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Site Name (Subject):	STARLING DAVID PROPERTY
Site ID (Document ID):	NCD003185311
Document Name (DocType):	Contractor Report (CONTR)
Report Segment:	
Description:	Final Report of Hydrogeological Assessment
Date of Document:	11/28/1983
Date Received:	
Box: *Enter SF and # with no spaces*	SF10,625
Access Level:	PUBLIC
Division:	WASTE MANAGEMENT
Section:	SUPERFUND
Program (Document Group):	SERB (SERB)
Document Category:	FACILITY

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FINAL REPORT OF

HYDROGEOLOGICAL ASSESSMENT

DAVID STARLING DISPOSAL SITE

PITT COUNTY, NORTH CAROLINA

FOR

UNION CARBIDE CORPORATION

NOVEMBER 1983

LAW ENGINEERING TESTING COMPANY

UNION CARBIDE

UNION CARBIDE CORPORATION
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SOLID & HAZARDOUS WASTE MANAGEMENT BRANCH

Mr. D. Mark Durway
North Carolina Dept. of Human Resources
Solid and Hazardous Waste Management Branch
P. O. Box 2091
Raleigh, N. C. 27602-2091

November 16, 1984

Subject: David Starling Disposal Site

Dear Mr. Durway:

This letter is in response to your 10/4/84 request for information about the Starling disposal site in Farmville, N. C. In 1970, Union Carbide Corporation (UCC) was awarded a contract to produce a magnesium battery for the Federal government. Part of the production operation involved chrome coating. Excess barium carbonate was added to spent coating solution to precipitate chromium such that the remaining wastewater could be safely discharged to the local POTW. The sludge generated from this treatment step consisted of 40% to 50% barium carbonate and 50% to 60% barium chromate. Between 1/6/71 and 3/31/71, approximately 542 containers were shipped to the Starling disposal site. The containers consisted of 55-gallon drums and 5-gallon pails and the total volume of sludge disposed of is estimated to be 10,000 gallons. The containers were transported to the disposal site by Mr. Starling; approximately 30 trips were made during that time period. This sludge was the only UCC material disposed of at the Starling site.

In late 1982, UCC hired Law Engineering to conduct a site environmental reconnaissance and preliminary site assessment. A copy of their report is provided with this letter. That document summarizes most of our actions to date and answers most of your questions relating to chronology, waste disposal practices, and site investigation information. The Law Engineering report concludes that the waste disposal on the Starling property does not represent an environmental hazard to surface or groundwater resources outside the immediate disposal area at this time (page 25).

Based on discussions with Law Engineering and several hazardous waste handling and disposal firms, we have concluded that the risks associated with disturbing the waste at this time outweigh the risks of leaving it in place. With proper site grading, there is no definite indication that the site is or will ever be an environmental or health problem. Our plan, therefore, is to adequately define the site, implement a monitoring program, and establish a contingency plan describing actions to be taken based on predetermined levels of surface water or groundwater degradation. Contingency plan remedial actions being considered include slurry wall construction, waste stabilization, in-place fixation, and waste excavation.

Law Engineering has been hired to complete the Starling site assessment and to develop both the monitoring program and the contingency plan. Attachment No. 1 of this letter is a copy of our criteria for the above work. Our UCC action plan is shown in Attachment No. 2. The dates are approximations shown only for current planning purposes; they are not meant to be binding commitments. Please keep in mind that this is a voluntary effort being done with the cooperation of Mr. Starling, the site owner and operator.

I believe that this letter has responded to all of your concerns. If you have any questions, please call me at 216/333-0500.

AMN:ps
Attachs.

Very truly yours,

Albert M Nash

A. M. Nash

ATTACHMENT No. 1

SITE EVALUATION-5-25-84

This order is to complete the David Starling disposal site evaluation and assessment. It is broken into several key tasks as listed below. Where appropriate, references are made to recommendations contained in Contractor's November 1983 Hydrogeological Assessment Report.

1) To obtain a better understanding of ground-water flow in the immediate vicinity of the waste disposal area, Contractor shall install several shallow (less than 5-foot deep) standpipes per recommendation 9.3. The standpipes would only be used for waterlevel measurements and could probably be installed by hand techniques. The standpipes would particurlarly be important along the northern and eastern side of the waste fill area where the hydraulic relationships to the existing hog pond are not well understood. This task includes topographic surveying and submission of a report of findings.

2) The surface of the waste disposal area shall be graded to prevent direct runoff of contaminants into the northern drainage ditchand to minimize exposure of animals to contaminated standing water. Recommedation 9.4 refers to this task. UCC-Greenville will provide labor, equipment, and any necessary material to accomplish this task. The grading operation shall be supervised by Contractor's soils engineer or geologist familiar with the site conditions and safety considerations.

3) To delineate the approximate limits (widths and depth) of the disposal trench, Contractor shall conduct a geophysical survey using electrical techniques (electromagnetic and/or resistivity) and a magnetometer to traverse the disposal area. This task corresponds to recommendation 9.5. A report of findings is included in this task.

4 A) Contractor shall develop an annual groundwater monitoring program based on eight(8) sampling stations- 4 wells, 2 to 3 surface water samples, 1 contingency. Surface and groundwater samples collected from the site shall be analyzed for total barium and chromium. Field measurements of PH and conductivity are to be obtained at the time of sample collection. The results of water quality shall be statistically compared to the existing data base to determine if significant changes have occured in the water quality conditions. Ground and surface-water elevations shall be obtained in the vicinity of the waste disposal area at the time of sample collection. The water level data shall be compared to the past potentiometric surfaces to determine if significant changes in flow or gradients have occcurred. Contractor shall conduct one annual groundwater monitoring check (as described above) under this order. The report of findings is to include:

(a) description of groundwater monitoring program

(b) description of sample collection techniques and sample preservation, as appropriate

(continued on page 2)

(c) description of on-site tests (equipment, procedures)

(d) description of off-site analysis (equipment, test method)

(e) other descriptive information considered pertinent by the Contractor

(f) summary, discussion, and evaluation of monitoring results

4B) In developing the above groundwater monitoring program, the Contractor is to evaluate and report on the adequacy of the existing four(4) wells for sampling purposes. If due to hydrogeological or other condsiderations additional wells are recommended by the Contractor and approved by the Owner, the Contractor shall install said wells using similar techniques as in Contractors original study and to depths not exceeding 25 feet. In any event, no more than two(2) additional wells should be required. Well installation includes all materials, well development, supervision, surveying, and transmitting soil test boring/monitoring well records.

5) Contractor shall prepare a contingency plan describing what levels of degradation in surface or ground-water samples collected over the monitoring period require action by Union Carbide. The plan would be developed with Union Carbide's input, recognizing the current remedial measure alternatives being considered by Union Carbide. The action could include resampling if relatively low concentrations are detected, or implementation of a pre-specified remedial measure alternative if the concentrations are determined to represent statistically significant increases. The concentration levels will be based on drinking water standards or other applicable criteria.

ATTACHMENT No. 2

ACTION PLAN

DAVID STARLING DISPOSAL SITE

	Action	Responsibility	Timing
1)	Receive and review final Hydrogeological Assessment Report.	UCC	Complete
2)	Review Hydrogeological Assessment Report with David and Francis Starling.	UCC	Complete
3)	Obtain permission from David Starling allowing UCC to do the site work outlined in the Hydrogeological Assessment Report and UCC's 5/25/84 criteria.	UCC	Complete
4)	Obtain quotes for removal and disposal of surface trash and for site grading.	UCC	December 1984
5)	Complete surface trash removal and disposal.	UCC	January 1985
6)	Complete site grading under Law Engineering supervision.	UCC Law Engineering	February 1985
7)	Perform geophysical survey.	Law Engineering	March 1985
8)	Install shallow standpipes and begin water level monitoring.	Law Engineering	April 1985
9)	Law Eng. issues report on grading, geophysical survey, and standpipe study. Report includes assessment of adequacy of existing wells for groundwater monitoring program.	Law Engineering	June 1985
10)	Installation of additional wells (if necessary and approved).	UCC Law Engineering	July 1985
11)	Complete draft Monitoring Program and Contingency Plan.	Law Engineering	Sept. 1985
12)	Review written Monitoring Program and Contingency Plan with:	UCC	
	(a) UCC internal		Oct. 1985
	(b) David Starling		Nov. 1985
	(c) North Carolina Solid & Hazardous Waste Management Branch and/or U.S. EPA		Dec. 1985
13)	Modify Monitoring Program & Contingency Plan as appropriate.	UCC	Jan. 1986
14)	Approval of Monitoring Program & Contingency Plan	UCC	Feb. 1986
15)	Implement	UCC	March 1986

LAW ENGINEERING TESTING COMPANY
geotechnical, environmental & construction materials consultants
2749 DELK ROAD, S.E.
MARIETTA, GEORGIA 30067
(404) 952-9005

November 28, 1983

Union Carbide Corporation
20575 Center Ridge Road
P.O. Box 16000
Rocky River, Ohio 44116

CERCLA

Attention: Mr. Albert M. Nash
General Engineering Department

Subject: Final Report of Hydrogeological Assessment
David Starling Disposal Site
Pitt County, North Carolina
Law Engineering Project No. MH2303

Dear Mr. Nash:

Law Engineering has completed a hydrogeological assessment of the David Starling disposal site as outlined in Union Carbide's Order No. 732-97521. Our report is based on various phases of study we have conducted on the site between September 1982 and May 1983.

We have concluded on the basis of our studies that the waste disposal on the David Starling property does not represent an environmental hazard at this time for surface or ground-water resources outside the immediate disposal area. We have provided recommendations for subsequent monitoring which should be evaluated before closure plans are implemented.

We would be happy to answer any questions you have regarding this report. Law Engineering looks forward to continued work on this assessment program.

Sincerely,

LAW ENGINEERING TESTING COMPANY

W. Joseph Alexander

W. Joseph Alexander, P.G.
Senior Hydrogeologist
Project Manager

JRWallace

for Larry A. Neal, P.E.
Senior Environmental Engineer

WJA-LAN/pc

cc: G. A. Babcock

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(Pocket)

Plate 1 Base Map

1.0 INTRODUCTION

Law Engineering was contracted by Union Carbide Corporation's Battery Products Division to evaluate potential environmental impacts associated with sludge disposal at the David Starling disposal site. The battery sludge was produced by Union Carbide's Greenville, North Carolina plant in 1970. In early 1971 the sludge was shipped to the property of Mr. David Starling located halfway between Farmville and Fountain, North Carolina. In June 1981 the disposal site was listed by Union Carbide in EPA's CERCLA list of inactive sites.

