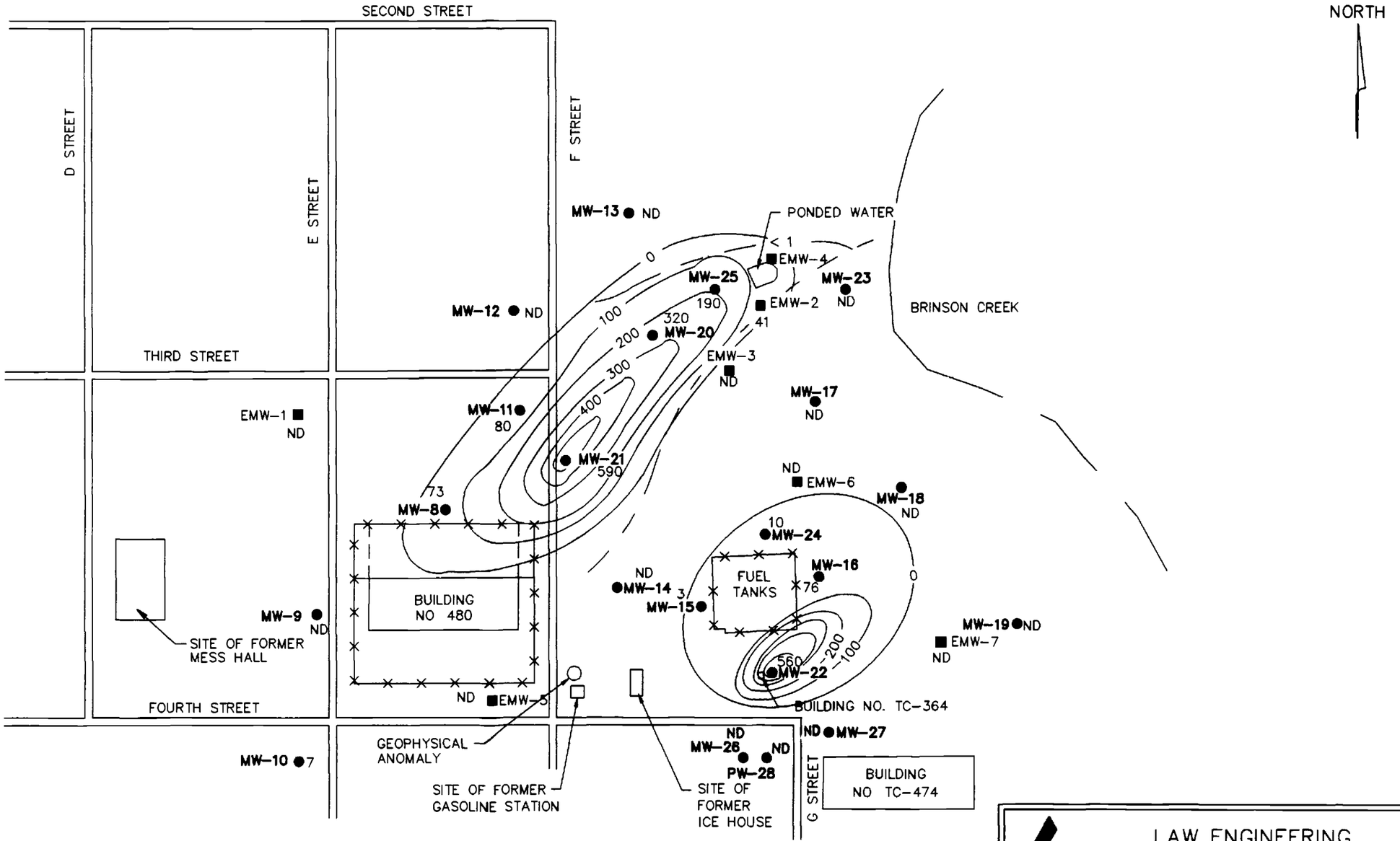
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP – TOLUENE CONCENTRATIONS WATER SAMPLES FROM SHALLOW SCREENED INTERVAL CAMP GEIGER FUEL FARM CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: NOV. 1991
DFT CHECK: DLR	SCALE: 1"=150'
ENG CHECK:	JOB: J47590-6014
APPROVAL:	DWG: 4.7.2

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

00290B06Z



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 8905 ETHYLBENZENE CONCENTRATION IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

CONTOUR INTERVAL = 100 ug/L

J6014B07

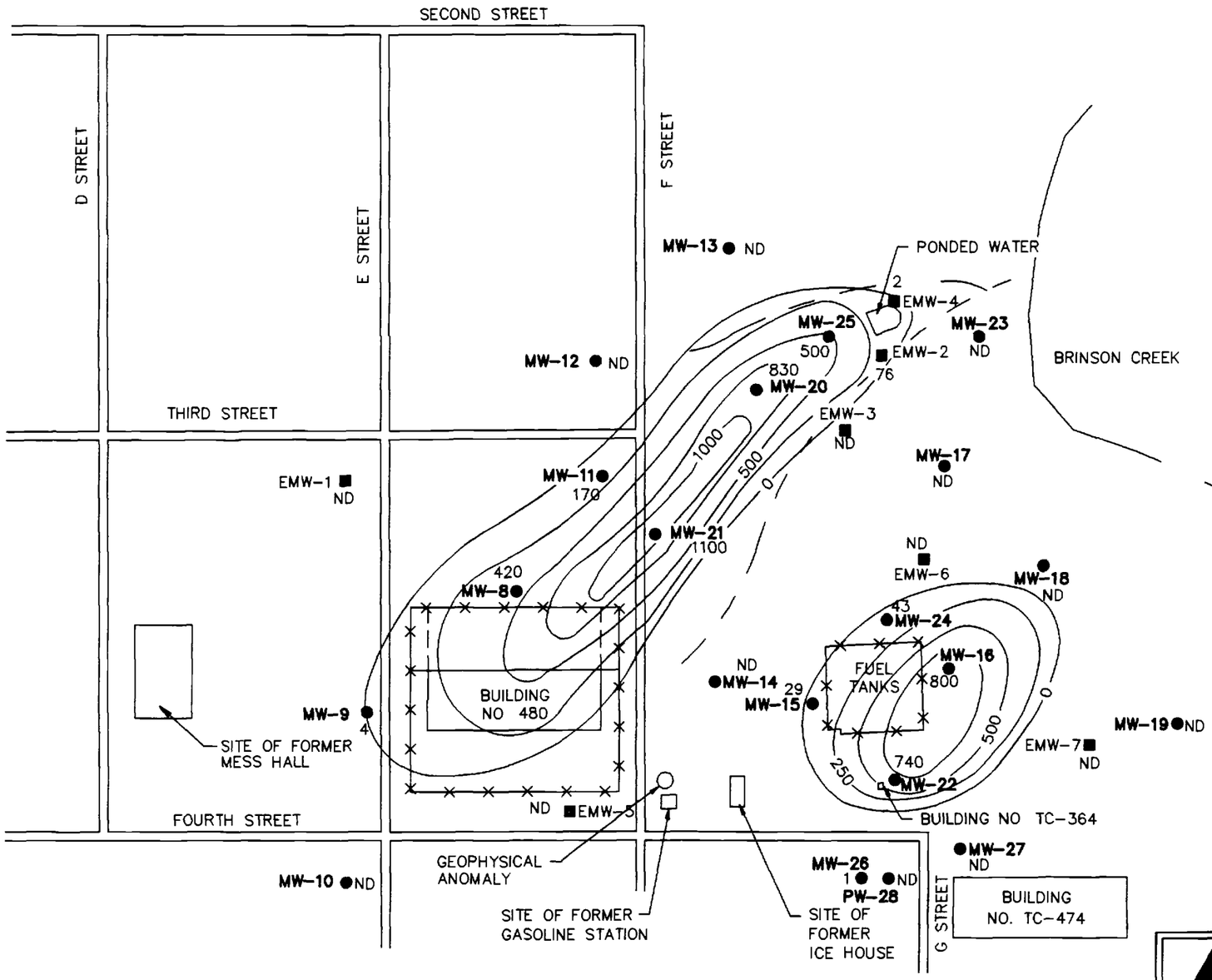
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP - ETHYLBENZENE CONCENTRATIONS WATER SAMPLES FROM SHALLOW SCREENED INTERVAL CAMP GEIGER FUEL FARM CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: NOV. 1991
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK: BJB	JOB: J47590-6014
APPROVAL: WAD, JRG	DWG: 4.7.3

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

00290B07Z



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 8905 XYLENES CONCENTRATION IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

CONTOUR INTERVAL = 250 ug/L

J6014B08

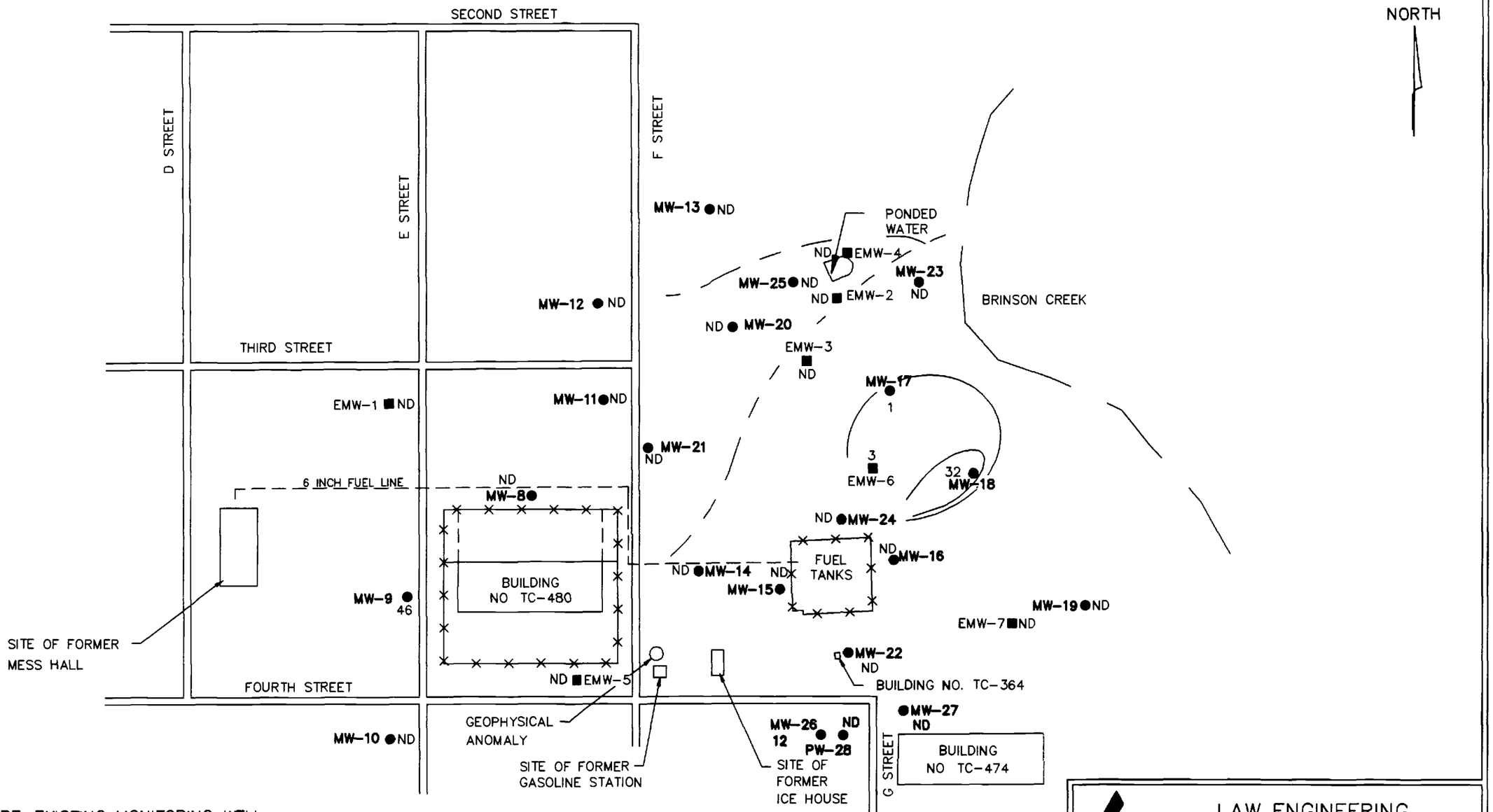
LAW ENGINEERING
RALEIGH, NORTH CAROLINA

ISOPLETH MAP
TOTAL XYLENES CONCENTRATIONS
WATER SAMPLES FROM SHALLOW SCREENED INTERVAL
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: DEC. 1992
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK:	JOB: 475-08135-01
APPROVAL:	DWG: 4.7.4

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

00290B08Z



LEGEND

- FENCE
- EMW-1 LOCATION OF PRE-EXISTING MONITORING WELL
- MW-1 LOCATION OF LAW ENGINEERING MONITORING WELL
- 46 CONCENTRATION OF MTBE IN ug/L
- ND NONE DETECTED
- TRANSITORY STREAM
- PERENNIAL STREAM

J6014Z15

LAW ENGINEERING
RALEIGH, NORTH CAROLINA

MTBE CONCENTRATIONS
WATER SAMPLES FROM SHALLOW SCREENED INTERVAL
CAMP GEIGER FUEL FARM
CAMP LEJEUNE, NORTH CAROLINA

DRAWN: WBJ	DATE: NOV. 1991
DFT CHECK: DCR	SCALE: 1"=150'
ENG CHECK: RHB	JOB: J47590-6014
APPROVAL:	DWG: 4.13

REFERENCE: JAMES E. STEWART AND ASSOC.; SHT 1&2 OF 2; 9/13/91

C0290B09Z

APPENDIX A

RECORDS OF SOIL-TEST BORINGS

UNIFIED SOIL CLASSIFICATION

(Including Identification and Description)

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3 in. and basing fractions on estimated weights)		
COARSE-GRAINED SOILS: More than half of material is larger than No 200 sieve size. The No 200 sieve is about the smallest particle visible to the naked eye	GRAVELS: More than half of coarse fraction is larger than No 4 sieve size. (For visual classification, the ¼-in. size may be used as equivalent to the No 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravel, gravel-sand-silts mixture	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
	SANDS: More than half of coarse fraction is smaller than No 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate particle sizes.		
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			SC	Clayey sands, sand-clay mixtures	Plastic fines (for identification procedures see CL below).		
					IDENTIFICATION PROCEDURES On Fraction Smaller than No 40 Sieve Size		
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)
FINE-GRAINED SOILS: More than half of material is smaller than No 200 sieve size. The No 200 sieve is about the smallest particle visible to the naked eye	SILTS AND CLAYS: Liquid limit is less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None
			CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight
	SILTS AND CLAYS: Liquid limit is greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Slight to medium	Slow to none	Slight to medium
			CH	Inorganic clays of high plasticity, fat clays.	High to very High	None	High
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		

CORRELATION OF PENETRATION RESISTANCE (ASTM D 1586) WITH RELATIVE DENSITY AND CONSISTENCY

	PENETRATION RESISTANCE, N Blows per foot	RELATIVE DENSITY
SANDS AND GRAVELS	0 — 4	Very Loose
	5 — 10	Loose
	11 — 20	Firm
	21 — 30	Very Firm
	31 — 50	Dense
	Over 50	Very Dense

	PENETRATION RESISTANCE, N Blows per foot	CONSISTENCY
SILTS AND CLAYS	0 — 2	Very Soft
	3 — 4	Soft
	5 — 8	Firm
	9 — 15	Stiff
	16 — 30	Very Stiff
	31 +	Hard

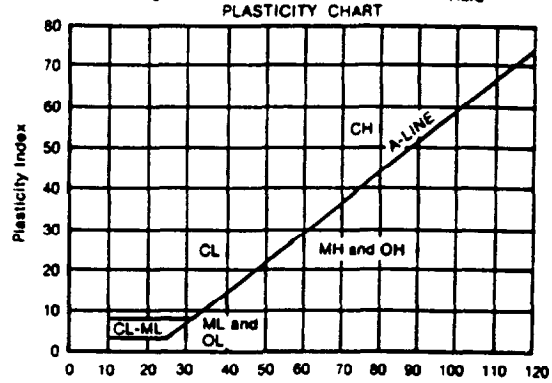
PARTICLE SIZE IDENTIFICATION

BOULDER	- Greater than 12 inches	SAND	- Coarse - 2 mm to 4.76 mm Medium - 0.42 mm to 2 mm Fine - 0.074 mm to 0.42 mm
COBBLES	- 3 inches to 12 inches		
GRAVEL	- Coarse - ¾ inch to 3 inches - Fine - 4.76 mm to ¾ inch	SILT & CLAY	- Less than 0.074 mm

SOIL LABORATORY TEST DATA SYMBOLS FOR BORING LOGS

γ_w	= Wet Unit Weight	W	= Moisture Content (%)
γ_d	= Dry Unit Weight	LL	= Liquid Limit (%)
e	= Void Ratio	PL	= Plastic Limit (%)
q	= Unconfined Compressive Strength	PI	= Plasticity Index (%) (LL-PL)
C_c	= Compression Index		
c	= Cohesion, Total Stress		
c'	= Cohesion, Effective Stress		
Φ	= Friction Angle, Degrees, Total Stress	TRIAXIAL	= Triaxial Shear Test
Φ'	= Friction Angle, Degrees,	CONSOL.	= Consolidation Test

PLASTICITY CHART



CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	NO. OF BLOWS, N	RELATIVE DENSITY
SANDS:	0-4	Very Loose
	5-10	Loose
	11-30	Firm
	31-50	Dense
	OVER 50	Very Dense

		CONSISTENCY
SILTS & CLAYS:	0-2	Very Soft
	3-4	Soft
	5-8	Firm
	9-15	Stiff
	16-30	Very stiff
	31-50	Hard
	OVER 50	Very Hard

PARTICAL SIZE IDENTIFICATION

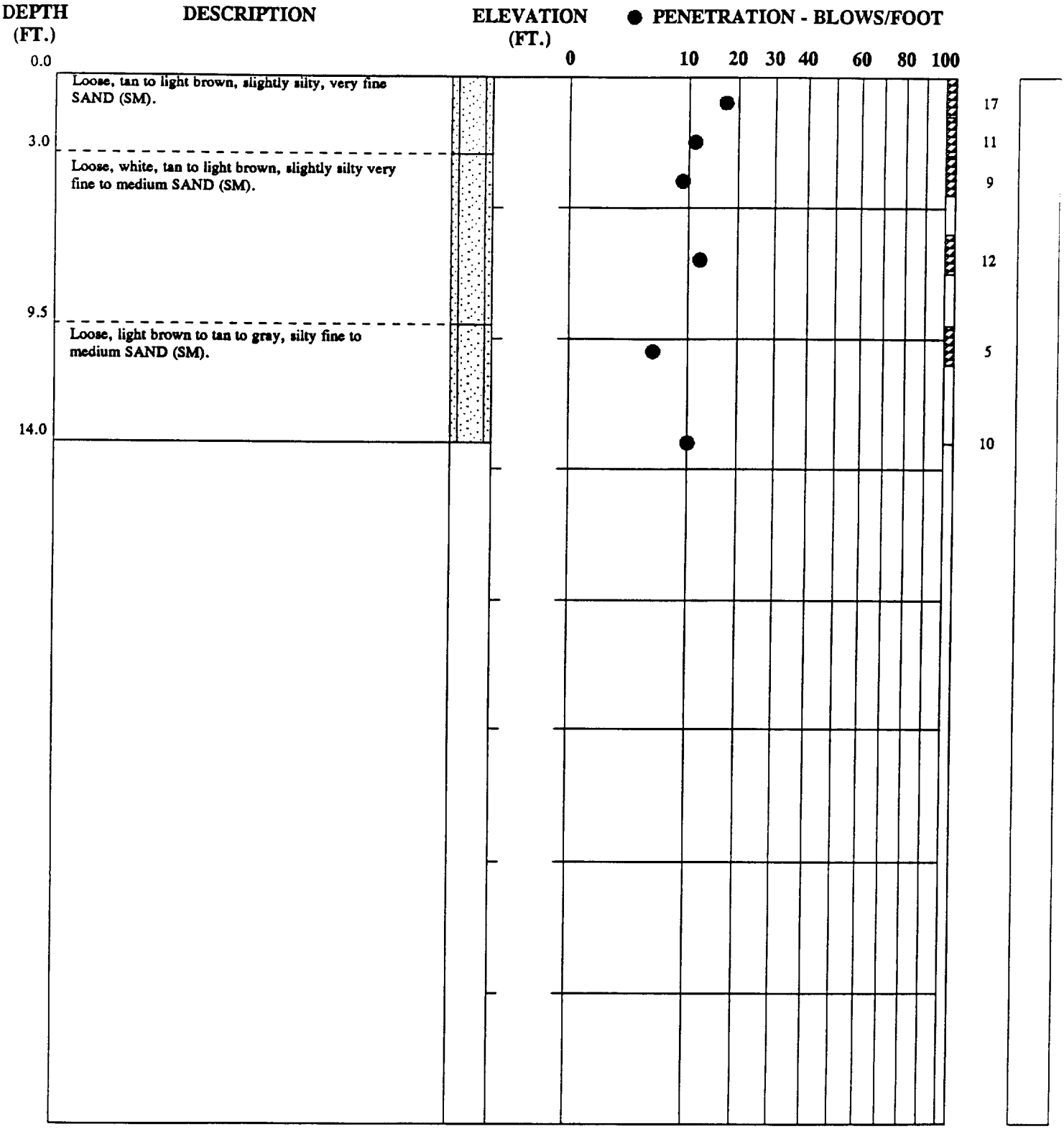
BOULDERS:		Greater than 300 mm
COBBLES:		75 mm to 300 mm
GRAVEL:	Coarse -	19.0 mm to 75 mm
	Fine -	4.75 mm to 19.0 mm
SANDS:	Coarse -	2.00 mm to 4.75 mm
	Medium -	0.425 mm to 2.00 mm
	Fine -	0.075 mm to 0.425 mm
SILTS & CLAYS:		Less than 0.075 mm

KEY TO DRILLING SYMBOLS

- Undisturbed Sample
- Split Spoon Sample
- Water Table 24 HR.
- Water Table at Time of Drilling
- M=82% Moisture Content
- Loss of Drilling Water

KEY TO SOIL CLASSIFICATIONS

- FILL
- CL - Low plasticity inorganic clays
- CH - High plasticity inorganic silts
- ML - Low plasticity inorganic silts and very fine sands
- MH - High plasticity inorganic silts
- SP - Poorly graded sands
- SW - Well graded sands
- GP - Poorly graded gravels
- PARTIALLY WEATHERED ROCK - A transitional material between soil and rock which retains the relict structure of the parent rock
- GW - Well graded gravels
- OL - Low plasticity organic silts and clays
- OH - High plasticity organic silts and clays
- SM - Silty sands
- GM - Silty gravels
- SC - Clayey sands
- GC - Clayey gravels
- SP-SM - Typical Dual Classification



REMARKS:

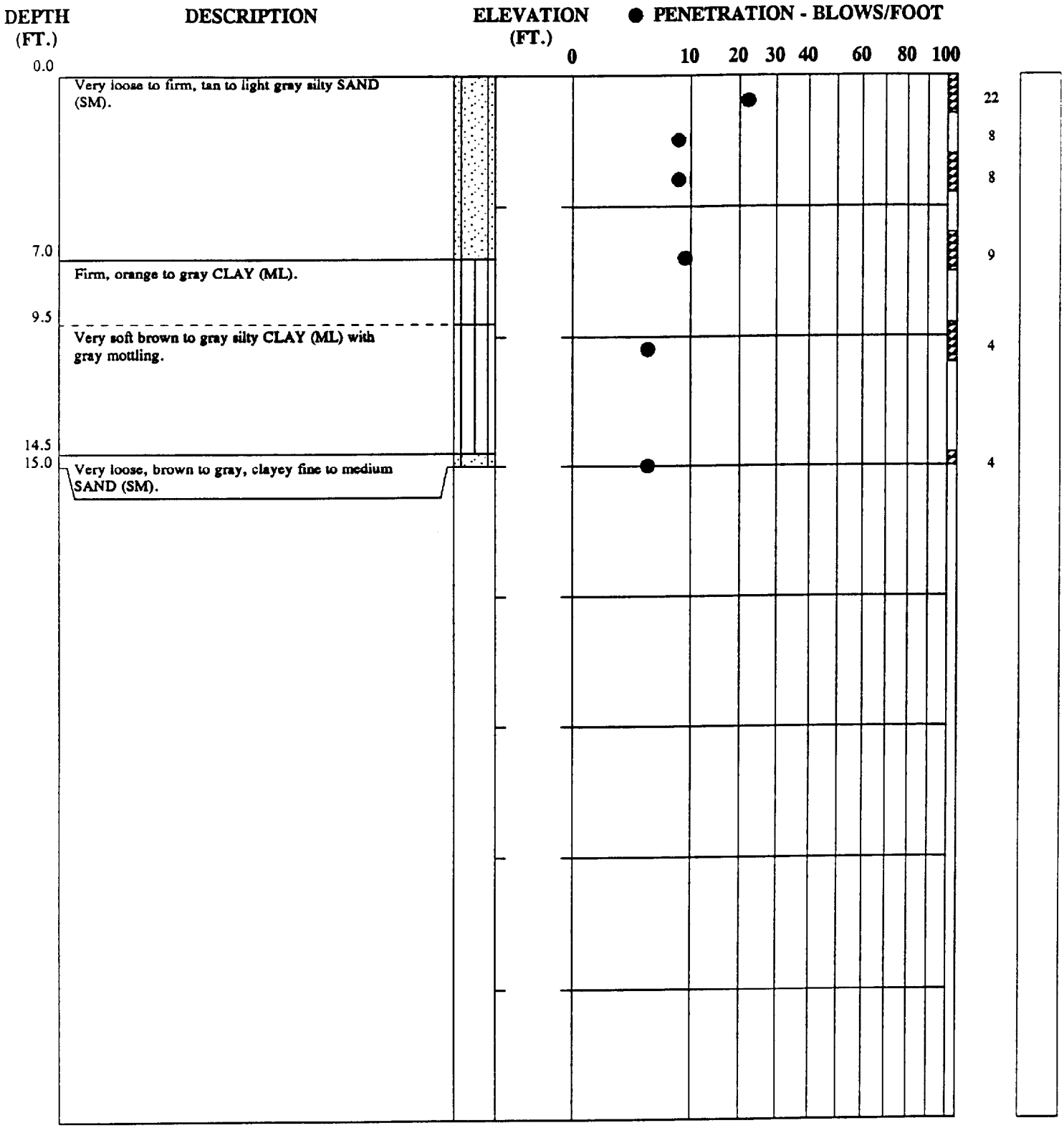
BORING TERMINATED AT 14.0'. UPON BORING COMPLETION, SINGLE-CASED MONITORING WELL INSTALLED. SEE WELL CONSTRUCTION RECORDS FOR DETAILS.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-26
DATE DRILLED	October 29, 1992
PROJECT NUMBER	475-08135-01
PROJECT	CAMP GEIGER FUEL FARM
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

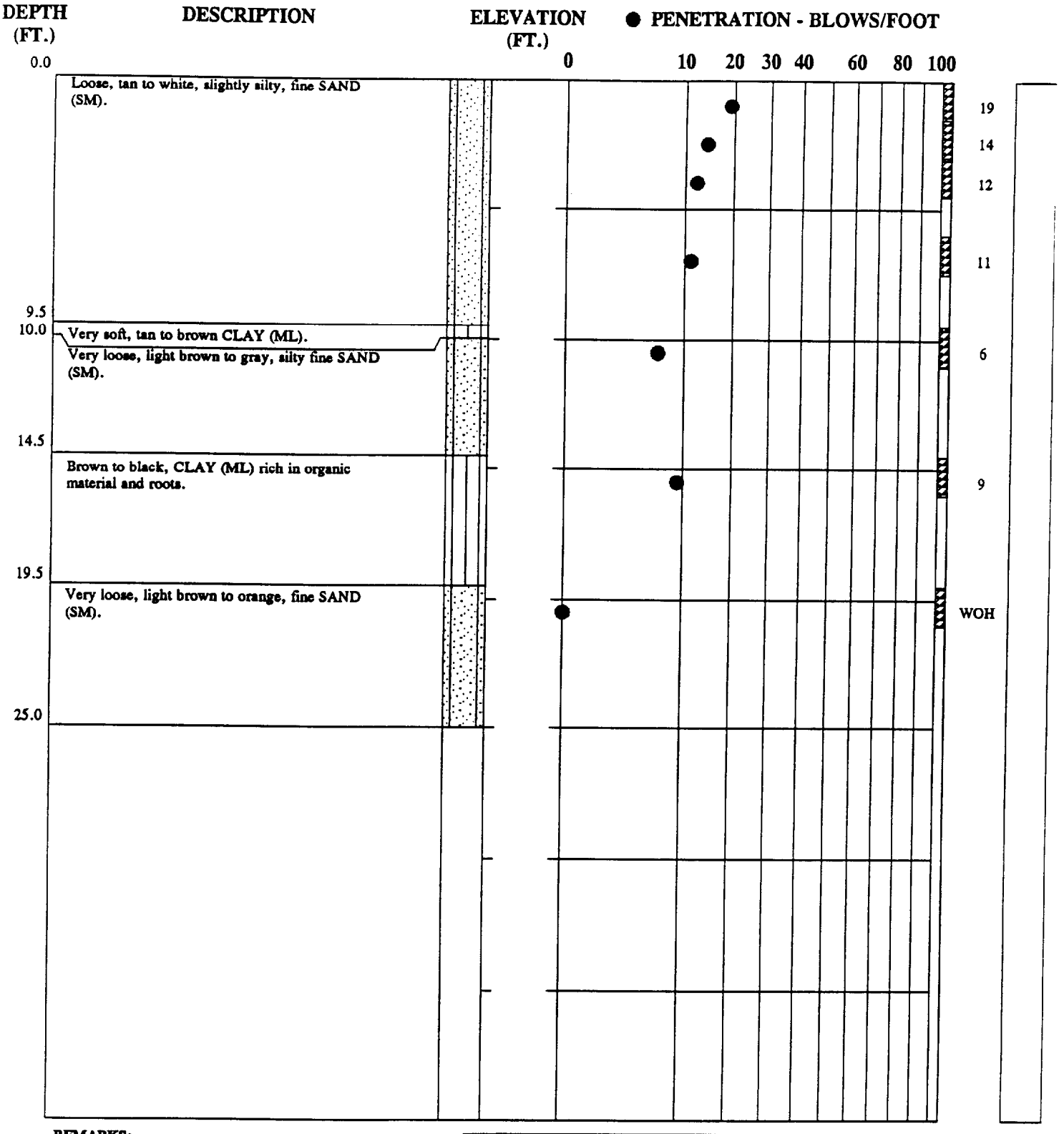
BORING TERMINATED AT 15.0'. UPON BORING COMPLETION, SINGLE-CASED MONITORING WELL INSTALLED. SEE WELL CONSTRUCTION RECORDS FOR DETAILS.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-27
DATE DRILLED	October 29, 1992
PROJECT NUMBER	475-08135-01
PROJECT	CAMP GEIGER FUEL FARM
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