Law Engineering's site assessment program was conducted in a sequence of tasks generally between September 1982 and May 1983. Our studies have basically included collection of area data, site reconnaissance, construction of a base map, soil test borings, monitoring well installation, collection and analysis of soil and water samples, and evaluation of data. Our study approach is described in more detail in Section 2.0 (Methodology). The purpose of our hydrogeological assessment was to determine if the disposal site represents an environmental hazard from the standpoint of water resources.

2.0 METHODOLOGY

2.1 Collection of Existing Data

Data were collected from the following sources for use in this hydrogeological assessment:

Union Carbide:

- various information regarding the sludge disposal activities at the David Starling site
- information regarding the quantities and characteristics of the waste material
- analytical results of water and sludge analyses

Property Owner:

In our interviews with Mr. Starling over the course of this assessment we obtained information on:

- drainage features
- water-well locations and usage
- general methods of excavation and sludge burial

North Carolina Division of Environmental Management (Ground Water Section):

- hydrogeologic data from wells in the vicinity of Farmville

Pitt County Soil Conservation Service:

- various aerial photographs of the site and surrounding area reviewed
- soil survey of Pitt County

North Carolina Department of Human Resources (Division of Health Services):

- representative water quality data for wells in the vicinity of the site

Publications:

- various State, County, and USGS publications and maps

2.2 Reconnaissance of Site Area

We have conducted the following types of activities over the study period:

- observations in the sludge disposal area
- observations of the general setting with particular emphasis on drainage ditches
- observations of nearby streams
- inventory of existing water wells on site
- photographic coverage of pertinent site features

2.3 Construction of Base Map

Law Engineering arranged for photogrammetric mapping and ground surveying to prepare a base map of the site including the following features:

- general property lines
- drainage ditches and ponds
- water-well locations
- roads, buildings, and other pertinent features

- elevations of selected features such as wells, ponds, drainage ditches, and land surface at selected locations

The aerial survey of the site was conducted by Piedmont Aerial Surveys, Inc. in December, 1982. This base map is provided in the pocket of the report (Plate 1). The ground surveying was performed by McDavid Associates, Inc. in April 1983. The immediate sludge disposal area was surveyed in more detail than the surrounding site features (Plate 1).

2.4 Exploratory Drilling

Law Engineering drilled two exploratory borings outside the waste disposal area. Upon completion the borings were grouted closed from their termination depth to the ground surface. Soil samples were collected at regular intervals and were classified to determine the subsurface geological conditions. The data collected were used to characterize the material comprising the water-table aquifer, the confining bed, and the upper section of the principal aquifer. This information was used to determine the actual depths of subsequent monitoring wells installed within the sludge disposal area. The soil test boring records are provided in Appendix 1.

2.5 Installation of Monitoring Wells

After completion of the two exploratory borings, Law Engineering installed four shallow monitoring wells (approximately 25 feet deep) in the immediate vicinity of the sludge

disposal area (Appendix 2). These wells terminated above the confining layer to prevent downward movement of potential contaminants. Soil samples were collected on a regular basis and compared with subsurface information collected in the initial two borings. Grain size analyses were performed on selected soil samples (Appendix 3).

The shallow wells consist of 2-inch diameter PVC and manufacturer-slotted screens with .010 inch slot widths. The well construction utilized sand packing, bentonite seals, and surficial grout seals. The drilling equipment exposed to the subsurface was washed between each well location to minimize potential cross contamination. The shallow wells were installed under a variance from the State of North Carolina (Appendix 4). The monitoring wells are installed with protective, lockable covers and are marked "Ground-Water Monitoring Well - Not for Drinking Purposes."

2.6 Collection of Ground and Surface Water Data

After completion of the monitoring well installation, the wells were developed by over-pumping and bailing techniques. Hydraulic tests were performed in selected wells (slug tests and bailing tests) to obtain estimates of the permeability of the water-table aquifer. Representative ground-water levels were measured in the four monitoring wells and other selected water wells to produce potentiometric surface maps of the aquifer system. All development and testing equipment was thoroughly washed between well locations.

Ground-water samples were collected from the four monitoring wells with a PVC bailer and analyzed for constituents likely to be associated with the sludge disposal. Surface water samples were also collected for analysis. All sampling equipment was thoroughly washed between sampling locations. Field measurements of pH and conductivity were obtained. The water samples were filtered within a few hours after collection using a .45 micron pore filter and a vacuum pump system. The samples for metals analyses were then preserved with nitric acid to a pH of less than 2. The remaining samples were iced and shipped overnight to our laboratory in Marietta, Georgia for analysis.

3.0 SITE CONDITIONS

3.1 Topography and Drainage

The site is located in western Pitt County, North Carolina (Figure 1), midway between Farmville and Fountain. The sludge disposal area of the site is approximately 1400 feet west of N.C. Highway 258 on the property of Mr. David Starling.

The site has relatively little relief (about 4 feet) and slopes toward the southeast. Ground-surface elevations at the site range from elevation 94 feet, msl along the western portion of the Starling property to 90 feet, msl in the vicinity of the Starling residences (Plate 1). The site is drained primarily by man-made ditches. The flow in the ditches as determined by the April 5, 1983 survey is indicated on Plate 1. These ditches generally drain eastward toward Jacob Branch which is a tributary to Little Contentnea Creek (Figure 2). Contentnea Creek joins the Neuse River in southern Pitt County. It was learned in our meeting with Mr. Starling that subsurface-drain lines exist in fields just east of the sludge disposal area (Plate 1).

3.2 Existing Water Wells

Several wells exist at or near the site at locations shown on Plate 1. The information reported on these wells (from interviews with Mr. Starling) and our measurements are presented in Table 1. The small-diameter wells were washed down and no seals were reported in the installation process. Several of the water wells were installed around 1950. Several of the nearby

residences to the site are reported to be using water from a municipal water supply system (which is also derived from ground water) since spring of 1982.

Ground-water levels were measured in the accessible water wells (Table 2). Of these wells, only Well No. 2 was considered useful for monitoring water levels in the immediate sludge disposal area.

4.0 WASTE DISPOSAL

4.1 Sludge Disposal Activities

The Greenville, North Carolina Plant of Union Carbide Corporation produced a magnesium-can battery for the Federal Government in 1970. The plating operation produced a sludge with a composition of 40-50 percent barium carbonate and 50-60 percent barium chromate. Between January 6, 1971 and March 31, 1971, approximately 542 containers of the sludge were shipped to the David Starling disposal site (this number is based on Mr. Starling's memory). The containers consisted of 55 gallon drums and 5 gallon chromic acid pails. The total volume of sludge is estimated by Union Carbide Corporation to be approximately 10,000 gallons.

The containers of sludge remained above ground at the site until early fall of 1971. At this time Mr. Starling excavated a large trench, placed the containers in the trench and backfilled the trench with soil. Mr. Starling reported trench dimensions to Law Engineering as follows: width 15 to 25 feet; length 80 to 100 feet; and depth 12 to 14 feet. The trench is reported (by Mr. Starling) to have been open about two weeks before a tractor pushed soil back into the trench.

4.2 Observations

It was difficult for us to determine the actual dimensions of the sludge disposal trench by observation in the field although the approximate layout of the area is indicated in Figure 3. The surface of the immediate disposal area has about 4 feet of relief

caused by remnant piles of excavated soil. The original ground-surface elevation is interpreted to be approximately 93 feet, msl. Some unlabeled drums were exposed along the northern end of the trench and are in standing water. A small willow tree marks this location. On the southern end of the disposal area several chromic acid pails are exposed. We observed dark yellow-brown puddles of standing water along the eastern and southern end of the disposal area in December, 1982. The surface of the waste disposal area has scattered metal scraps, cross ties, and other miscellaneous debris. The area is overgrown with weeds.

4.3 Previous Chemical Data

Samples of ground water, surface water, and sludge were collected from the site or nearby areas prior to this study and analyzed by various laboratories in the time period between March and June, 1982. The majority of the sample analyses have been performed by the Edgewater Technology Laboratory of Union Carbide Corporation and compare favorably with results from other laboratories (Appendix 5). The ground-water samples typically had barium concentrations of less than 0.5 mg/l and chromium concentrations of less than 0.1 mg/l. The water samples from the drainage ditch adjacent to the sludge disposal area and a surface puddle at the disposal area had higher concentrations of barium than ground water (from 1.2 to 20 mg/l respectively). The sludge sample obtained from an exposed barrel at the site had a significantly higher concentration of extractable barium (between 6300 and 8500 ppm) than chromium (between 0.1 to 3.7 ppm).

5.0 AREA HYDROGEOLOGY

This section of the report provides a brief description of the hydrogeologic framework of Western Pitt County. The information is primarily based upon published data.

5.1 Area Physiography

The site is in the Central Coastal Plain province. The mean annual precipitation in the area of the site is about 48 inches. Evapotranspiration in the area is probably on the order of 35 inches, leaving excess water for ground-water recharge. The topography in the site area is characterized by a flat upland, generally between 90 and 100 feet above mean sea level (msl). The upland topography near the site has been dissected by Little Contentnea Creek and its tributaries (Figure 2).

The Coastal Plain is comprised of a wedge-shaped sequence of stratified deposits which thicken seaward. The deposits overlie the crystalline basement surface which is interpreted to occur near elevation -300 feet, msl in the site area. (Estimated to be about 400 feet below land surface). The bedrock surface is irregular, being exposed at land surface just north of the site at the Fountain quarry.

5.2 Hydrogeologic Units

A summary of hydrogeologic units formed by the unconsolidated deposits in the Central Coastal Plain of North Carolina is

provided in Table 4. Hydrogeologic units of significance in the area of the site include in descending order:

Water-table aquifer

Yorktown confining bed

Lower Unit of Cretaceous aquifer system

The general thickness of these hydrogeologic units near the site is depicted by Figure 4.

5.3 Water-Table Aquifer

The water-table aquifer is recharged by precipitation and discharges primarily into streams. Water levels are typically highest in the aquifer between January and March and lowest in late summer and between November and December. The water-table aquifer also recharges the underlying confined aquifer system through induced leakage. The water-table aquifer is a limited source of supply to a small number of domestic users. Water in this aquifer is typically soft, low in total dissolved solids, corrosive, and commonly contains high concentrations of iron.

5.4 Yorktown Formation

The lithology of the Yorktown Formation varies widely. Where present in the western parts of Pitt County the formation commonly occurs as a gray silty clay. Lenticular layers of sand occur in the formation. The fine texture of the formation precludes its use as a major aquifer although some small supplies are developed from the sand layers. In general the Yorktwon Formation serves as a semi-pervious confining bed for underlying aquifer systems.

5.5 Cretaceous Lower Sand Unit

The Cretaceous Lower Sand Unit comprises the lower part of the Cretaceous aquifer system and includes the water-bearing sands of the Black Creek and Tuscaloosa stratigraphic units. The aquifer is probably about 200 feet thick in the vicinity of the site. Ground water in the aquifer is primarily under confined conditions. Ground water in the aquifer moves from the site area to the southeast (Figure 5). Extensive cones of depression exist within the unit and are associated with major pumping centers such as Greenville and Kinston. A notable cone of depression also exists at Farmville, a few miles southeast of the site (Figure 5). Ground-water usage in the Farmville area range between 10 and 20 mgd.

Significant changes have occurred in the decline of the potentiometric surface of the aquifer near Greenville and Farmville. Between 1965 and 1979, the decline near Farmville has been as great as 60 feet and near Greenville 80 feet. The depth to the ground-water level in this principal aquifer in the vicinity of the site is estimated to be at least 70 feet. The quality of water from the Cretaceous Lower Sand is excellent, typically requiring little or no treatment.

5.6 Ground-Water Usage Near Site

The closest known community well to the site is located at the Woodland Hills Motor Court (Plate 1). The well is within 1 mile southeast of the site near Highway 258. Highland Motor Court is located about 2 miles southeast of the site on Highway 258 and

also uses ground water. No treatment is required for these two water supplies, apparently developed in the Cretaceous Lower Sand Unit. Basic chemical analyses of these ground water supplies were obtained from the North Carolina Division of Health Services. No analyses for total barium or chromium are performed in these wells.

The closest well to the site known to be in use is the Starling Well No. 4 (Table 1). This well is approximately 1100 feet east of the disposal area and apparently developed in the Cretaceous Lower Sand Unit. The shallow wells in the immediate vicinity of the disposal area (Wells 1, 2, and 3 in Table 1) are no longer in use.

6.0 SITE HYDROGEOLOGY

This section of the report is primarily based on the two exploratory borings and four monitoring wells drilled by Law Engineering.

6.1 Geology

The records of the two exploratory borings (located in Figure 6) are provided in Appendix 1. Boring B-1 terminated at a depth of 100 feet and boring B-2 terminated at a depth of 59 feet. The borings encountered similar strata as depicted by the hydrogeological profile in Figure 7. Four strata were identified by the two borings, described in descending order below (Figure 7).

6.1.1 Silty/Clayey Fine Sand Stratum

This sand stratum was encountered in all borings (the two exploratory borings and the four monitoring well borings). The sand stratum typically occurs to a depth of about 22 feet below land surface (elevation 71, msl). The stratum is predominantly composed of fine sand but also contains interbedded layers of very silty or clayey sand. The stratum is usually light gray or tan colored with some orange sands in the lower sections of borings MW-3 and MW-4 (Appendix 2). Penetration resistances in the sand stratum are typically between 10 and 30 blows per foot (bpf). The disposal trench was excavated within this stratum but apparently not into underlying strata (Figure 7).

6.1.2 Gray Sand/Silt Stratum

The gray sand/silt stratum was encountered in all borings at a depth of about 22 feet. The stratum has an average thickness of about 14 feet as measured in borings B-1 and B-2. The borings for the shallow wells terminated in the top of this stratum. The stratum is distinguished from the overlying stratum by its darker gray color and greater percentage of silt (20 and 25 percent silt as measured in samples from MW-3 and MW-4, respectively, Appendix 3). The stratum is interbedded with thin layers of fine sand and silt and contains some phosphate pebbles and wood fragments. In borings B-1 and MW-1 the stratum is composed almost entirely of silt. Penetration resistances in the stratum are typically less than 15 bpf.

6.1.3 Silty-Shell Stratum

The silty-shell stratum was encountered in the two exploratory borings between the depths of 34 and 47 feet in boring B-1 and 37 and 44.5 feet in boring B-2. The stratum is predominantly composed of shell fragments in a dark gray silt matrix. The stratum also contains fine to medium sand. Penetration resistances in the stratum are typically between 10 and 20 bpf.

6.1.4 Lower Gray Silt Stratum

The lower gray silt stratum underlies the shell stratum in borings B-1 and B-2. Boring B-2 terminated in the stratum at 59 feet. Boring B-1 encountered 52.8 feet of the gray silt before terminating in a coarse silty sand and gravel at 99.8 feet. The

silt stratum is predominantly composed of silt but also contains a small percentage of fine sand, clay, and shell fragments. The penetration resistance of the lower gray silt stratum is typically between 30 and 60 bpf.

6.2 Shallow Aquifer System

The saturated portion of the silty/clayey fine sand stratum (Section 6.1.1) forms a shallow aquifer under water-table conditions. The gray sand/silt stratum (Section 6.1.2) and underlying strata probably represent the base of the water-table aquifer. These strata have a lower permeability than the water-table aquifer and serve as a confining layer to deeper, more permeable aquifers. These low-permeability deposits probably correlate to the Yorktown confining bed. The sand and gravel encountered near 100 feet in boring B-1 may represent the top of the Cretaceous Lower Sand Unit (Section 5.5).

The four monitoring wells were installed within the water-table aquifer. The wells terminated within the top of the gray sand/silt stratum. The wells essentially screen the entire saturated thickness of the aquifer (Appendix 2).

Ground-water levels were measured in the monitoring wells and other nearby water wells on at least two occasions (Tables 2 and 3). The water elevations measured on May 26, 1983 are considered to be representative of stabilized ground-water conditions at the site. These measurements were used to construct a potentiometric surface map of the water-table aquifer (Figure 8). Water Well No. 2 is also considered to be representative of water levels in

the aquifer and was used in construction of Figure 8. As indicated by the potentiometric surface, ground-water flow is toward the northeast where discharge primarily occurs in the drainage ditch that forms the northern property line of the Starling property.

The presence of the hog ponds complicate the hydraulic flow conditions. Both ponds were apparently excavated into the water-table aquifer. The west hog pond appears to serve as a discharge point for ground water at the time of the May 1983 readings. The east hog pond appears to serve as a ground-water recharge area based on elevations measured in May 1983. Both ponds were apparently ground-water recharge areas in April 1983. This flow system is influenced by washing operations that discharge into one or both ponds, and direct response of the pond levels to rainfall.

The water table declined about 1/2 foot between the April and May readings (Table 3). Surface water level data are provided in Table 5.

6.3 Aquifer Properties

The permeability of the water-table aquifer was determined by slug tests or bailing tests in selected monitoring wells (Table 6). The aquifer has an average permeability of about 3×10^{-4} centimeters per second (cm/sec). This value is representative of very silty or clayey fine sands. The aquifer is anisotropic on a small scale due to the statification observed and relatively thin zones of higher and lower permeability likely exist. Taken as a

composite section, however, the aquifer essentially behaves as a homogeneous-isotropic medium in which flow is predominantly horizontal. As previously discussed, the strata underlying the sand stratum probably serve as a base to the water-table aquifer because of lower permeability.

The hydraulic gradient of the water-table aquifer is quite low (.005 feet per feet) on the basis of the potentiometric surfaces measured over the period of this study. The gradient may steepen slightly near the principal discharge area (northern property ditch). The gradient did not change sigificantly between April and May, 1983.

The velocity of the ground water moving in the water-table aquifer can be estimated on the basis of the following equation:

$$V = \frac{Ki}{ne}$$

where V = velocity of ground water (feet per year)

K = permeability of aquifer (3×10^{-4} cm/sec or 310 feet per year)

i = hydraulic gradient of water table (.005)

ne = effective porosity of the aquifer (assumed to be about 15 percent)

The ground-water velocity is, therefore, estimated to be quite low, less than 10 feet per year.

7.0 GEOCHEMISTRY

This section of the report is primarily based on samples collected and analyzed by Law Engineering. Our evaluation was based on analyses of ground water, surface water, and soil samples.

7.1 Ground-Water Quality

Well MW-2 is representative of background water quality conditions on the basis of ground-water hydraulics and water quality observed. Wells MW-1, MW-3 and MW-4 are in locations that could measure impacts from the disposal operation. Four ground-water samples were collected on April 7, 1983, and analyzed for total barium and chromium as well as other indicator parameters (Table 7). With the exception of water from well MW-1, the results were less than detection limits for barium (0.3 mg/l) and chromium (.005 mg/l).

The April 7 sample from well MW-1 indicated an elevated concentration of total barium (6.4 mg/l) and total chromium (0.010 mg/l). The well was resampled on May 26, 1983, and indicated a lower concentration of total barium (0.5 mg/l) but essentially the same concentration of total chromium (0.012 mg/l). The high initial concentration of barium could be a result of near-surface contamination carried down in the drilling operation. The ground surface in the southeastern corner of the waste disposal area was noted to have dark yellow-brown puddles of standing water. Well MW-1 is situated in a location that could be impacted by the

disposal area (Figure 8) and may be indicative of contaminant migration in the subsurface. We anticipate that the barium could have mobilized from the barium carbonate portion of the waste sludge which is more soluble than barium chromate. The chromium could be derived from the barium chromate or residual chromic acid from the pails observed on site (Section 4.2).

The results of other parameters tested in the wells indicate that total magnesium and dissolved sulfate were lowest in wells MW-1 and MW-2 and highest in wells MW-3 and MW-4 (Table 7). The conductivity of the ground water is lowest in the background well (MW-2) ranging from 75 to 95 umhos/cm over the two sample collections. The conductivity of the ground water was highest in wells MW-3 (560 umhos/cm) and MW-4 (about 1000 umhos/cm). The pH of the ground water is acidic in the range of 5 to less than 7.