BORING TERMINATED AT 25.0'. UPON BORING COMPLETION, SINGLE-CASED MONITORING WELL INSTALLED. SEE WELL CONSTRUCTION RECORDS FOR DETAILS.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

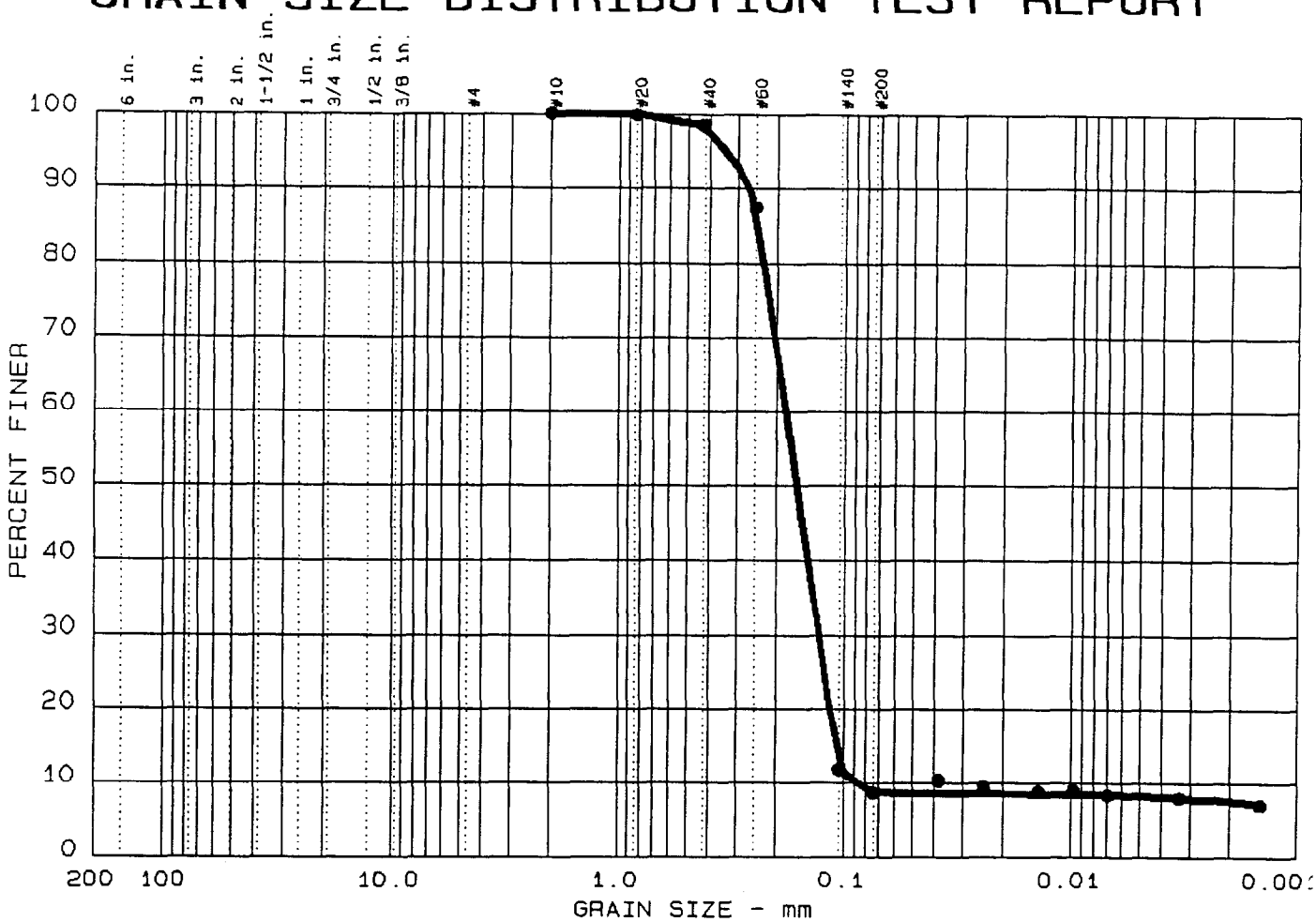
BORING NUMBER	PW-28
DATE DRILLED	October 28, 1992
PROJECT NUMBER	475-08135-01
PROJECT	CAMP GEIGER FUEL FARM
PAGE 1 OF 1	

LAW ENGINEERING

APPENDIX B

TEST DATA OF GRAIN-SIZE DISTRIBUTION

GRAIN SIZE DISTRIBUTION TEST REPORT



	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	91.3	0.4	8.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	N/A	N/A	0.24	0.18	0.16	0.129	0.1089	0.0855	1.07	2.1

	MATERIAL DESCRIPTION	USCS	AASHTO
●	S-7	SP-SM	N/A

Project No.: 475-08135-01
Project: CAMP GEIGER FUEL TANK
● Location: PW-28

Date: 11-17-92

Remarks:
OUTLINER POINTS NOT INCLUDED IN GRAPH.

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING

Figure No. 5

GRAIN SIZE DISTRIBUTION TEST DATA — Test No.: 5

Date: 11-17-92
Project No.: 475-08135-01
Project: CAMP GEIGER FUEL TANK

Sample Data

Location of Sample: PW-28
Sample Description: S-7
USCS Class: SP-SM — Liquid limit: N/A
AASHTO Class: N/A — Plasticity index: N/A

Notes

Remarks: OUTLINER POINTS NOT INCLUDED IN GRAPH.

Fig. No.: 5

Mechanical Analysis Data

Initial
Dry sample and tare= 77.37
Tare = 0.00
Dry sample weight = 77.37
Sample split on number 10 sieve
Split sample data:
Sample and tare = 68.59 Tare = 0 Sample weight = 68.59
Cumulative weight retained tare= 0
Tare for cumulative weight retained= 0

Sieve	Cumul. Wt. retained	Percent finer
# 10	0.00	100.0
# 20	0.12	99.8
# 40	1.06	98.5
# 60	8.60	87.5
# 140	60.50	11.8
# 200	62.64	8.7

Hydrometer Analysis Data

Separation sieve is number 10
Percent -# 10 based on complete sample= 100.0
Weight of hydrometer sample: 68.59
Calculated biased weight= 68.59
Automatic temperature correction
Composite correction at 20 deg C =-3

Meniscus correction only=-1
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000

Hydrometer type: 152H Effective depth L= 16.294964 - 0.164 x Rm

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.0	18.0	10.5	7.0	0.0140	9.5	14.7	0.0380	10.3
5.0	18.0	10.0	6.5	0.0140	9.0	14.8	0.0241	9.5
15.0	18.0	9.5	6.0	0.0140	8.5	14.9	0.0139	8.8
30.0	18.5	9.5	6.1	0.0139	8.5	14.9	0.0098	9.0
60.0	19.0	9.0	5.8	0.0138	8.0	15.0	0.0069	8.4
250.0	20.0	8.5	5.5	0.0136	7.5	15.1	0.0033	8.0
1347.0	19.5	8.0	4.9	0.0137	7.0	15.1	0.0015	7.1

Fractional Components

% + 75mm. = 0.0 % GRAVEL = 0.0 % SAND = 91.3
% SILT = 0.4 % CLAY = 8.3

D85= 0.24 D60= 0.182 D50= 0.163
D30= 0.1291 D15= 0.10889 D10= 0.08551
Cc = 1.0691 Cu = 2.1330

APPENDIX C

WELL-CONSTRUCTION RECORDS AND

GROUNDWATER MONITORING-WELL INSTALLATION DETAILS

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: Law Engineering

DRILLER REGISTRATION NUMBER: 332

STATE WELL CONSTRUCTION PERMIT NUMBER: 66-0277-WM-0297

1. WELL LOCATION: (Show sketch of the location below) MW-26
   Nearest Town: Jacksonville County: Onslow
   _____
   (Road, Community, or Subdivision and Lot No.)
2. OWNER * See Address Below
   ADDRESS _____
   (Street or Route No.)
   _____
   City or Town State Zip Code
3. DATE DRILLED 10/29/92 USE OF WELL Monitoring
4. TOTAL DEPTH 14'
5. CUTTINGS COLLECTED YES [XX] NO [ ]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [XX]
7. STATIC WATER LEVEL Below Top of Casing: 7.47 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 0' FT. Above Land Surface*

* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118

9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): N/A
    _____
11. CHLORINATION: Type N/A Amount _____
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 4.5	Ft.	2"	SCH 80	PVC
From _____	To _____	Ft.	_____	_____	_____
From _____	To _____	Ft.	_____	_____	_____

13. GROUT:

	Depth		Material	Method
From 1.5	To 3.0	Ft.	Bentonite	Pour
From _____	To _____	Ft.	_____	_____

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 4.5	To 13.5	Ft	2	in.	0.010	in.	PVC
From _____	To _____	Ft.	_____	in.	_____	in.	_____
From _____	To _____	Ft.	_____	in.	_____	in.	_____

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 3.0	To 14.0	Ft.	Torpedo	Sand
From _____	To _____	Ft.	_____	_____

16. REMARKS: Concrete from 0' - 1.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
		See Attached Test Boring Records

If additional space is needed use back of form

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See Attached Site Location Map

* Commander
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia 23511-6287
Attention: Code 1821, Mr. Trueman Seamans

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Richard A. Kaw — 12/14/92
SIGNATURE OF CONTRACTOR OR AGENT — DATE

GW-1 REV. 9/91

Submit original to Division of Environmental Management and copy to well owner.

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: Law Engineering

DRILLER REGISTRATION NUMBER: 332

STATE WELL CONSTRUCTION PERMIT NUMBER: 66-0277-WM-0297

1. WELL LOCATION: (Show sketch of the location below) MW-27
   Nearest Town: Jacksonville County: Onslow
   _____
   (Road, Community, or Subdivision and Lot No.)
2. OWNER * See Address Below
   ADDRESS _____
   (Street or Route No.)
   _____
   City or Town State Zip Code
3. DATE DRILLED 10/29/92 USE OF WELL Monitoring
4. TOTAL DEPTH 15'
5. CUTTINGS COLLECTED YES [XX] NO [ ]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [XX]
7. STATIC WATER LEVEL Below Top of Casing: 8.22 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 0' FT. Above Land Surface*

* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118

9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): N/A
    _____
11. CHLORINATION: Type N/A Amount _____
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 5.5	Ft.	2"	SCH 80	PVC
From _____	To _____	Ft.	_____	_____	_____
From _____	To _____	Ft.	_____	_____	_____

13. GROUT:

	Depth		Material	Method
From 1.5	To 3	Ft.	Bentonite	Pour
From _____	To _____	Ft.	_____	_____

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 5.5	To 14.5	Ft	2	in.	0.010	in.	PVC
From _____	To _____	Ft. _____		in. _____		in.	_____
From _____	To _____	Ft. _____		in. _____		in.	_____

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 3	To 15	Ft.	Torpedo	Sand
From _____	To _____	Ft.	_____	_____

16. REMARKS: Concrete from 0' - 1.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
		See Attached Test Boring Records

If additional space is needed use back of form

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See Attached Site Location Map

* Commander
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia 23511-6287
Attention: Code 1821,
Mr. Trueman Seamans

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Richard A. Hall 12/14/92

SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 9/91

Submit original to Division of Environmental Management and copy to well owner.

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ RO _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR: Law Engineering

DRILLER REGISTRATION NUMBER: 332

STATE WELL CONSTRUCTION PERMIT NUMBER: 66-0277-WM-0297

1. WELL LOCATION: (Show sketch of the location below) PW-28
   Nearest Town: Jacksonville County: Onslow
   (Road, Community, or Subdivision and Lot No.)
2. OWNER * See Address Below
   ADDRESS
   (Street or Route No.)
   City or Town State Zip Code
3. DATE DRILLED 10/28/92 USE OF WELL Pump Test
4. TOTAL DEPTH 25'
5. CUTTINGS COLLECTED YES [XX] NO [ ]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [XX]
7. STATIC WATER LEVEL Below Top of Casing: 8.11 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 0' FT. Above Land Surface*

*** Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118**

9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): N/A
11. CHLORINATION: Type N/A Amount _____
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 5.5	Ft.	4"	SCH 80	PVC
From _____	To _____	Ft.	_____	_____	_____
From _____	To _____	Ft.	_____	_____	_____

13. GROUT:

	Depth		Material	Method
From 2	To 3	Ft.	Bentonite	Pour
From _____	To _____	Ft.	_____	_____

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 5.5	To 24.5	Ft.	4	in.	0.010	in.	PVC
From _____	To _____	Ft.	_____	in.	_____	in.	_____
From _____	To _____	Ft.	_____	in.	_____	in.	_____

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 3	To 25	Ft.	Torpedo	Sand
From _____	To _____	Ft.	_____	_____

16. REMARKS: Concrete from 0' - 2'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
		See Attached Test Boring Records

If additional space is needed use back of form

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See Attached Site Location Map

* Commander
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia 23511-6287
Attention: Code 1821,
Mr. Trueman Seamans

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Richard A. Hall 12/14/92
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 REV. 9/91

Submit original to Division of Environmental Management and copy to well owner.