The results of the ground-water samples indicate some contamination may have reached well MW-1 as a result of sludge disposal. The higher conductivity values in wells MW-3 and MW-4 compared to background conditions may also be indicative of ground-water quality degradation from the disposal area.

7.2 Surface-Water Quality

The results of the surface-water quality analyses are presented in Table 8. These results indicate that no contamination by barium or chromium was detected in the northern drainage ditch in April, 1983. This ditch forms the principal discharge feature for the water-table aquifer, however, it is not likely for contaminants in the ground water to have migrated to this point (at

this time) based on the estimated velocity of ground water and the low solubility of the waste. The results of previous surface-water samples (Appendix 5) indicate some chromium (0.2 mg/l) and barium (1.2 mg/l) may have been encountered in the drainage ditch at the time of earlier sampling (April 1982). High barium and chromium concentrations exist in the exposed sludge and surface puddle in the disposal area (refer to Section 3.3). It is not unlikely that during intense rainfall events some contamination could reach the northern drainage ditch via over-land flow from the exposed portions of the disposal area. The surface water conditions were observed by Law Engineering during a heavy rainfall event on April 6, 1983. Although direct over-land flow to the ditch was not observed on this occasion, the existing topographic setting could permit this condition for storms of longer duration.

7.3 Soil Chemistry

Soil samples were collected from the soil test borings for analysis of background concentrations and determination of the cation exchange capacity of the soils.

7.3.1 Background Conditions

Borings B-1 and B-2 were drilled in areas thought to be out of the direct impact of the waste disposal area (Figure 3). Soil samples were collected within the soils constituting the water-table aquifer (between depths of 8 to 15 feet). Background concentrations of barium in the soil are noted to range between 4

and 13 ppm and chromium is in the range of 5 to 7 ppm (Table 9). Hexavalent chromium was not detected as a constituent of the total chromium measured in the soils.

7.3.2 Cation Exchange Capacity

Soil samples were collected from strata in the four borings in the immediate vicinity of the disposal area for analysis of cation exchange capacity (Table 10). Although the soils selected were fine-grained materials, the resulting cation exchange capacities were relatively low (4 to 10 meq/100 gm). This is an indication that the shallow soils will provide little capacity to attenuate potential contaminant migration from the standpoint of cation exchange.

8.0 CONCLUSIONS

The sludge disposal trench on the Starling property contains barium carbonate and barium chromate from Union Carbide's plating operation in 1970. The general disposal area is easily recognized although the actual layout of the trench is not known.

The site is underlain by a relatively low permeability aquifer composed of silty clayey fine sand. The apparent base of the aquifer is about 22 feet below land surface at which depth a thick sequence of low permeability silty materials are encountered to a depth of about 100 feet. This thick sequence of silty material probably correlates with the Yorktown confining bed that overlies the lower unit of the Cretaceous aquifer system.

The water table is shallow (2 to 3 feet below land surface) and fluctuates in response to recharge by precipitation and discharge into surface-water features. The water-table aquifer primarily discharges into a northern drainage ditch that coincides with the Starling property line. This ditch drains to Jacob Branch, a tributary to Little Contentnea Creek. Ground-water flow and discharge/recharge relationships are complicated by the operation of the adjacent hog ponds. Because of the low permeability of the aquifer and relatively flat hydraulic gradients, the ground-water velocity in the vicinity of the waste disposal area is probably less than 10 feet per year.

The water-quality analyses from well MW-1 indicate some barium/chromium contamination is present in the ground water. It

is not known if the elevated concentrations are a result of contamination near the land surface carried downward in the drilling process, or from subsurface migration from the disposal trench. Relatively high values of conductivity measured in wells MW-3 and MW-4 may also be an indication of ground-water degradation from the disposal area. The shallow subsurface materials have a relatively low cation exchange capacity for attenuating potential contaminants. The water wells in the immediate vicinity of the waste disposal area (Wells No. 1 and 2) are no longer used by the property owner, however, these wells should be clearly designated for monitoring purposes only. The underlying Cretaceous aquifer is protected by the thick Yorktown confining bed and is very unlikely to be impacted by potential contamination from the water-table aquifer in the site area.

No surface-water contamination by barium or chromium was detected in the northern drainage ditch at the time of this study. Some potential exists for over-land flow of contaminated water to enter the northern drainage ditch under intense rainfall periods. It is also likely that some contaminated ground water will ultimately discharge into the northern drainage ditch.

Law Engineering concludes that the waste disposal on the Starling property does not represent an environmental hazard at this time for surface or ground-water resources outside the immediate disposal area.

9.0 RECOMMENDATIONS

Law Engineering makes the following recommendations on the basis of our studies to date:

9.1 Water-Quality Monitoring

A second suite of surface and ground-water samples should be collected and analyzed for total barium and chromium. Field measurements of pH, conductivity, and oxidation reduction potential should be obtained at the time of sample collection. The results of these analyses should be used to determine the frequency (or need) of further sampling.

9.2 Water-Level Monitoring (Existing Stations)

Ground and surface-water elevations should be obtained in the vicinity of the waste disposal area at the time of sample collection. These data should be compared to the past potentiometric surfaces to determine if significant changes in flow or gradients have occurred.

9.3 Water-Level Monitoring (New Stations)

To obtain a better understanding of ground-water flow in the immediate vicinity of the waste disposal area, we recommend the installation several shallow (less than 5-foot deep) standpipes. The standpipes would only be used for water-level measurements and could probably be installed by hand techniques. The standpipes would particularly be important along the northern and

eastern side of the waste fill area where the hydraulic relationships to the existing hog pond are not well understood.

9.4 Surface Grading

The surface of the waste disposal area should be graded to prevent direct runoff of contaminants into the northern drainage ditch. The grading should also minimize exposure of animals to contaminated standing water.

The grading should be considered as a temporary control measure and not necessarily a permanent closure alternative. The surface grading is not intended to represent a low-permeability cover over the disposal area. Because the waste is largely buried within the water table, there is no obvious technical reason for using a cover material in the traditional sense of preventing infiltration of precipitation into the waste. It should be recognized that soils brought into the waste fill area may become contaminated and require incorporation in closure design. The trench area is probably not stable for heavy construction equipment and consideration will have to be given for the use of a low pressure front-end loader. The grading operation should be supervised by a soils engineer or geologist familiar with the site conditions and safety considerations.

9.5 Trench Definition by Geophysics

We recommend that the disposal area be geophysically surveyed to delineate the approximate limits (widths and depth) of the trench. We recommend the use of electrical techniques

(electromagnetic and/or resistivity) and a magnetometer to traverse the disposal area. The magnetometer should detect buried metallic objects in the trench. The electrical techniques should be able to detect contrasts in soil characteristics or pore fluids resulting from the excavation/backfill operation. The combination of magnetics and electrical techniques also has the potential for providing some relative indication of contaminant migration beyond the trench limits. The geophysical survey should be performed after the grading operation for access and safety considerations. In addition it would be desirable to remove the majority of surficial scrap metal to prevent interference with the survey.

10.0 BIBLIGRAPHY

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TABLES

Table 1. Water Well Information Near Site [1)]

Well Number[2)]	Well Details (Reported)	Well Details (Measured)[3)]	Usage or Comments
1	2" galvanized 200 to 210' deep	2" galvanized 39.2' deep [4)]	Not in use since 1975. Formerly use for hog operation.
2	24" terra-cotta 15 feet deep	24" terra-cotta 13' deep	Not in use. Installed 1960.
3	24" concrete 16-18 feet deep	24" concrete 27.5' deep	Not in use since 1960. Formerly used for hog operation.
4	4" irrigation well with concrete slab 180 feet deep.	4" steel with submersible pump (not accessible)	Used for irrigation (nursery) and drinking water supply.
5 *	2" galvanized 65 feet deep	2" galvanized 40.9' deep	Used for drinking water supply.
6 **	2" galvanized 200 deet deep	(not accessible)	Used to water yard and garden.
7	1-1/4" well 15 feet deep	(not accessible)	Not in use.

Notes:
1) Information from Starling, 1982
2) Refer to Plate 1 for locations of wells
3) By Law Engineering
4) Below ground surface
* Formerly referred to as John Starling house well
** Formerly referred to as David Starling house well

Table 2. Summary of Ground-Water Level Data (Water Wells)

Well Designation[1)]	Reference Elevation[2)] (feet, msl)	Date Measured	Depth Below Reference (feet)	Water Surface Elevation (feet, msl)
No. 1	93.03	12-23-82	38.1	54.93
		4-6-83	37.6	55.43
No. 2	93.68	12-23-82	3.35	90.33
		4-6-83	3.15	90.53
		5-26-83	3.4	90.28
No. 3	95.67	12-23-82	4.15	91.52
		4-6-83	4.15	91.52
No. 5	91.83	12-23-82	18.67	73.16

Notes:

1) Refer to Figure 3 for location of wells.
2) Top of casing; marked in field and surveyed.

Table 3. Summary of Ground-Water Level Data (Monitoring Wells)

Well Designation[1)]	Reference Elevation[2)] (feet, msl)	Date Measured	Depth Below Reference (feet)	Water Surface Elevation (feet, msl)
MW-1	92.98	4-6-83	2.66	90.32
		5-26-83	3.44	89.55
MW-2	93.32	4-6-83	2.44	90.88
		5-26-83	2.93	90.39
MW-3	93.91	4-6-83	3.53	90.38
		5-26-83	4.26	89.65
MW-4	93.76	4-6-83	3.45	90.31
		5-26-83	4.14	89.62

Notes:

1) Refer to Figure 3 for location of wells.
2) Top of casing; marked in field and surveyed.