APPENDIX D

CHAIN-OF-CUSTODY FORMS

1371

LAW ENVIRONMENTAL, INC.
NATIONAL LABORATORIES
7215 PINE FOREST ROAD
PENSACOLA, FLORIDA 32526
(904) 944-9772

CHAIN OF CUSTODY RECORD

SAMPLING INFORMATION
NPDES NUMBER

NAME OF FACILITY: CAMP GEIGER - TANK FARM
STREET ADDRESS: JACKSONVILLE NC

PROJECT NAME: CAMP GEIGER FUEL FARM
JOB NO.: 475-08135-01
SAMPLERS (SIGNATURE): Robert J. Lyon
SAMPLING DATE: 10/28-29/1992

TIME	GRAB	COMP.	*SOURCE CODE	SAMPLE STATION DESCRIPTION	TOTAL NO. OF CONTAINERS	CONTAINER TYPE: 40 ml G VOA HCl	1 L G - AMBER	8 oz. G. W/M	2 oz. G. W/M	1 L G (H_2SO_4)	500 ml - AMBER	1 L. PL (HNO_3)	1 L. PL (H_2SO_4)	1L. PL (NaOH+Ascorbic Acid)	1 L. PL (Zn Acetate + NaOH)	1 L. PL	4 oz. PL W/M	250 ml PL	1 L. TEFLON	LENL LAB NO.
1600	X		SO	MW-26A	3			1	2											AA26345
1600	X		SO	MW-26B	3			1	2											AA26346
1100	X		SO	MW-27BA	3			1	2											AA26347
1100	X		SO	MW-27B	3			1	2											AA26348
1100	X		SO	MW-28A	3			1	2											AA26349
1100	X		SO	MW-28B	3			1	2											AA26350
0900	X		DW	SUPPLY SOURCE	2	2														AA26351
																				~~AA26352~~

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME	RELINQUISHED BY: (SIGNATURE)	RECEIVED BY LABORATORY: (SIGNATURE)	DATE / TIME
Robert J. Lyon	10/29/92 1100				Nida Tahir	10/29/92 1100

DISTRIBUTION: ORIGINAL AND YELLOW COPIES ACCOMPANY SAMPLE SHIPMENT TO LABORATORY. PINK COPY RETAINED BY SAMPLERS. YELLOW COPY RETAINED BY LABORATORY.

REMARKS

Airbill # 810841566 4

***SOURCE CODES**

- RECOVERY WELL - RW
- RCRA MONITORING WELL - MW
- SOIL / SEDIMENT - SO
- SLUDGE - SL
- NPDES DISCHARGE - ND
- DRINKING WATER - DW
- HAZARDOUS WASTE - HW
- SURFACE WATER - SW
- NON AQUEOUS - NA

LAW ENVIRONMENTAL, INC.
NATIONAL LABORATORIES
7215 PINE FOREST ROAD
PENSACOLA, FLORIDA 32526
(904) 944-9722

CHAIN OF CUSTODY RECORD

3815

SAMPLING INFORMATION
NPDES NUMBER

NAME OF FACILITY: _____

STREET ADDRESS: _____

PROJECT NAME: Camp Geiger fuel farm
JOB NO.: 08135-01
SAMPLERS (SIGNATURE): Chris Cornelison
SAMPLING DATE: 11/4/92

TIME	GRAB	COMP.	*SOURCE CODE	SAMPLE STATION DESCRIPTION	TOTAL NO. OF CONTAINERS	CONTAINER TYPE: 40 ml G VOA HCl	1 L G - AMBER	8 oz. G, W/M	2 oz. G, W/M	1 L G (H_2SO_4)	500 ml - AMBER	1 L, PL (HNO_3)	1 L, PL (H_2SO_4)	1L, PL (NaOH+Ascorbic Acid)	1 L, PL (Zn Acetate + NaOH)	1 L, PL	4 oz. PL W/M	250 ml PL	1 L, TEFLON				LENL LAB NO.
0650	✓		MW	MW-26	3	3																	AA26775
0745	✓		MW	MW-27	3	3																	AA26776
0730	✓		MW	PW-28	3	3																	AA26777
1600	✓			STORAGE TANKER	3	3																	AA26778
0700	✓			Rinse BLANK	3	3																	AA26779
				TRIP BLANK	3	3																	AA26780

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME	RELINQUISHED BY: (SIGNATURE)	RECEIVED BY LABORATORY: (SIGNATURE)	DATE / TIME
Chris Cornelison	11/5/92 1730					6 NOV 1992 10:30

DISTRIBUTION: ORIGINAL AND YELLOW COPIES ACCOMPANY SAMPLE SHIPMENT TO LABORATORY. PINK COPY RETAINED BY SAMPLERS. YELLOW COPY RETAINED BY LABORATORY.

REMARKS

Shipped Via Airborne Express
Airbill # 210891 5946
AIRBORNE # 210891 5946

***SOURCE CODES**

RECOVERY WELL - RW
RCRA MONITORING WELL - MW
SOIL / SEDIMENT - SO
SLUDGE - SL
NPDES DISCHARGE - ND
DRINKING WATER - DW
HAZARDOUS WASTE - HW
SURFACE WATER - SW
NON-AQUEOUS - NA

APPENDIX E

LABORATORY ANALYTICAL TEST REPORTS

SOIL SAMPLES

Law Environmental, Inc.
Pensacola Branch
7215 Pine Forest Road
Pensacola, Florida 32526

November 23, 1992

Mr. Leland Laymon
Law Engineering, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604
Clt. #12024 Proj. #475-08135-01

Dear: Mr. Laymon:

Below are the results of analysis of 7 samples received for examination on October 30, 1992:

Sample I.D. AA26345 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-26A Sample collector: LAYMON
Sample collection date: 10/28/92 Time: 16:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.3
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	3.0

Sample I.D. AA26346 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-26B Sample collector: LAYMON
Sample collection date: 10/28/92 Time: 16:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	3.0
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.2

Sample I.D. AA26347 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-27A Sample collector: LAYMON
Sample collection date: 10/29/92 Time: 11:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.3
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	3.0

Sample I.D. AA26348 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-27B Sample collector: LAYMON
Sample collection date: 10/29/92 Time: 11:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	4.0
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.3

Sample I.D. AA26349 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-28A Sample collector: LAYMON
Sample collection date: 10/29/92 Time: 11:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.3
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	3.0

Sample I.D. AA26350 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-28B Sample collector: LAYMON
Sample collection date: 10/29/92 Time: 11:00
Lab submittal date: 10/30/92 Time: 17:19

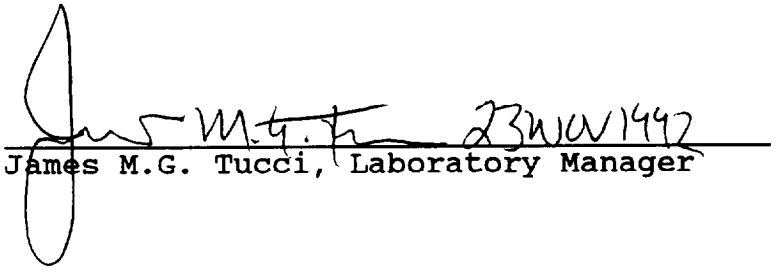
TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
2323-Tot. Pet. Hydro. Prep. Soil		Completed	
Multicomponent analysis: 2321-TPHXS Cal-DHS			
Diesel	mg/Kg	Not detected	3.0
Multicomponent analysis: 2321-TPHVS Cal-DHS			
Gasoline	mg/Kg	Not detected	0.2

Sample I.D. AA26351 Location code: CAMPGEI
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: Supply Source Sample collector: LAYMON
Sample collection date: 10/29/92 Time: 09:00
Lab submittal date: 10/30/92 Time: 17:19

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	Not detected	0.6

Please advise should you have questions concerning these data.

Respectfully submitted,



23 NOV 1992

James M.G. Tucci, Laboratory Manager

APPENDIX F

MONITORING WELL AND

SAMPLING FIELD DATA WORKSHEETS

LAW ENGINEERING
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

MONITORING WELL AND SAMPLING FIELD DATA WORKSHEET

LAW JOB NUMBER 475-08135-01 MONITORING WELL NUMBER MW-26

SITE NAME CAMP GEIGER FUEL FARM

DATE (MO/DAY/YR) 11/4/92 TIME (MILITARY) 0642

FIELD PERSONNEL CORNELISSEN

WEATHER CONDITIONS WARM, CLOUDY

TOTAL WELL DEPTH (TWD) 14.0 1/10 FT. (DEPTH BELOW MEASURING POINT)

HEIGHT OF MEASURING POINT ABOVE LAND SURFACE 0.0 1/10 FT.

DESCRIPTION OF MEASURING POINT TOP OF MARKED CASING

DEPTH TO GROUNDWATER (DGW) 7.47 1/100 FT. (DEPTH BELOW MEASURING POINT)

LENGTH OF WATER COLUMN (LWC) = TWD - DGW = 6.53 1/100 FT.

ONE STANDING WELL VOLUME (SWV) = LWC X .17 = 1.1 1/10 GAL.

THREE STANDING WELL VOLUMES = 3XSWV = 3.3 1/10 GAL = STANDARD EVACUATION VOLUME

METHOD OF WELL EVACUATION X TEFLON BAILER _____ OTHER: _____

TOTAL VOLUME OF WATER REMOVED 1.5 1/10 GAL. CASING DIAMETER 2 In.

CASING MATERIAL PVC X S.S. _____ TEFLON _____ OTHER _____

SCREENED INTERVAL (FROM ID PLATE) 4.5 - 13.5 (DEPTHS BELOW LAND SURFACE - FT.)

STEEL GUARD PIPE AROUND CASING	YES X	NO _____	COMMENTS _____
LOCKING CAP	YES X	NO _____	_____
PROTECTIVE POST/ABUTMENT	YES _____	NO X	_____
NONPOTABLE LABEL	YES X	NO _____	_____
ID PLATE	YES X	NO _____	_____
WELL INTEGRITY SATISFACTORY	YES X	NO _____	_____

WELL YIELD LOW X MODERATE _____ HIGH _____ COMMENTS _____

FIELD ANALYSES

VOLUME (1/10 GAL.)	0.0	1.5		
pH (S.U.)	6.37	5.95		
SP. COND. (μMHOS/CM)	267	284		
WATER TEMP. (°C)**	-----	-----		
TURBIDITY*	1	4		

*VISUAL DETERMINATION ONLY
(1) CLEAR (2) SLIGHT (3) MODERATE (4) HIGH
** METER NOT FUNCTIONAL

LAW ENGINEERING
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

MONITORING WELL AND SAMPLING FIELD DATA WORKSHEET

LAW JOB NUMBER 475-08135-01 MONITORING WELL NUMBER MW-27

SITE NAME CAMP GEIGER FUEL FARM

DATE (MO/DAY/YR) 11/4/92 TIME (MILITARY) 0737

FIELD PERSONNEL CORNELISSEN

WEATHER CONDITIONS OVERCAST, WARM

TOTAL WELL DEPTH (TWD) 15.0 1/10 FT. (DEPTH BELOW MEASURING POINT)

HEIGHT OF MEASURING POINT ABOVE LAND SURFACE 0.0 1/10 FT.

DESCRIPTION OF MEASURING POINT TOP OF MARKED CASING

DEPTH TO GROUNDWATER (DGW) 7.53 1/100 FT. (DEPTH BELOW MEASURING POINT)

LENGTH OF WATER COLUMN (LWC) = TWD - DGW = 7.47 1/100 FT.

ONE STANDING WELL VOLUME (SWV) = LWC X .17 = 1.3 1/10 GAL.

THREE STANDING WELL VOLUMES = 3XSWV = 3.9 1/10 GAL=STANDARD EVACUATION VOLUME

METHOD OF WELL EVACUATION X TEFLON BAILER _____ OTHER: _____

TOTAL VOLUME OF WATER REMOVED 4.0 1/10 GAL. CASING DIAMETER 2 In.

CASING MATERIAL PVC X S.S. _____ TEFLON _____ OTHER _____

SCREENED INTERVAL (FROM ID PLATE) 5.5 - 14.5 (DEPTHS BELOW LAND SURFACE - FT.)

STEEL GUARD PIPE AROUND CASING YES X NO _____ COMMENTS _____

LOCKING CAP YES X NO _____

PROTECTIVE POST/ABUTMENT YES _____ NO X

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE X HIGH _____ COMMENTS _____

FIELD ANALYSES

VOLUME (1/10 GAL.)	0.0	2.0	4.0	
pH (S.U.)	6.31	6.23	6.21	
SP. COND. (μMHOS/CM)	267	251	241	
WATER TEMP. (°C)**	-----	-----	-----	
TURBIDITY*	1	2	2	

*VISUAL DETERMINATION ONLY
(1) CLEAR (2) SLIGHT (3) MODERATE (4) HIGH
** METER NOT FUNCTIONAL

LAW ENGINEERING
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

MONITORING WELL AND SAMPLING FIELD DATA WORKSHEET

LAW JOB NUMBER 475-08135-01 MONITORING WELL NUMBER PW-28

SITE NAME CAMP GEIGER FUEL FARM

DATE (MO/DAY/YR) 11/4/92 TIME (MILITARY) 0652

FIELD PERSONNEL CORNELISSEN

WEATHER CONDITIONS OVERCAST, WARM

TOTAL WELL DEPTH (TWD) 25.0 1/10 FT. (DEPTH BELOW MEASURING POINT)

HEIGHT OF MEASURING POINT ABOVE LAND SURFACE 0.0 1/10 FT.

DESCRIPTION OF MEASURING POINT TOP OF MARKED CASING

DEPTH TO GROUNDWATER (DGW) 8.11 1/100 FT. (DEPTH BELOW MEASURING POINT)

LENGTH OF WATER COLUMN (LWC) = TWD - DGW = 16.89 1/100 FT.

ONE STANDING WELL VOLUME (SWV) = LWC X .66 = 11.1 1/10 GAL.

THREE STANDING WELL VOLUMES = 3XSWV = 33.3 1/10 GAL = STANDARD EVACUATION VOLUME

METHOD OF WELL EVACUATION X TEFLON BAILER _____ OTHER: _____

TOTAL VOLUME OF WATER REMOVED 33.5 1/10 GAL. CASING DIAMETER 4 In.

CASING MATERIAL PVC X S.S. _____ TEFLON _____ OTHER _____

SCREENED INTERVAL (FROM ID PLATE) 5.5 - 24.5 (DEPTHS BELOW LAND SURFACE - FT.)