TABLE 4

HYDROGEOLOGIC UNITS CENTRAL COASTAL PLAIN

SYSTEM	SERIES	STRATIGRAPHIC UNIT	HYDROGEOLOGIC UNIT		HYDROGEOLOGIC PROPERTIES	DESCRIPTION AND EXTENT
QUATERNARY	RECENT	SURFICIAL	WATER TABLE		The deposits serve as an unconfined aquifer. The water table is shallow, ranging from land surface to within 20 feet of land surface even during dry periods. Water from this unit is soft and low in total dissolved solids. *It is commonly corrosive and contains objectionable amounts of iron.*	Surficial deposits consisting chiefly of sand, clay and gravel. Shell material is also present in the eastern part of the region. The relatively thin deposits overlie the entire area and range in thickness from a few *feet to approximately 35 feet.*
	PLEISTOCENE					
TERTIARY	MIOCENE	YORKTOWN	YORKTOWN		In the west, the Yorktown serves as a confining bed for those units below the water table aquifer. Small amounts of water are available from lenticular sand beds within the unit. In the east, the unit acts as a permeable semi-confined aquifer capable of yielding moderate amounts of good quality water.	In the western part of the study area, the Yorktown unit consists of a dark blue, massive clay matrix containing abundant shells. In the eastern part, the unit consists of loose shells and limestone in a sand matrix. Some amounts of yellow to gray clay are also present. The unit occurs as scattered remnants in the west, and as a continuous unit east of Greenville, New Bern, Pollocksville and Jacksonville. The thickness of the unit ranges from 0 to 15 feet in the west to about 60 feet in the eastern part
	OLIGOCENE	UNNAMED	CASTLE HAYNE AQUIFER SYSTEM	CASTLE HAYNE	The Castle Hayne Unit is a highly permeable semi-confined aquifer capable of yielding large amounts of water. It is an important aquifer in the eastern part of the area, but remains relatively undeveloped in the western part where better quality water is available at slightly greater depth. The unit yields a hard, calcium bicarbonate - type water.	The Castle Hayne Unit varies in lithology and consolidation from shell limestone to sand with shell fragments. It occurs as a continuous unit throughout Craven, Jones and Onslow counties, and also in southeastern Duplin and eastern Pitt Counties. The unit thickens to the south and east from its western limit to more than 400 feet in the eastern part of the shady area.
	EOCENE	CASTLE HAYNE				
	PALEOCENE	BEAUFORT				
CRETACEOUS	UPPER CRETACEOUS	PEEDEE	CRETACEOUS AQUIFER SYSTEM	CRETACEOUS UPPER SAND	This unit is a semi-confined aquifer whose water-bearing sands yield moderate amounts of water to municipal, industrial or agricultural wells. The water is a soft, sodium bicarbonate-type except in those areas where indurated calcareous beds cause it to be moderately hard. Heavy withdrawals from the Cretaceous Lower Sand Unit are reflected in leakage from the Upper Sand Unit.	The Cretaceous Upper Sand Unit consists of dark green or gray glauconitic or clayey sands interbedded with massive dark gray clay beds. Indurated shell beds are present throughout. The unit outcrops or is near the surface in Duplin, Greene, Lenoir and Pitt counties. It thickens to the east from its origin to between 60 and 80 feet The unit is overlain unconformably by the Surficial, Yorktown or Castle Hayne Units and separated from them by a massive clay layer 20 to 30 feet thick.
		BLACK CREEK		CRETACEOUS LOWER SAND	The Cretaceous Lower Sand Unit is the principal aquifer in the area. It is a semi confined aquifer capable of supplying large amounts of excellent quality water. The water is a soft sodium bicarbonate-type except in those areas where indurated calcareous beds cause it to be moderately hard. Heavy withdrawals have resulted in declining water levels and expanding cones of depression.	The Cretaceous Lower Sand Unit consists of glauconitic sand and dark gray massive clays. Lenticular gravel deposits are also present. The unit outcrops in the extreme western parts of Lenoir, Greene and Pitt Counties. *It dips and thickens to the east ranging from 140 feet in the west to more* than 700 feet in the east. It is separated from the Cretaceous Upper Sand Unit by a massive clay confining bed.
		TUSCALOOSA				

Modified after Narkunas, 1980

Table 5. Summary of Surface-Water Level Data

Station Location[1]	Reference Elevation[2] (feet, msl)	Date Measured	Depth Below Reference (feet)	Water Surface Elevation (feet, msl)
A	88.19	4-5-83	0.89	87.3
B	89.29	4-5-83	1.25	88.04
		5-26-83	1.55	87.74
C	90.18	4-5-83	0.95	89.23
		5-26-83	1.26	88.92
D	90.34	4-5-83	0.86	89.48
E	90.58	4-5-83	0.80	89.78
F	93.02	4-5-83	1.20	91.82
G	92.96	4-5-83	1.55	91.41
H	92.73	4-5-83	0.95	91.78
I	92.13	4-5-83	1.43	90.70
J	91.63	4-5-83	1.62	90.01
K	90.38	4-5-83	1.35	89.03
L	87.04	4-5-83	1.18	85.86
M	87.65	4-5-83	1.27	86.38
N	89.04	4-5-83	1.33	87.71
O	92.83	4-5-83	1.13	91.70
		5-26-83	1.36	91.47
P	91.70	4-5-83	1.29	90.41
		5-26-83	2.42	89.28

Notes:

1) Refer to Plate 1 for station locations.
2) Top of stake; marked in field and surveyed.

Table 6. Results of Permeability Tests

Monitoring Well	Type of Test	Estimated Permeability (cm/sec)
MW-1	Slug Out	4.6×10^{-4}
MW-3	Bailing	2.2×10^{-4}
MW-4	Slug Out	1.4×10^{-4}

Table 7. Results of Chemical Analyses - Ground Water

Well Number[1)]	Sample Date (1983)	Total Barium (mg/l)	Total Chromium (mg/l)	Total Magnesium (mg/l)	Dissolved Sulfate (mg/l)	pH (S.U.)	Conductivity (umhos/cm)
MW-1	4-7	6.4	0.010	2.4	6.	4.8	145
	5-26	0.5	0.012	-	-	4.9	290
MW-2	4-7	< 0.3	< 0.005	2.8	< 5.	4.7	75
	5-26	-	-	-	-	5.2	95
MW-3	4-7	< 0.3	< 0.005	16.	84.	6.9	560
	5-26	-	-	-	-	6.7	560
MW-4	4-7	< 0.3	< 0.005	34.	92.	5.6	1000
	5-26	-	-	-	-	6.4	1100

Notes:

1) Refer to Figure 3 for location of wells.
< indicates less than detection limit.
- indicates no analysis performed.
pH and conductivity measured in field.
Samples for metal analyses were filtered in field.

Table 8. Results of Chemical Analyses - Surface Water

Sample Location[1)]	Total Barium (mg/l)	Total Chromium (mg/l)	Total Magnesium (mg/l)	Dissolved Sulfate (mg/l)	pH (S.U.)	Conductivity (umhos/cm)
SW-A	< 0.3	< 0.005	-	-	-	-
SW-B	< 0.3	< 0.005	-	-	-	-
SW-B/C	< 0.3	< 0.005	2.0	10.	3.4	50
SW-C	< 0.3	< 0.005	-	-	-	-
SW-D	< 0.3	< 0.005	-	-	3.2	-

Notes:

1) Refer to Plate 1 for location of surface-water stations.
< indicates less than detection limit.
- indicates no analysis performed.
Samples collected and preserved on April 7, 1983.
Station SW-B/C is half way between Stations B and C.

Table 9. Results of Chemical Analyses - Soil

Boring Number	Soil Sample Depth Below Land Surface (Feet)	Total Barium (ppm)	Total Chromium (ppm)	Hexavalent Chromium (ppm)
B-1	13.5 - 15.0	4.4	6.7	< 0.3
B-2	8.5 - 10.0	13.	5.0	< 0.3

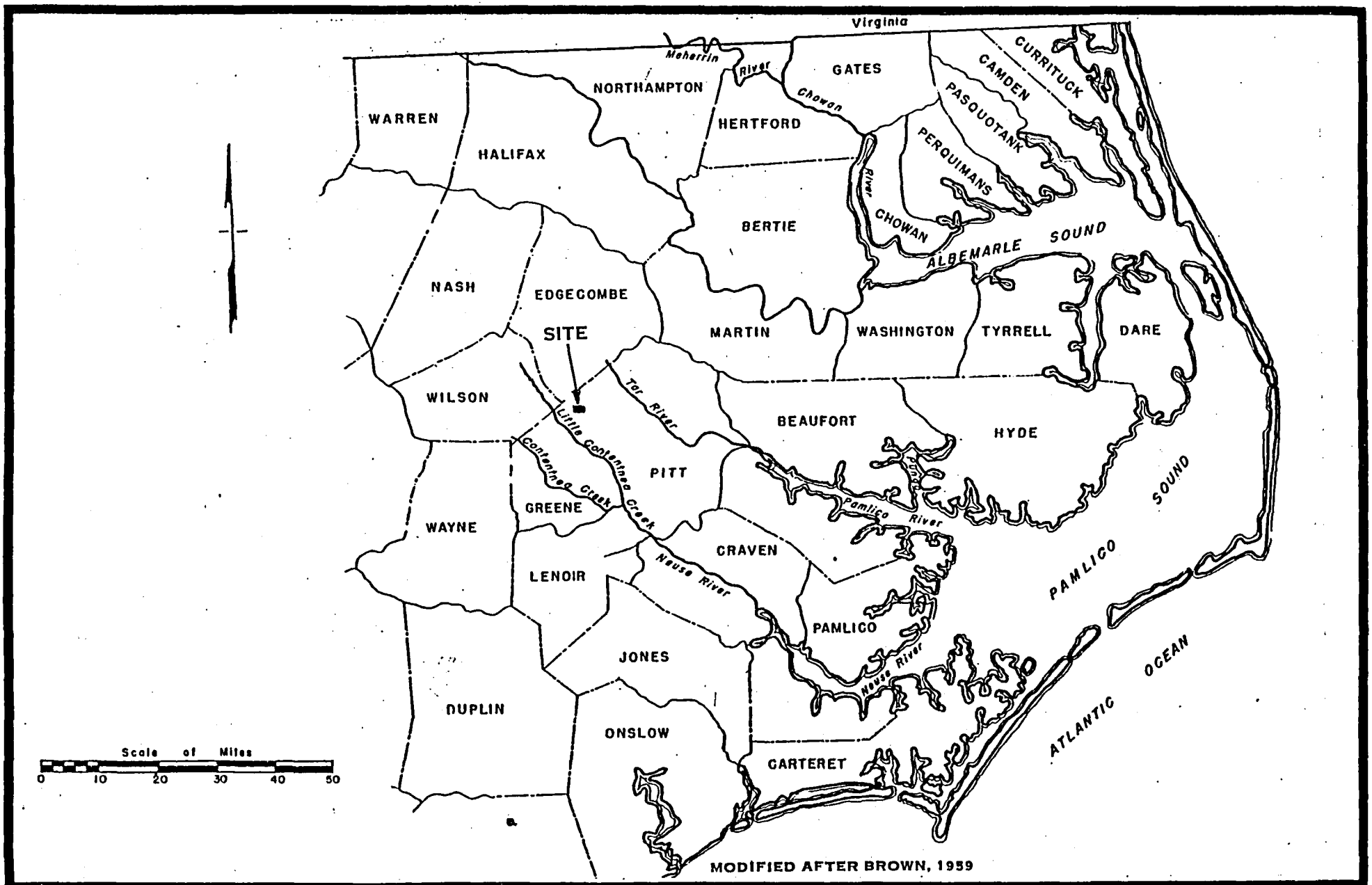
Table 10. Results of Cation Exchange Capacity Tests

Boring Number[1)]	Soil Sample Depth Below Land Surface (Feet)	Cation Exchange Capacity (meq/100 gm)	Soil Description
MW-1	10	10.	Gray slightly silty very clayey medium to fine sand
MW-2	15	4.1	Light gray slightly silty and clayey medium to fine sand
MW-3	25	6.3	Dark gray very silty fine sand
MW-4	25	7.4	Gray very silty medium to fine sand

Notes:

1) Refer to Figure 3 for location of borings.