STEEL GUARD PIPE AROUND CASING	YES X	NO _____	COMMENTS _____
LOCKING CAP	YES X	NO _____	_____
PROTECTIVE POST/ABUTMENT	YES _____	NO X	_____
NONPOTABLE LABEL	YES X	NO _____	_____
ID PLATE	YES X	NO _____	_____
WELL INTEGRITY SATISFACTORY	YES X	NO _____	_____

WELL YIELD LOW _____ MODERATE _____ HIGH X COMMENTS _____

FIELD ANALYSES

VOLUME (1/10 GAL.)	0.0	16.0	33.5	
pH (S.U.)	6.20	6.24	6.33	
SP. COND. (μMHOS/CM)	308	336	312	
WATER TEMP. (°C)**	-----	-----	-----	
TURBIDITY*	1	4	4	

*VISUAL DETERMINATION ONLY
(1) CLEAR (2) SLIGHT (3) MODERATE (4) HIGH
** METER NOT FUNCTIONAL

APPENDIX G

MONITORING-WELL CASING AND

WATER-ELEVATION WORKSHEETS

LAW ENGINEERING
3301 ATLANTIC AVENUE
RALEIGH, NORTH CAROLINA 27604

ENVIRONMENTAL DEPARTMENT

MONITORING WELL CASING AND WATER ELEVATION WORKSHEET

PROJECT NAME CAMP GEIGER FUEL FARM JOB NUMBER 475-08135-01

LOCATION CAMP LEJEUNE, NORTH CAROLINA DATE 11/19/92

DESCRIPTION OF SURVEY DATUM MEAN SEA LEVEL

FIELD PERSONNEL CORNELISSEN, ADKINS

MEASURING DEVICE(S) MMC OIL-WATER INTERFACE PROBE MODEL D-2401-2UI

WELL NUMBER	MEASURING POINT CALCULATIONS			DEPTH TO WATER (FT)	ELEV OF WATER (FT)	PRODUCT THICKNESS (FT)	COMMENTS (ODOR, WELL COND., PROTECTIVE COVER CONDITION)
	ROD HEIGHT (FT)	INSTRUMENT HEIGHT (FT)	ELEV OF MEASURING POINT (1) (FT)				
MW-26	5.46	19.93	14.47	7.47	7.00	ND	Good Condition
MW-27	5.47	19.93	14.46	7.53	6.93	ND	Good Condition
PW-28	5.12	19.93	14.81	8.11	6.70	ND	Good Condition

(1) Measuring point top of casing unless otherwise noted.
ND = None detected; equipment capable of measuring ≥0.01 feet.

12/91

APPENDIX H

LABORATORY ANALYTICAL TEST REPORTS

GROUNDWATER SAMPLES

Law Environmental, Inc.
Pensacola Branch
7215 Pine Forest Road
Pensacola, Florida 32526

November 16, 1992

Mr. Chris Cornelissen
Law Engineering, Inc.
3301 Atlantic Avenue
Raleigh, NC 27604
Clt. #12024 Proj. #475-08135-01

Dear: Mr. Cornelissen:

Below are the results of analysis of 6 samples received for examination on November 7, 1992:

Sample I.D. AA26775 Location code: CAMPGEI2
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-26 Sample collector: CORNELISSEN
Sample collection date: 11/04/92 Time: 06:50
Lab submittal date: 11/07/92 Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	1.0	1.0
Methyl tert-butyl ether	ug/L	12.0	0.6

Sample I.D. AA26776 Location code: CAMPGEI2
P.O./Project No.: 47508135 Client No.: 12024
Loc. Desc.: MW-27 Sample collector: CORNELISSEN
Sample collection date: 11/04/92 Time: 07:45
Lab submittal date: 11/07/92 Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602 (continued)			
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	Not detected	0.6

Sample I.D. AA26777
P.O./Project No.: 47508135
Loc. Desc.: PW-28
Sample collection date: 11/04/92
Lab submittal date: 11/07/92

Location code: CAMPGEI2
Client No.: 12024
Sample collector: CORNELISSEN
Time: 07:30
Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	Not detected	0.6

Sample I.D. AA26778
P.O./Project No.: 47508135
Loc. Desc.: STORAGE TANKER
Sample collection date: 11/04/92
Lab submittal date: 11/07/92

Location code: CAMPGEI2
Client No.: 12024
Sample collector: CORNELISSEN
Time: 16:00
Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602 (continued)			
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	16.0	0.6

Sample I.D. AA26779
P.O./Project No.: 47508135
Loc. Desc.: RINSE BLANK
Sample collection date: 11/04/92
Lab submittal date: 11/07/92

Location code: CAMPGEI2
Client No.: 12024
Sample collector: CORNELISSEN
Time: 07:00
Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	Not detected	0.6

Sample I.D. AA26780
P.O./Project No.: 47508135
Loc. Desc.: TRIP BLANK
Sample collection date: 11/04/92
Lab submittal date: 11/07/92

Location code: CAMPGEI2
Client No.: 12024
Sample collector: CORNELISSEN
Time: 07:08

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
Multicomponent analysis: 2321-VOA W. by GC EPA 602			
Benzene	ug/L	Not detected	0.2
Chlorobenzene	ug/L	Not detected	0.3
1,2-Dichlorobenzene	ug/L	Not detected	0.3
1,3-Dichlorobenzene	ug/L	Not detected	0.3
1,4-Dichlorobenzene	ug/L	Not detected	0.3
Ethylbenzene	ug/L	Not detected	0.5
Toluene	ug/L	Not detected	1.0
Xylenes (total)	ug/L	Not detected	1.0
Methyl tert-butyl ether	ug/L	Not detected	0.6

Please advise should you have questions concerning these data.

Respectfully submitted,

16 NOV 1992

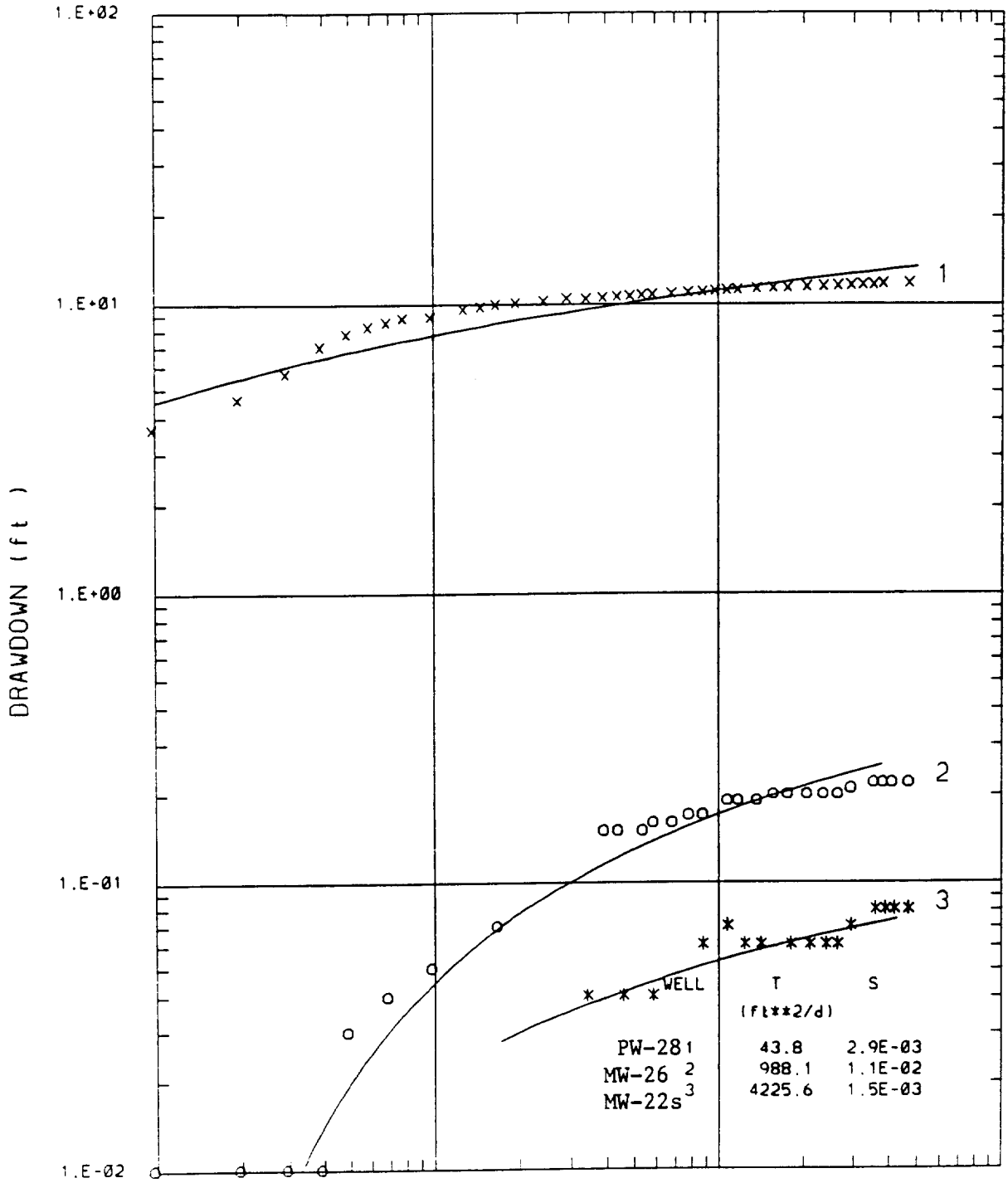
James M.G. Tucci, Laboratory Manager

APPENDIX I

PUMP TEST CALCULATIONS

CAMP GEIGER FUEL FARM PUMP TEST, PERFORMED 11/4/92

Theis Curve Automated Matching



T S - M A T C H V3.2

Theis Curve Automated Matching

IN-SITU INC. SOFTWARE SERIES

CAMP GEIGER FUEL FARM PUMP TEST - PERFORMED 11/4/92

Input File Name: c:CGFARMIN.DAT
Output File Name: c:TSCGFARM.OUT
Plot File Name: c:CGFARM1.PLT

****
The input/output will be in HYDROLOGY terminology
****

TIME VS. DRAWDOWN DATA:

Time (min)	Drawdown (ft) --> Well 1 PW-28	Well 2 MW-26	Well 3 MW-22s
1.00	3.63	.01	.00
2.00	4.63	.01	.00
3.00	5.68	.01	.00
4.00	7.05	.01	.00
5.00	7.84	.03	.00
6.00	8.28	-1.00	.00
7.00	8.58	.04	.00
8.00	8.88	-1.00	.00
10.00	8.94	.05	.00
13.00	9.55	-1.00	.00
15.00	9.70	-1.00	.00
17.00	9.90	.07	.00
20.00	10.00	-1.00	.00
25.00	10.20	-1.00	.00
30.00	10.42	-1.00	.00
35.00	10.36	-1.00	.04
40.00	10.44	.15	-1.00
45.00	10.54	.15	-1.00
47.00	-1.00	-1.00	.04
50.00	10.59	-1.00	-1.00

55.00	10.67	.15	-1.00
60.00	10.74	.16	.04
70.00	10.80	.16	-1.00
80.00	10.93	.17	-1.00
90.00	10.98	.17	.06
100.00	11.07	-1.00	-1.00
110.00	11.08	.19	.07
120.00	11.13	.19	-1.00
127.00	-1.00	-1.00	.06
140.00	11.26	.19	-1.00
145.00	-1.00	-1.00	.06
160.00	11.28	.20	-1.00
180.00	11.32	.20	-1.00
185.00	-1.00	-1.00	.06
210.00	11.40	.20	-1.00
216.00	-1.00	-1.00	.06
240.00	11.46	.20	-1.00
246.00	-1.00	-1.00	.06
270.00	11.50	.20	.06
300.00	11.56	.21	.07
330.00	11.59	-1.00	-1.00
360.00	11.60	.22	-1.00
367.00	-1.00	-1.00	.08
390.00	11.67	.22	-1.00
399.00	-1.00	-1.00	.08
420.00	-1.00	.22	-1.00
429.00	-1.00	-1.00	.08
480.00	11.73	.22	.08

Negative/Zero Drawdowns: 10 20 32

Flow rate = 4.10 gpm
Number of Observation Wells = 3
Number of Time-Drawdown Pairs/Well = 48
Maximum Number of Iterations = 60
Tolerance of Iteration (Relative) = 1.00E-03
Angular Frequency Interval = 15.00 deg

Observation Well Coordinates and Radial Distances Referenced to Pumping Well:

		X (ft)	Y (ft)	R (ft)
PW-28	Well 1	1.01	.00	1.01
MW-26	Well 2	-28.70	13.10	31.55
MW-22s	Well 3	49.50	101.90	113.29

THE "BEST-FIT" TIME-DRAWDOWN MATCH DATA:
==========

Well 1 PW-28

Transmissivity = 43.81 ft**2/d
Storage Coefficient = 2.9E-03

Time (min)	Drawdown (ft) Data	Match
1.00	3.63	4.53
2.00	4.63	5.50
3.00	5.68	6.08
4.00	7.05	6.49
5.00	7.84	6.81
6.00	8.28	7.07
7.00	8.58	7.29
8.00	8.88	7.48
10.00	8.94	7.80
13.00	9.55	8.17
15.00	9.70	8.38
17.00	9.90	8.56
20.00	10.00	8.79
25.00	10.20	9.11
30.00	10.42	9.37
35.00	10.36	9.59
40.00	10.44	9.78
45.00	10.54	9.95
47.00	-1.00	--
50.00	10.59	10.10
55.00	10.67	10.24
60.00	10.74	10.36
70.00	10.80	10.59
80.00	10.93	10.78
90.00	10.98	10.95
100.00	11.07	11.10
110.00	11.08	11.23
120.00	11.13	11.36
127.00	-1.00	--
140.00	11.26	11.58
145.00	-1.00	--
160.00	11.28	11.77
180.00	11.32	11.94
185.00	-1.00	--
210.00	11.40	12.16
216.00	-1.00	--
240.00	11.46	12.35
246.00	-1.00	--
270.00	11.50	12.52
300.00	11.56	12.67
330.00	11.59	12.81
360.00	11.60	12.93
367.00	-1.00	--
390.00	11.67	13.05
399.00	-1.00	--
420.00	-1.00	--

429.00	-1.00	--
480.00	11.73	13.35

Well 2 MW-26

Transmissivity = 988.10 ft**2/d
Storage Coefficient = 1.1E-02

Time (min)	Drawdown (ft) Data	Match
3.00	.01	.01
4.00	.01	.01
5.00	.03	.02
6.00	-1.00	--
7.00	.04	.03
8.00	-1.00	--
10.00	.05	.05
13.00	-1.00	--
15.00	-1.00	--
17.00	.07	.07
20.00	-1.00	--
25.00	-1.00	--
30.00	-1.00	--
35.00	-1.00	--
40.00	.15	.12
45.00	.15	.12
47.00	-1.00	--
50.00	-1.00	--
55.00	.15	.14
60.00	.16	.14
70.00	.16	.15
80.00	.17	.16
90.00	.17	.16
100.00	-1.00	--
110.00	.19	.18
120.00	.19	.18
127.00	-1.00	--
140.00	.19	.19
145.00	-1.00	--
160.00	.20	.20
180.00	.20	.21
185.00	-1.00	--
210.00	.20	.22
216.00	-1.00	--
240.00	.20	.23
246.00	-1.00	--
270.00	.20	.23
300.00	.21	.24

330.00	-1.00	--
360.00	.22	.25

Well 3 MW-22s

Transmissivity = 4225.58 ft**2/d
Storage Coefficient = 1.5E-03

Time (min)	Drawdown (ft) Data	Match
17.00	.00	--
20.00	.00	--
25.00	.00	--
30.00	.00	--
35.00	.04	.04
40.00	-1.00	--
45.00	-1.00	--
47.00	.04	.04
50.00	-1.00	--
55.00	-1.00	--
60.00	.04	.05
70.00	-1.00	--
80.00	-1.00	--
90.00	.06	.05
100.00	-1.00	--
110.00	.07	.05
120.00	-1.00	--
127.00	.06	.06
140.00	-1.00	--
145.00	.06	.06
160.00	-1.00	--
180.00	-1.00	--
185.00	.06	.06
210.00	-1.00	--
216.00	.06	.06
240.00	-1.00	--
246.00	.06	.07
270.00	.06	.07
300.00	.07	.07
330.00	-1.00	--
360.00	-1.00	--
367.00	.08	.07
390.00	-1.00	--
399.00	.08	.07

SUMMARY OF "TS-MATCH" PARAMETERS:

	Well #	T (ft**2/d)	S
PW-28	1	43.81	2.9E-03
MW-26	2	988.10	1.1E-02
MW-22s	3	4225.58	1.5E-03

****

D I R E C T I O N A L T R A N S M I S S I V I T Y C O M P U T A T I O N

****

SUMMARY OF RESULTS - 3 WELL COMBINATIONS

Well Combination	T-Major (ft**2/d)	T-Minor (ft**2/d)	T-mean (ft**2/d)	Angle of T-Major (degrees)	Storage Coeff.
1 2 3	Probably heterogeneous media				

The curve-matches of ALL the observation well data
are plotted on frame 1.