FIGURES



MODIFIED AFTER BROWN, 1959

UNION CARBIDE CORPORATION

DAVID STARLING DISPOSAL SITE

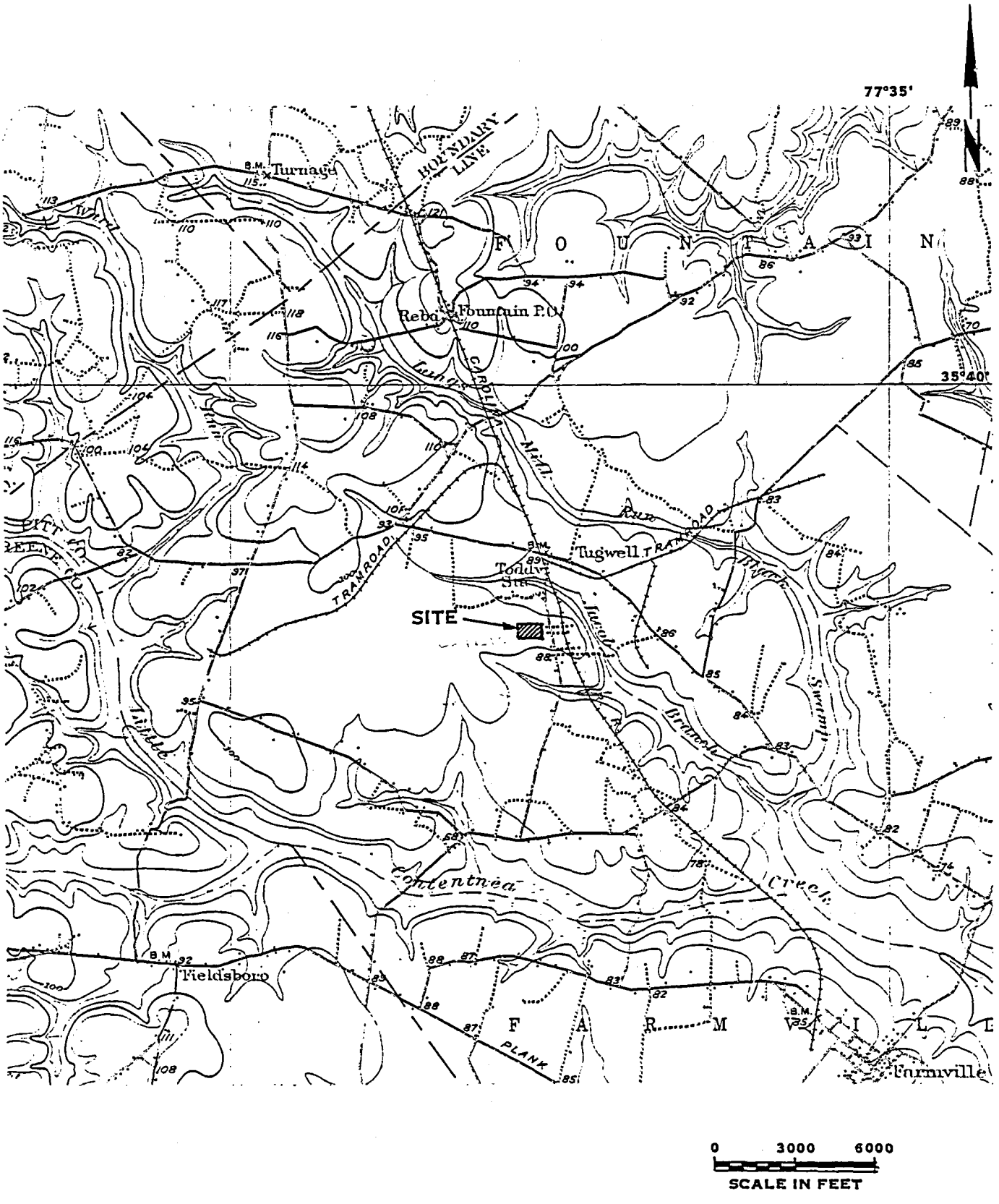
LAW ENGINEERING TESTING COMPANY

MARIETTA, GEORGIA

GENERAL LOCATION MAP

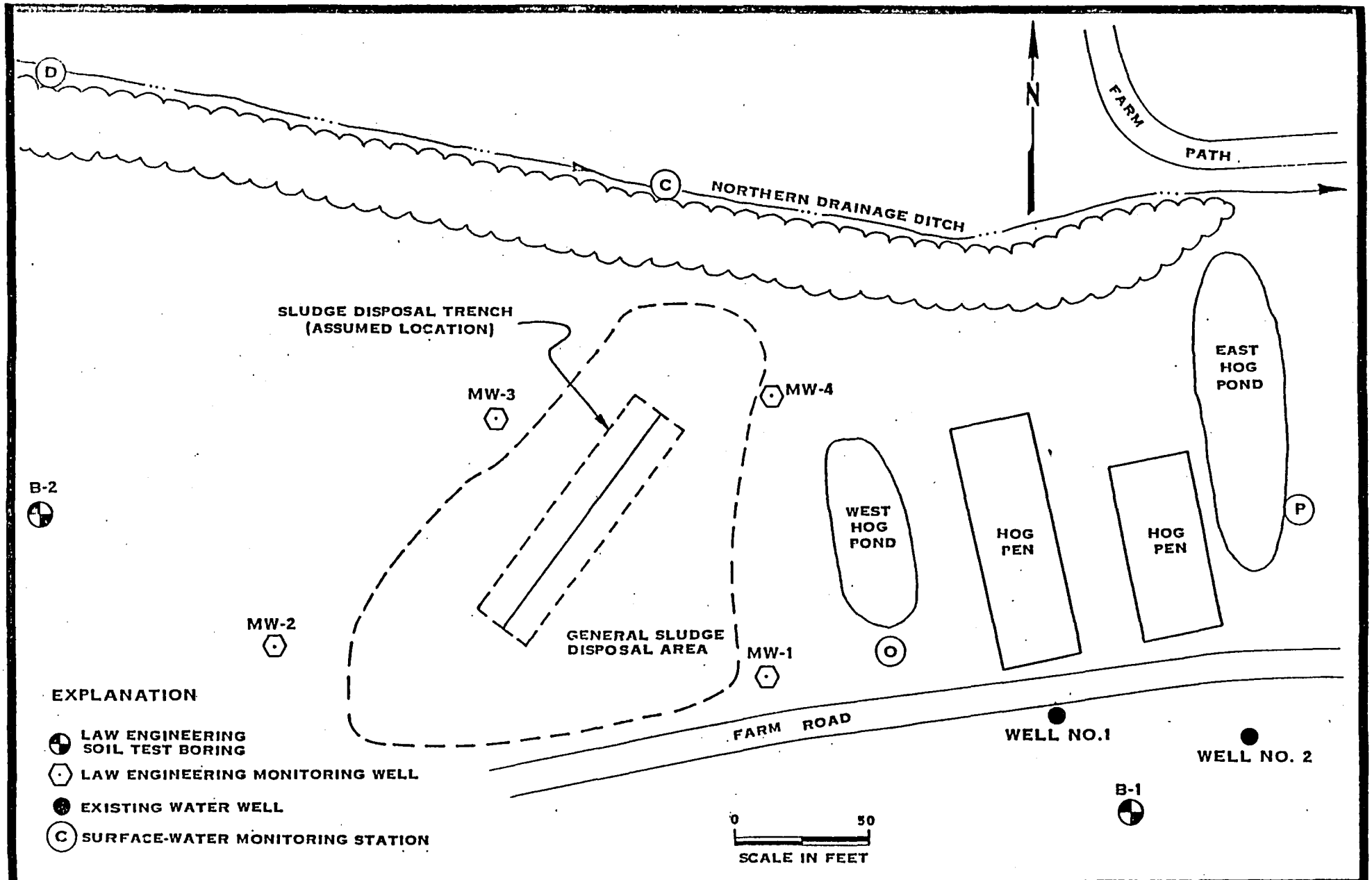
JOB NO. MH2303

FIGURE 1



MODIFIED AFTER FALKLAND, N.C. 1904 15 MINUTE QUADRANGLE

UNION CARBIDE CORPORATION DAVID STARLING DISPOSAL SITE	LAW ENGINEERING TESTING COMPANY MARIETTA, GEORGIA	TOPOGRAPHY OF SITE AREA JOB NO. MH2303 FIGURE 2