TS-MATCH COMPLETED.

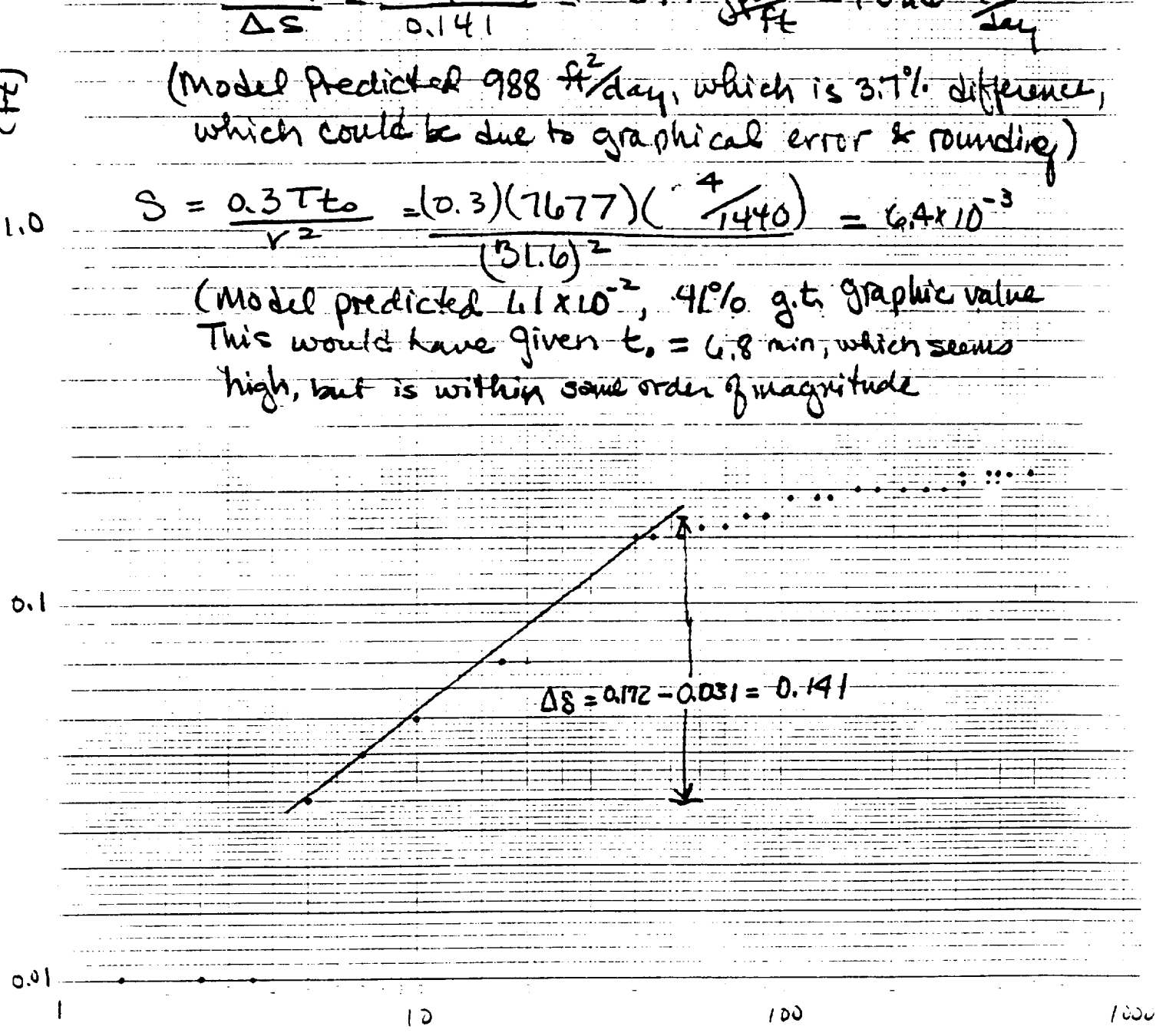
CAMP GEIGER FUEL FARM
Pump Test, 11/4/92
well MW-26

$$T = \frac{264\,Q}{\Delta s} = \frac{264(4.1)}{0.141} = 7677 \frac{gpd}{ft} = 1026 \frac{ft^2}{day}$$

(Model Predicted 988 ft^2/day, which is 3.7% difference, which could be due to graphical error & rounding)

$$S = \frac{0.3\,T\,t_o}{r^2} = \frac{(0.3)(7677)\left(\frac{4}{1440}\right)}{(31.6)^2} = 6.4 \times 10^{-3}$$

(Model predicted 6.1×10^{-2}, 41% g.t. graphic value
This would have given t_o = 6.8 min, which seems high, but is within same order of magnitude



Job 475-08135-01
CSC 11/25/92
Date 12/17 AZ

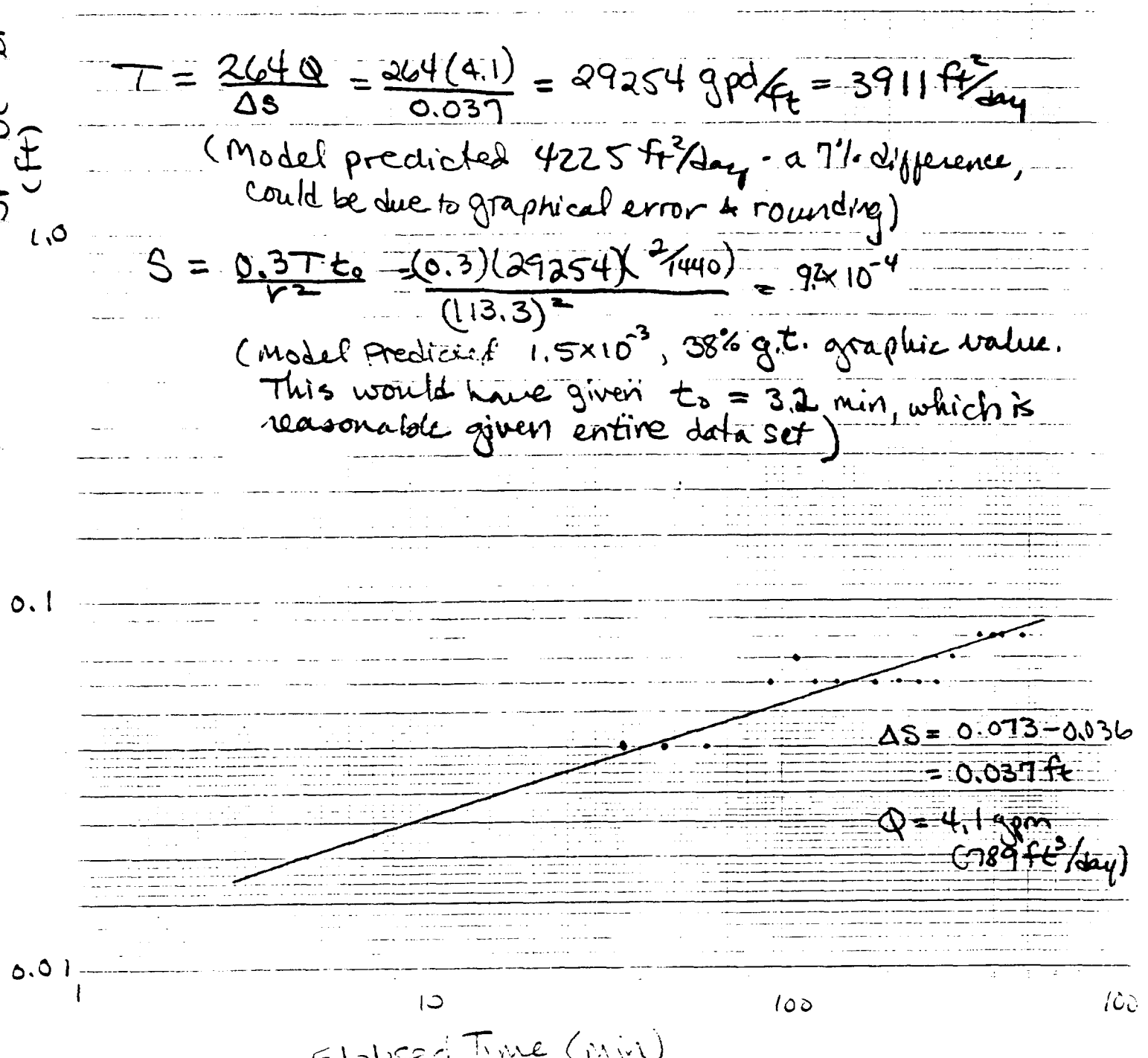
CAMP GEIGER FUEL FARM
Pump Test, 11/4/92
Well MW-22S

$$T = \frac{264Q}{\Delta s} = \frac{264(4.1)}{0.037} = 29254 \text{ gpd/ft} = 3911 \text{ ft}^2/\text{day}$$

(Model predicted 4225 ft^2/day - a 7% difference, could be due to graphical error & rounding)

$$S = \frac{0.3 T t_o}{r^2} = \frac{(0.3)(29254)(2/1440)}{(113.3)^2} = 9.2 \times 10^{-4}$$

(Model Predicted 1.5×10^{-3}, 38% g.t. graphic value. This would have given t_o = 3.2 min, which is reasonable given entire data set)



Job 475-08135-01
CA 11/25/92
DAS 12/17/92

LAW ENGINEERING

GEOTECHNICAL ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

JOB NO. 28135-01 SHEET 1 OF 1

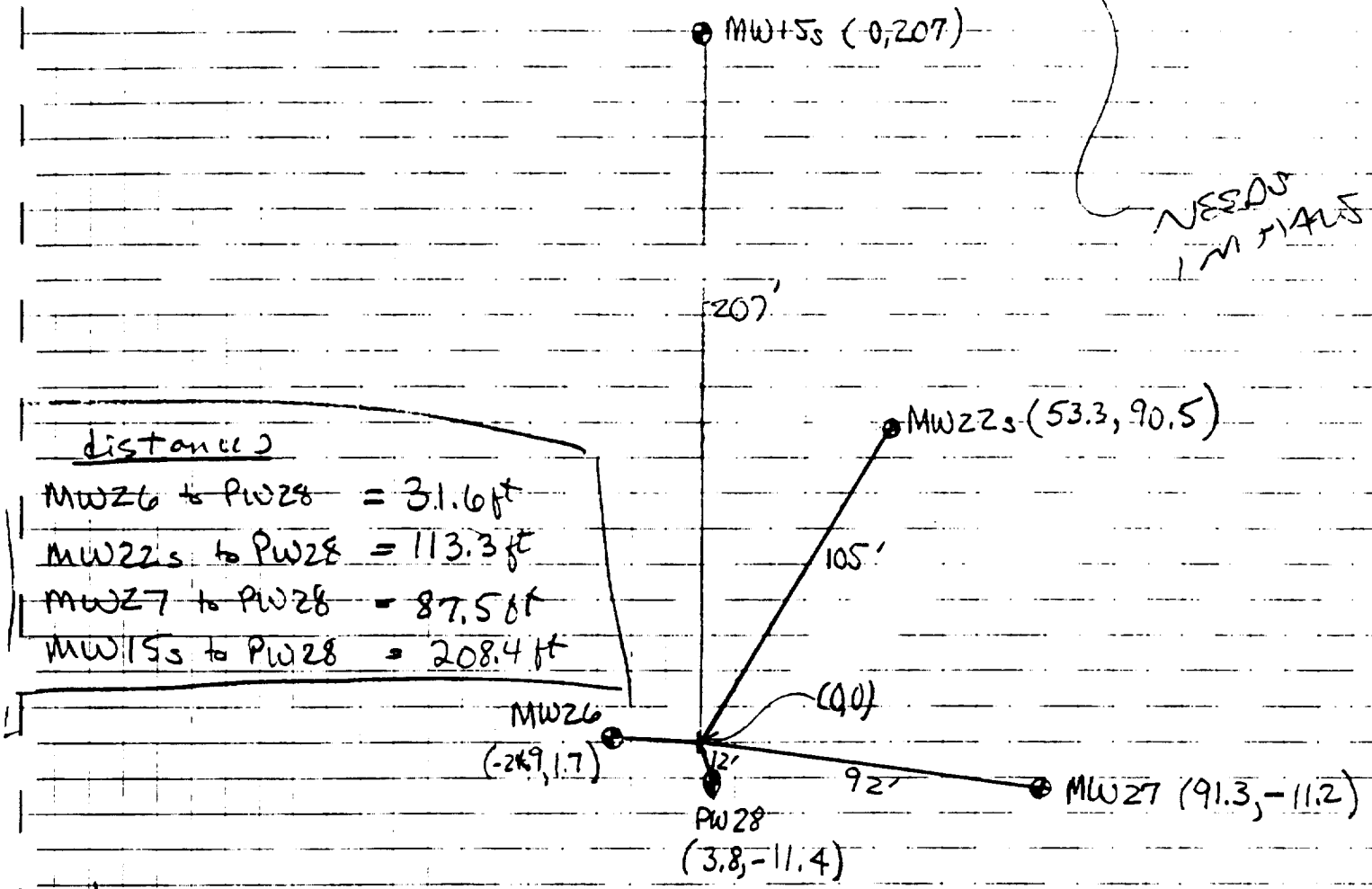
JOB NAME Camp Geiger Surveying

SUBJECT Surveyed well Locations

BY JEC DATE 11/25/12

CHECKED BY _____ DATE _____

NEEDS TO PLOT



distances

MW26 to PW28 = 31.6 ft

MW22s to PW28 = 113.3 ft

MW27 to PW28 = 87.5 ft

MW15s to PW28 = 208.4 ft

~~dis~~ coords, w.r.t. Pump well

PW 28 (1.01, 0.0)

MW 26 (-28.7, 13.1)

MW 22s (49.5, 101.9)

PUMP TEST FORM

COMPANY: [illegible] Engineering

JOB: Cond Gelcer [illegible]

JOB LOCATION: [illegible]

ENGINEER: [illegible]

DATE: 11/4/92

OBS. WELL NO.: [illegible]

DESCRIPTION OF MEASURING POINT: TOC

DISTANCE FROM PUMPED WELL: [illegible]

STATIC WATER LEVEL AT 1203 AM (PM) 7.55

Time of Measurement	Time Since Pumping (Began) Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
	1 min.			10.38	2.83	
	2 ~~00~~			12.18	4.63	
	3 ~~00~~			13.23	5.68	106 gal
	4 ~~00~~			14.60	7.05	
	5 ~~00~~			15.39	7.84	
	6 ~~00~~			15.83	8.28	
	7 ~~00~~			16.13	8.58	
	8 ~~00~~			16.43	[illegible]	
	10			16.79	[illegible]	
	13			17.10	9.55	
	15 ~~00~~			17.25	9.70	150 gal
	17 ~~00~~			17.45	9.90	4.1 gpm
	19.5			17.55	10.00	
	20 ~~00~~			17.75	10.20	4.1 gpm
	30 ~~00~~			17.[illegible]	10.42	
	35 ~~00~~			17.[illegible]	10.36	
	40 ~~00~~			17.99	10.44	4.1 gpm
	45 ~~00~~			18.09	10.54	
	50 ~~00~~			18.14	10.59	204 gal @ 51 gpm
	55 ~~00~~			18.22	10.67	

PUMP TEST FORM

OMPANY: _____ OBS. WELL NO.: PW-28

OB: Sand Gulch Fuel Farm DESCRIPTION OF MEASURING POINT: TOC

OB LOCATION: 94135-01 DISTANCE FROM PUMPED WELL: _____

NGINEER: C. Cornelissen STATIC WATER LEVEL

ATE: 11/4/92 AT 1203 AM (PM) 7.55

Time of Measurement	Time Since Pumping Began / Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
	70			18.35	10.80	
	80			18.48	10.93	@ 4.1 gpm
	90			18.53	10.98	
	100			18.62	11.07	
	110			18.63	11.08	TOTAL 546.5 gal
	122			18.68	11.13	4.1 GPM @ 124 minutes
	140			18.81	11.26	
2:39	159			18.83	11.28	
	180			18.87	11.32	
	210			18.95	11.40	TOTAL 377 @ 216 min 4.1 gpm @ 219 min
	240			19.01	11.46	
	270			19.05	11.50	4.0 gpm @ 278
	300			19.11	11.56	
	330			19.14	11.59	TOTAL 1430 @ 341 4.1 gpm @ 343
	360			19.15	11.60	
	393			19.22	11.67	TOTAL 1710 @ 395
	420			19.22	11.67	
	—			—	—	4.1 gpm @ 462 min
513	480			19.28		

PUMP TEST FORM

COMPANY: Law Engineering

OBS. WELL NO.: MW-2

B: 425-D-6135-1

DESCRIPTION OF MEASURING POINT: TOC

B LOCATION: Farm Fuel Farm

DISTANCE FROM PUMPED WELL: 113 ft

NGINEER: Proctor / Commission

STATE: 11/4/92

STATIC WATER LEVEL AT 1200 AM (PM) 13.18

12:13 pm

Time of Measurement	Time Since Pumping Began Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
~~12:15~~				~~7.55~~	~~5.37~~	
	13			13.18	0.00	
	36			13.22	0.04	
	47			13.22	0.04	
	62			13.22	0.04	
	93			13.24	0.06	
	110			13.25	0.07	
	127			13.24	0.06	
240 PM	145			13.25	0.06	
	185			13.25	0.06	
	216			13.25	0.06	
	246			13.25	0.06	
	275			13.25	0.06	
	305			13.26	0.07	
6:10	367			13.27	0.09	
6:52	399			13.27	0.09	
7:22	429			13.27	0.09	
8:15	482			11	11	

PUMP TEST FORM

COMPANY: Groton Fuel Farm

OBS. WELL NO.: MW-26

JOB: 425-98135-01

DESCRIPTION OF MEASURING POINT: TOC

JOB LOCATION:

DISTANCE FROM PUMPED WELL: 32'

ENGINEER: Daniel Cornelissen

DATE: 11/4/92

STATIC WATER LEVEL AT 1203 AM (PM) 7.49

Time of Measurement	Time Since Pumping Began / Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
	0.5			7.50	0.01	
	1.5			7.50	0.01	
	2.5			7.50	0.01	
	3.5			7.50	0.01	
	5			7.52	0.03	
	7			7.53	0.04	
	9					
	0			7.54	0.05	
	2			7.56	0.07	
	25					
	33					
	40			7.64	0.15	
	45			7.64	0.15	
	53			7.64	0.15	
	60			7.65	0.16	
	70			7.65	0.16	
	80			7.66	0.17	
	90			7.66	0.17	

2/2

PUMP TEST FORM

OMPANY: _____ OBS. WELL NO.: MW 2C

OB: _____ DESCRIPTION OF MEASURING POINT: TOC

OB LOCATION: _____ DISTANCE FROM PUMPED WELL: _____

NGINEER: _____ STATIC WATER LEVEL AT _____ AM PM _____

ATE: _____

Start 12:13 PM

Time of easurement	Time Since Pumping Began Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
	25			7.68	0.19	
	125			7.68	0.19	
	137			7.68	0.19	
255 PM	160			7.69	0.20	
	183			7.69	0.20	
	214			7.69	0.20	
	245			7.69	0.20	
	274			7.69	0.20	
	303			7.70	0.21	
	303			7.71	0.22	
616 PM	363			7.71	0.22	
649	396			7.71	0.22	
7:17	424			7.71	0.22	
8:15	482			7.71	0.22	

1/2

PUMP TEST FORM

COMPANY: Law Engineering

OBS. WELL NO.: MW-27

JOB: Cons Geotech Tech II & M

DESCRIPTION OF MEASURING POINT: TOC

JOB LOCATION: [illegible]

DISTANCE FROM PUMPED WELL: 88'

ENGINEER: [illegible]

STATIC WATER LEVEL AT 1202 AM (PM) 8.13

DATE: 11-1-92

Time of Measurement	Time Since Pumping Began / Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
	12			8.07	0.01	
	40			8.11		Pump was shut off and current from [illegible]
	54			8.10		
	64			8.10		
	74			8.11		
	84			8.11		
	94			8.12		
	104			8.12		
	114			8.12		
	125			8.12		
	141			8.12		
	164			8.12		
	181			8.12		
	212			8.12		
	243			8.14	0.01	
	272			8.13	—	
	301			8.13	—	
	332			8.14	0.01	
	362			8.14	0.01	
	395			8.13		

2/2

PUMP TEST FORM

OMPANY: _____

OB: Camp Geiger fuel farm

OB LOCATION: CS135-01

NGINEER: Carlisse - Proctor

ATE: 11/4/92

OBS. WELL NO.: MW-27

DESCRIPTION OF MEASURING POINT: TOC

DISTANCE FROM PUMPED WELL: _____

STATIC WATER LEVEL AT 1202 AM (PM) 8.13

Time of Measurement	Time Since Pumping Began Stopped Minutes	Tape Held at, ft	Tape Wet at, ft	Depth to Water ft	Drawdown ft	Remarks
1915	422			8.14	0.01	

TYPE CURVE CALCULATIONS NAVY PUMPING TESTS

TEST	WELL	Q gpm	R ft	T min	DELH ft	W(U)	U	T ft^2/d	T gpd/ft^2	S
CHERRY PT	MW1	5.1	67	4.8	0.285	1	1	274	2051	0.001
1697/98	MW2	5.1	33	5.2	0.62	1	1	126	943	0.002
	MW3	5.1	22	0.22	0.5	1	1	156	1169	0.0002
	N46W04	5.1	28	1.05	0.3	1	1	260	1948	0.001
CAMP GEIGER	MW26	4.1	32	1.9	0.04	1	1	1570	11746	0.008
FUEL FARM	MW22s	4.1	113	3.8	0.020	1	1	3064	22920	0.003
CAMP GEIGER	MW1	6.4	28	7	0.095	1	1	1032	7720	0.026
MINI-C	MW2	6.4	65	22	0.15	1	1	654	4890	0.009
	MW4	6.4	36	3.4	0.054	1	1	1816	13582	0.013
	MW5	6.4	84	520	0.34	1	1	288	2157	0.059
CHERRY PT	9GW01	12.4	28.4	9.6	0.12	1	1	1583	11842	0.052
TF D	9GW02	12.4	108	250	0.21	1	1	905	6767	0.054
	9GW03	12.4	55	7.3	0.028	1	1	6785	50751	0.045
	9GW05	12.4	84.4	5.8	0.132	1	1	1439	10765	0.003
	9GW07	12.4	84.3	105	0.044	1	1	4318	32296	0.177
	9GW09	12.4	16.7	5.3	0.35	1	1	543	4060	0.029
	9GW10	12.4	85.2	2.4	0.19	1	1	1000	7479	0.001
	9GW15	12.4	23.8	1	0.44	1	1	432	3230	0.002
BERKLEY	MW2	8.8	56	1	0.021	1	1	6420	48023	0.006
MANOR	MW3	8.8	54	12.5	0.13	1	1	1037	7758	0.012
	MW4	8.8	84	800	0.59	1	1	229	1709	0.072
	MW6	8.8	25.5	0.76	0.28	1	1	482	3602	0.002
	MW9	8.8	51	1.5	0.062	1	1	2175	16266	0.003

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

3301 ATLANTIC AVE.
P.O. BOX 18288
RALEIGH, NC 27619
919-876-0416

JOB NO. 425-08135-0 SHEET 1 OF 3

JOB NAME Camp Geiger

SUBJECT Hydraulic Conductivity PW-28

BY PAH DATE 12/14/92

CHECKED BY JAP DATE 12/17/92

CAMP GEIGER FUEL FARM PW-28 5.5'-24.5'

$d_{16} = 0.1089$

$d_{84} = 0.24$

$d_5 = 0.001$

$d_{95} = 0.35$

$d_{50} = 0.16$

KRUMBEIN'S ϕ UNITS

$\phi = -\log 2d$

$= -\log 2(0.1089) =$

$= \frac{\ln 0.1089}{2} = \frac{2.2173}{2} = 1.1087 = d_{16}$

$\phi = -\log 2(0.24)$

$= \frac{\log_n (0.24)}{2} = \frac{1.43}{2} = 0.72 = d_{84}$

$\phi = -\log 2(0.001)$

$= \frac{\log_n (0.001)}{2} = \frac{6.9}{2} = 3.5 = d_5$

$\phi = -\log 2(0.35)$

$= \frac{\log_n (0.35)}{2} = \frac{1.05}{2} = 0.53 = d_{95}$

$\phi = -\log 2(0.16)$

$= \frac{\log_n (0.16)}{2} = \frac{1.83}{2} = 0.92 = d_{50}$

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919-876-0416

JOB NO. 475-08135 SHEET 2 OF 3

JOB NAME Camp Geiger

SUBJECT K

BY RAK DATE 12/14/92

CHECKED BY TJH DATE 12/17/92

INCLUSIVE STANDARD DEVIATION (SIZE SORTING)

$$\sigma_I = \frac{d_{16} - d_{84}}{4} + \frac{d_5 - d_{95}}{6.6}$$

$$= \frac{1.1087 - 0.72}{4} + \frac{3.5 - 0.53}{6.6}$$

$$= 0.19 + 0.45 = 0.64$$

K = 2.14 cm/min from graph

K = 2.14 cm/min · 60 min/hr · 24 hr/day · 0.03281 ft/cm = (99.21 ft/day = K)

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919-876-0416

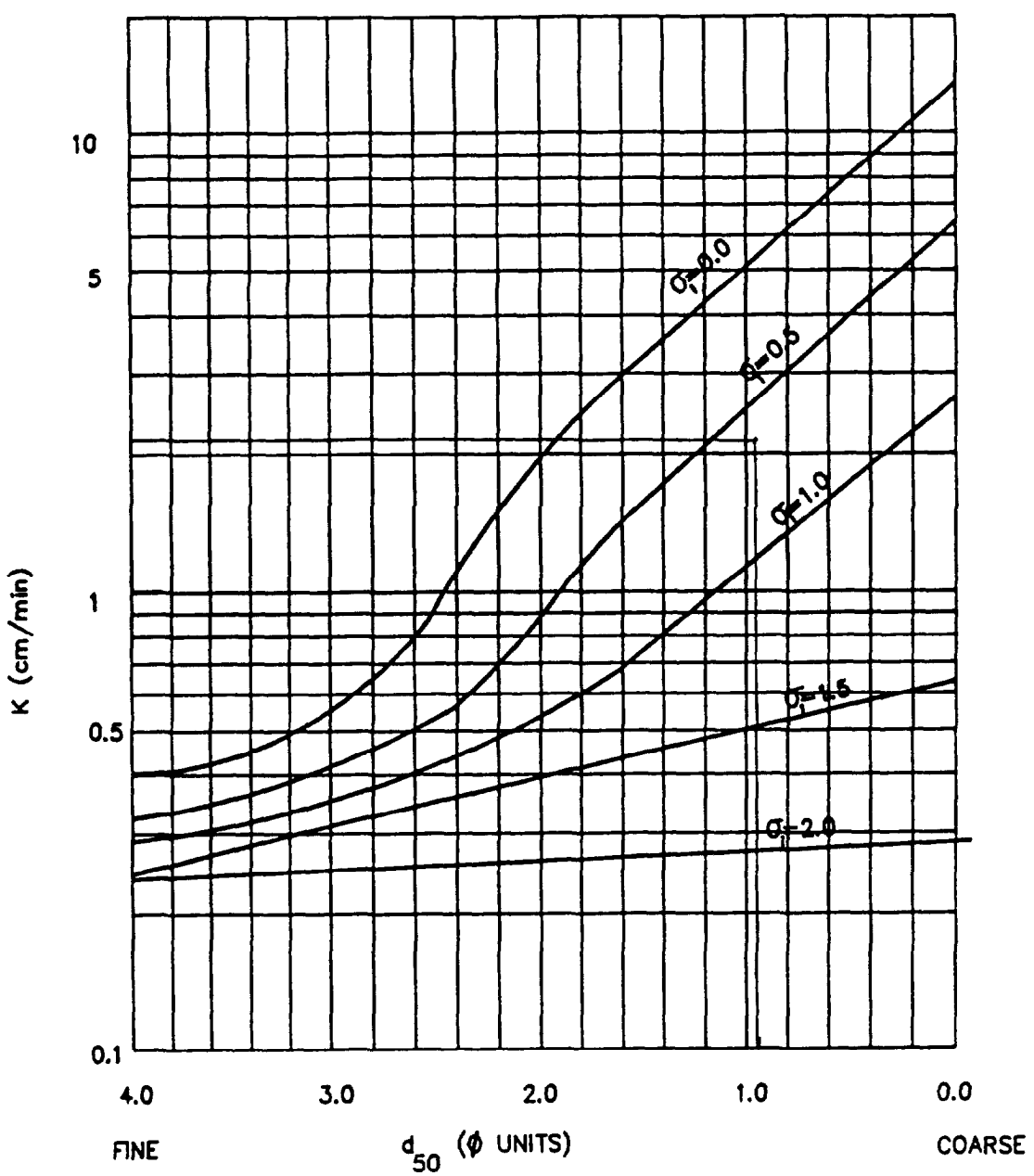
JOB NO. 475-08135-01 SHEET 3 OF 3

JOB NAME Camp Geiger

SUBJECT K

BY RAR DATE 12/14/92

CHECKED BY JAP DATE 12/17/92



DETERMINATION OF SATURATED HYDRAULIC CONDUCTIVITY
FROM GRAIN SIZE GRADATION CURVES FOR UNCONSOLIDATED SANDS
(AFTER MASCH AND DENNY, 1966; FROM FREEZE AND CHERRY, PG. 350)