UNION CARBIDE CORPORATION

DAVID STARLING DISPOSAL SITE

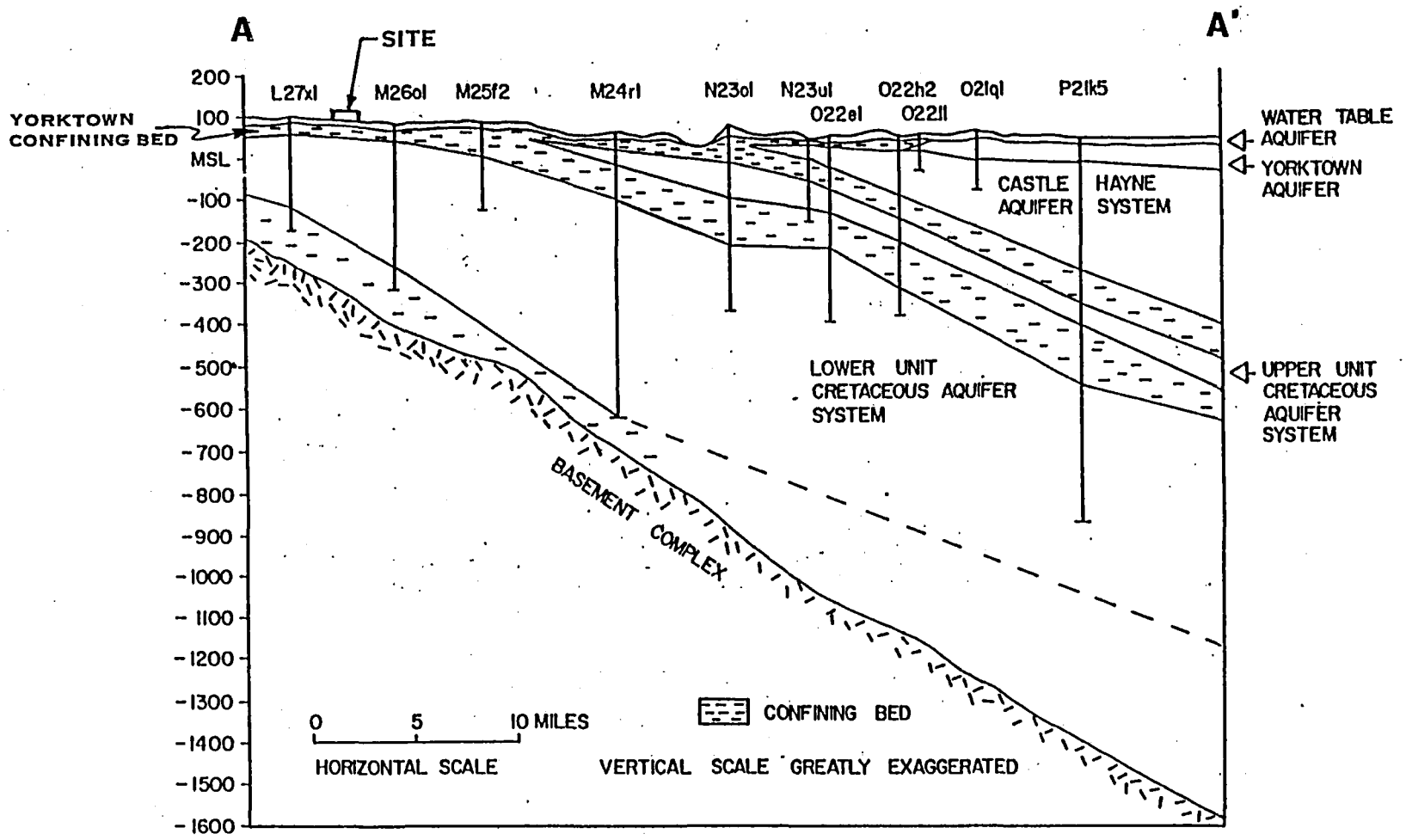
LAW ENGINEERING TESTING COMPANY

MARIETTA, GEORGIA

GENERAL SLUDGE DISPOSAL AREA AND LAYOUT OF BORINGS

JOB NO. MH2303

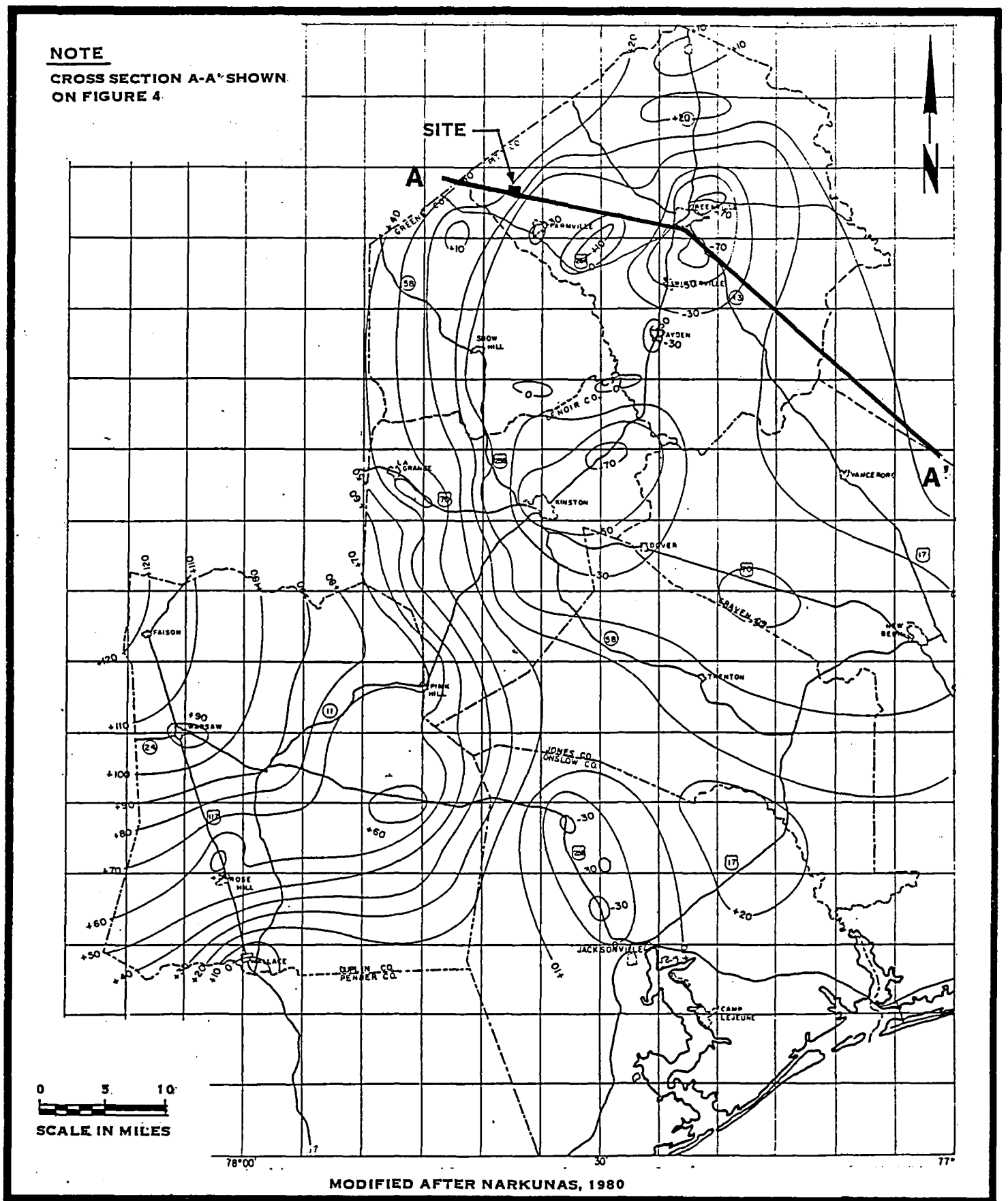
FIGURE 3



NOTE
REFER TO FIGURE 5 FOR LOCATION OF CROSS SECTION

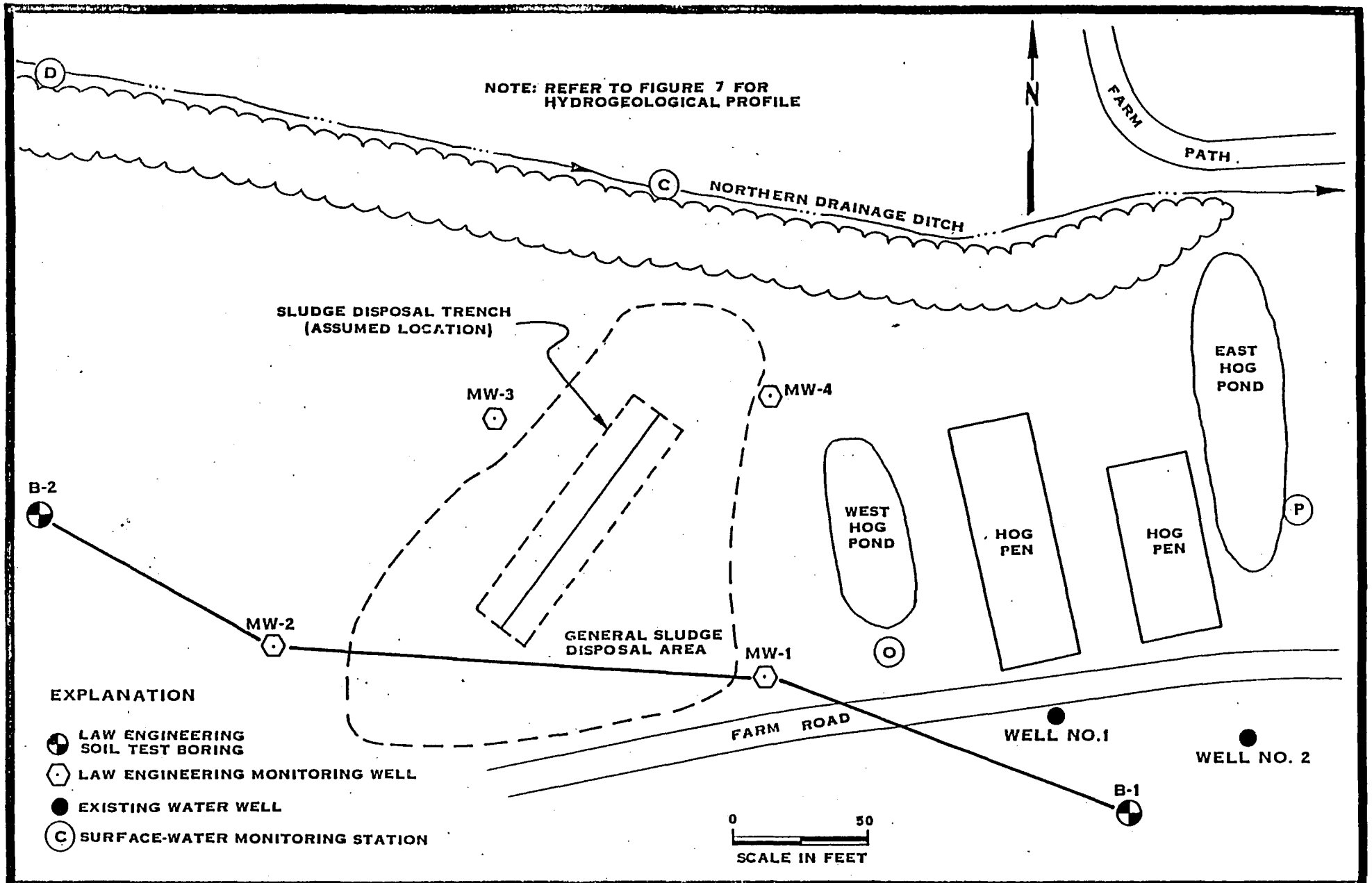
MODIFIED AFTER NARKUNAS, 1980

UNION CARBIDE CORPORATION DAVID STARLING DISPOSAL SITE	LAW ENGINEERING TESTING COMPANY MARIETTA, GEORGIA	GENERALIZED HYDROGEOLOGIC CROSS SECTION JOB NO. MH2303 FIGURE 4