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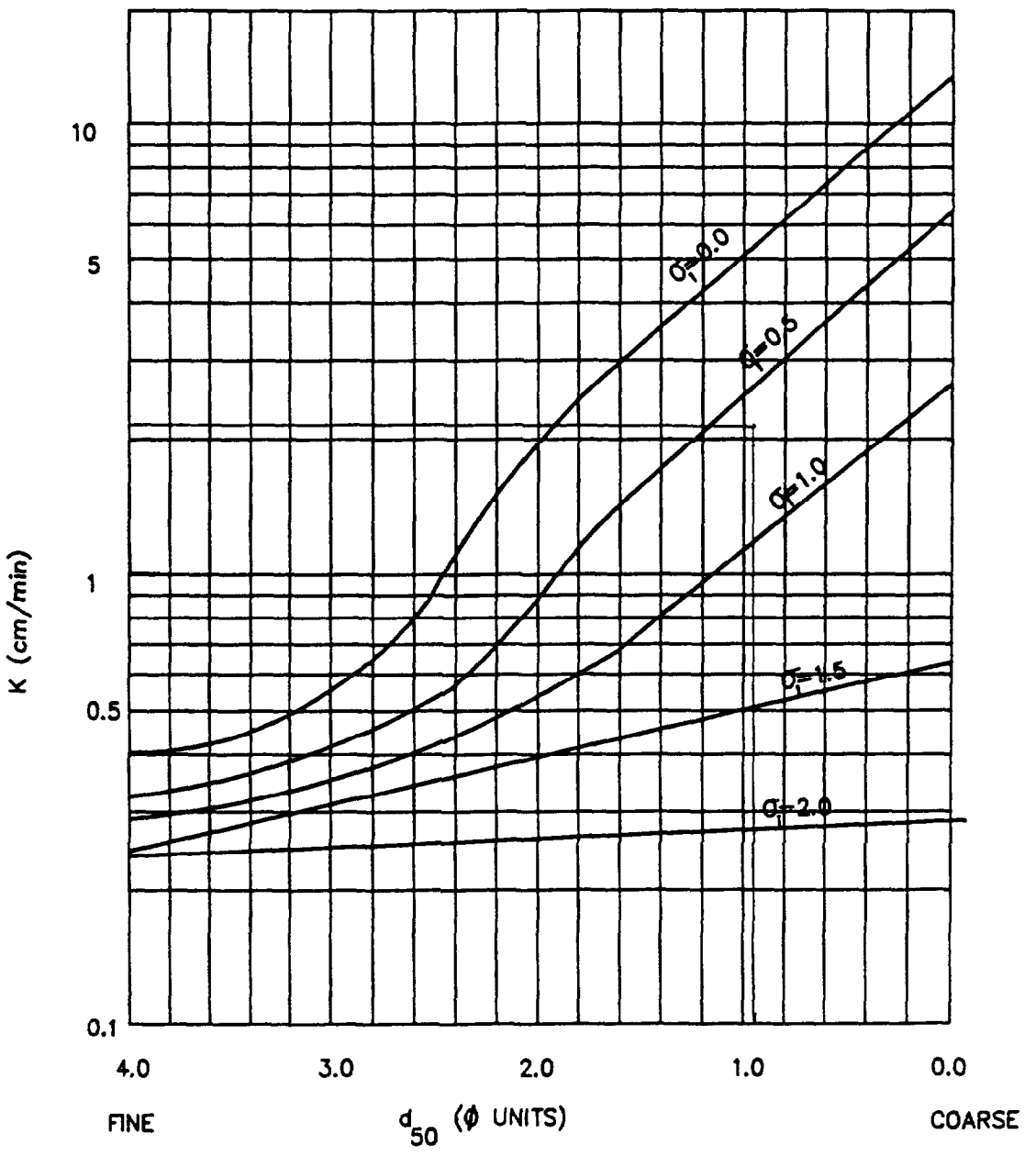
JOB NO. 475-08135-01 SHEET 3 OF 3

JOB NAME Camp Geiger

SUBJECT K

BY RAR DATE 12/14/92

CHECKED BY TAP DATE 12/17/92



DETERMINATION OF SATURATED HYDRAULIC CONDUCTIVITY
FROM GRAIN SIZE GRADATION CURVES FOR UNCONSOLIDATED SANDS
(AFTER MASCH AND DENNY, 1966; FROM FREEZE AND CHERRY, PG. 350)

RESULTS OF INSITU TSMATCH (Automated Theis Curve Matching) for LANTDIV PUMP TESTS

1. CAMP GEIGER FUEL FARM, 11/4/92

Well	R(ft)	T (ft**2/day)	S
PW-28	0	43.8	2.9E-3
MW-26	32	988.1	1.1E-2
MW-22s	113	4225.6	1.5E-3
MW-27	88	No Data----------	

2. CHERRY POINT TANKS 1697/1698, 11/17/92

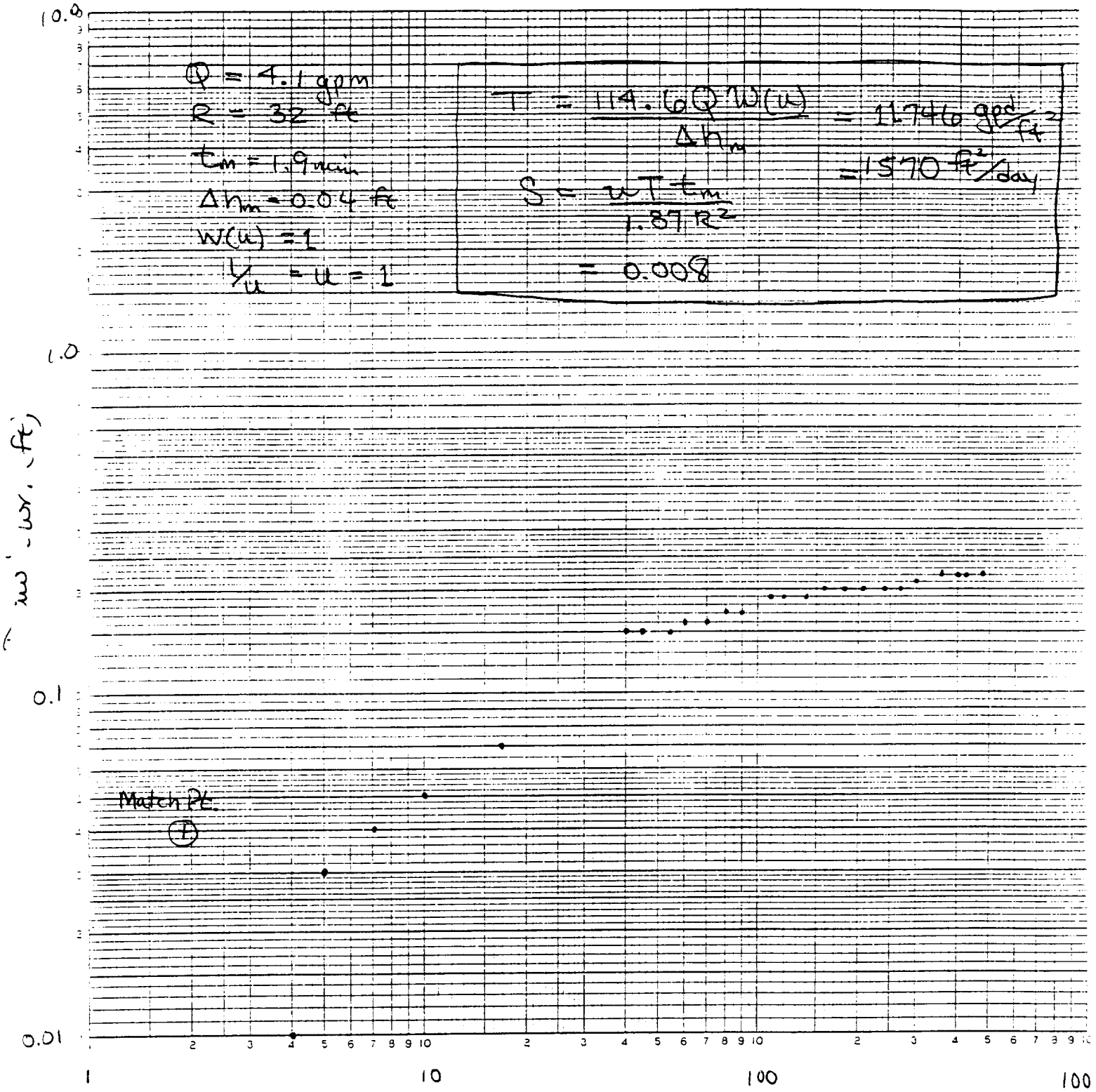
Well	R(ft)	T (ft**2/day)	S
PW-1, ALL DATA	0	58.7	6.5E-2
PW-1, DELETE 2 MIN	0	45.9	1.5E-2
MW-1, GRAPHIC METH	67	5900	1.2E-3
MW-2	33	358.7	4.9E-4
MW-3	22	445.1	5.9E-7
N46W04	28	281.7	9.9E-4

3. CAMP GEIGER MINI-C STORE, 11/19/92

Well	R(ft)	T (ft**2/day)	S
PW-8, ALL DATA	0	71.3	1.8E-2
PW-8, DEL SLOPE RISE	0	69.4	1.8E-2
MW-1	28	876.5	3.3E-2
MW-2	65	2949.7	8.4E-2
MW-4	36	1339.8	2.0E-2
MW-5	84	1001.3	1.3E-1

12-081

Field Data - Camp Geiger Full Farm Pumping Test, 11/4/92, MW-26

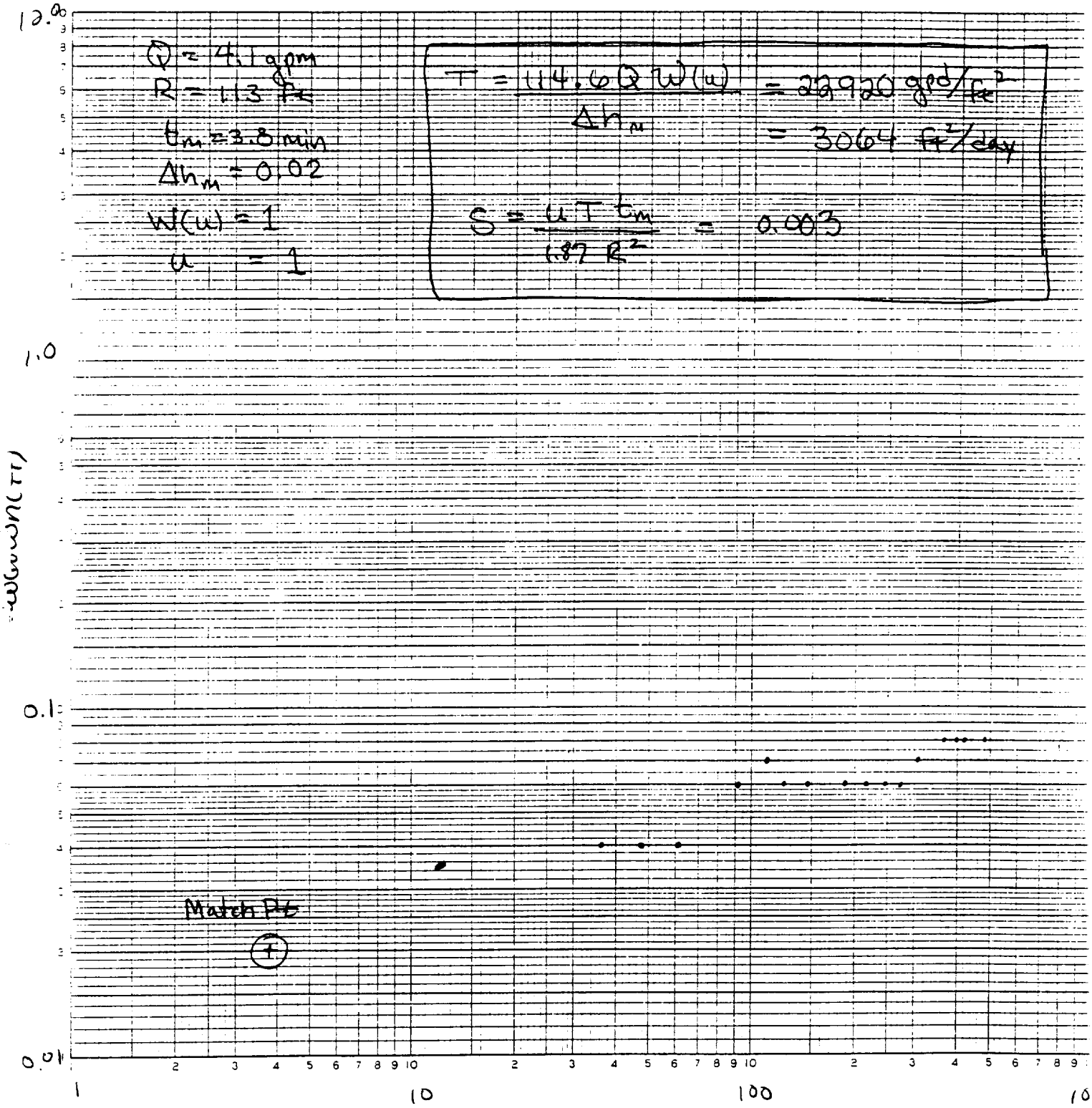


Full Logarithmic, 3 × 3 Cycles

By: [signature] 1/13/93

12-081

Field Data - Camp Geiger Fuel Farm
Pumping Test, 11/4/92, MW22S



Full Logarithmic, 3 × 3 Cycles

By: [signature] 1/13/93