MODIFIED AFTER NARKUNAS, 1980

UNION CARBIDE CORPORATION DAVID STARLING DISPOSAL SITE	LAW ENGINEERING TESTING COMPANY MARIETTA, GEORGIA	POTENTIOMETRIC SURFACE CRETACEOUS LOWER SAND UNIT - 1979 JOB NO. MH2303 FIGURE 5



UNION CARBIDE CORPORATION

DAVID STARLING DISPOSAL SITE

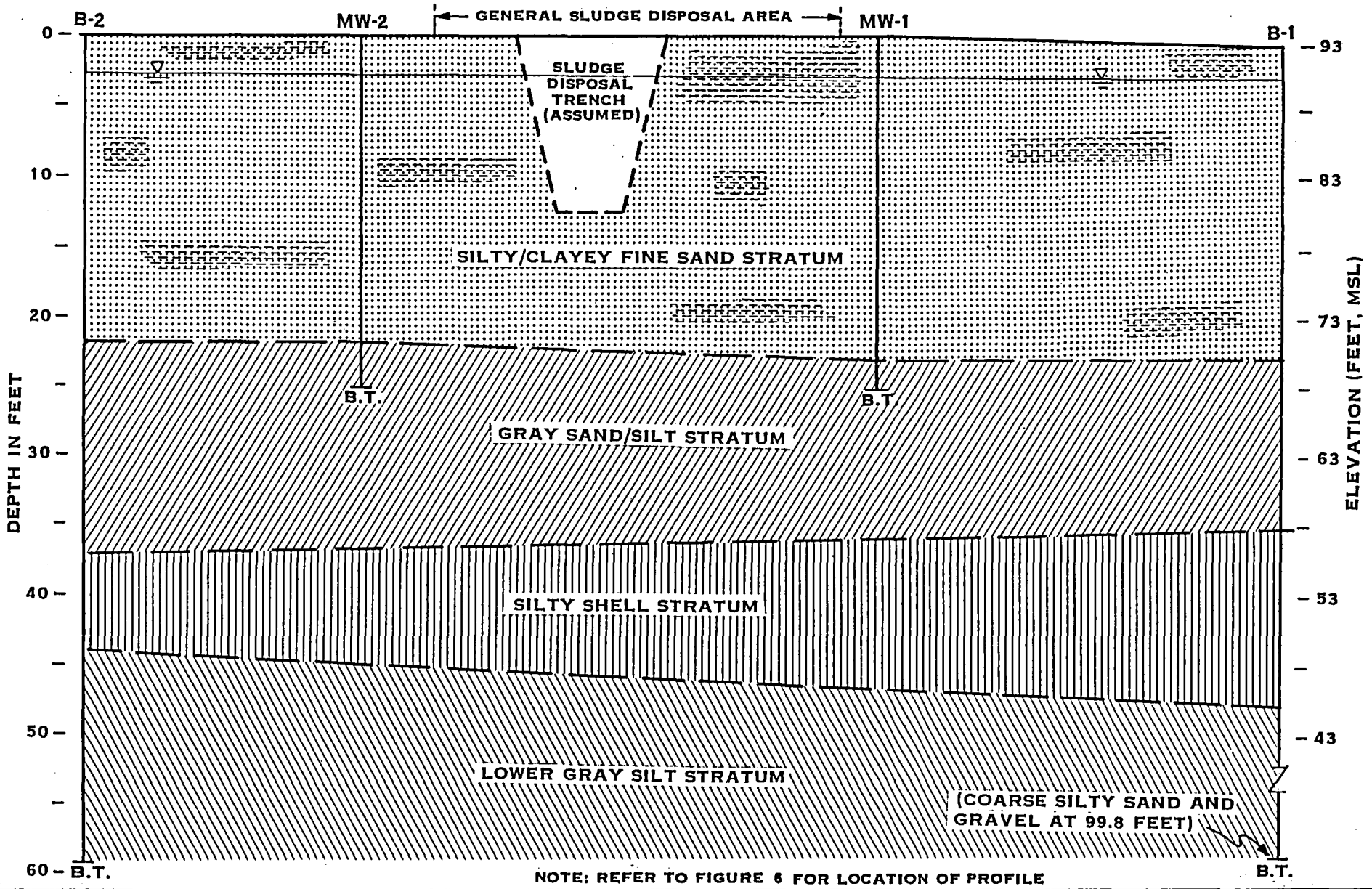
LAW ENGINEERING TESTING COMPANY

MARIETTA, GEORGIA

LOCATION OF HYDROGEOLOGICAL PROFILE

JOB NO. MH2303

FIGURE 6



UNION CARBIDE CORPORATION

DAVID STARLING DISPOSAL SITE

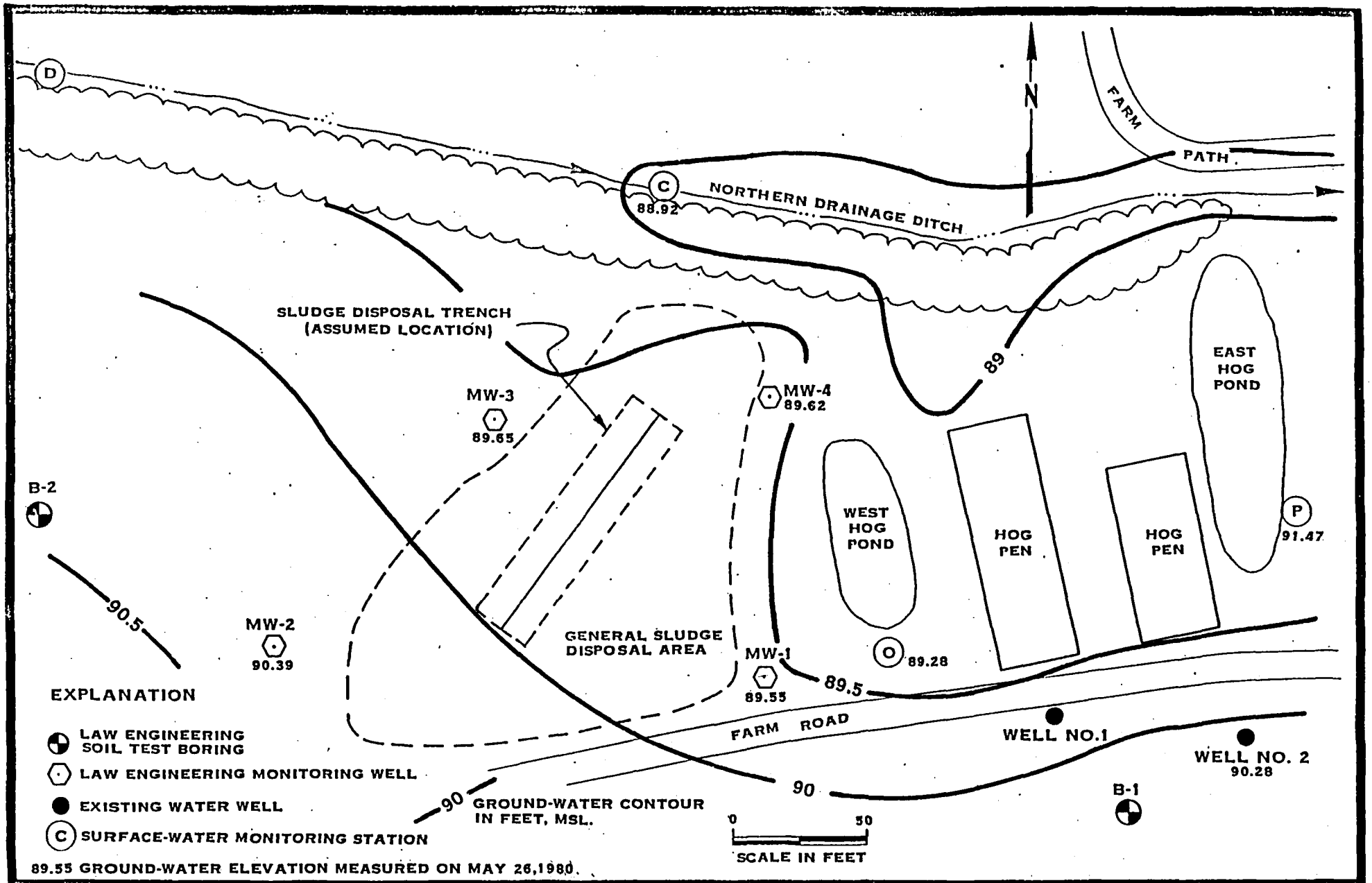
LAW ENGINEERING TESTING COMPANY

MARIETTA, GEORGIA

HYDROGEOLOGICAL PROFILE OF DISPOSAL AREA

JOB NO. MH2303

FIGURE 7



UNION CARBIDE CORPORATION

DAVID STARLING DISPOSAL SITE

LAW ENGINEERING TESTING COMPANY

MARIETTA, GEORGIA

POTENTIOMETRIC SURFACE OF WATER - TABLE AQUIFER (MAY 26,1983)

JOB NO. MH2303

FIGURE 8

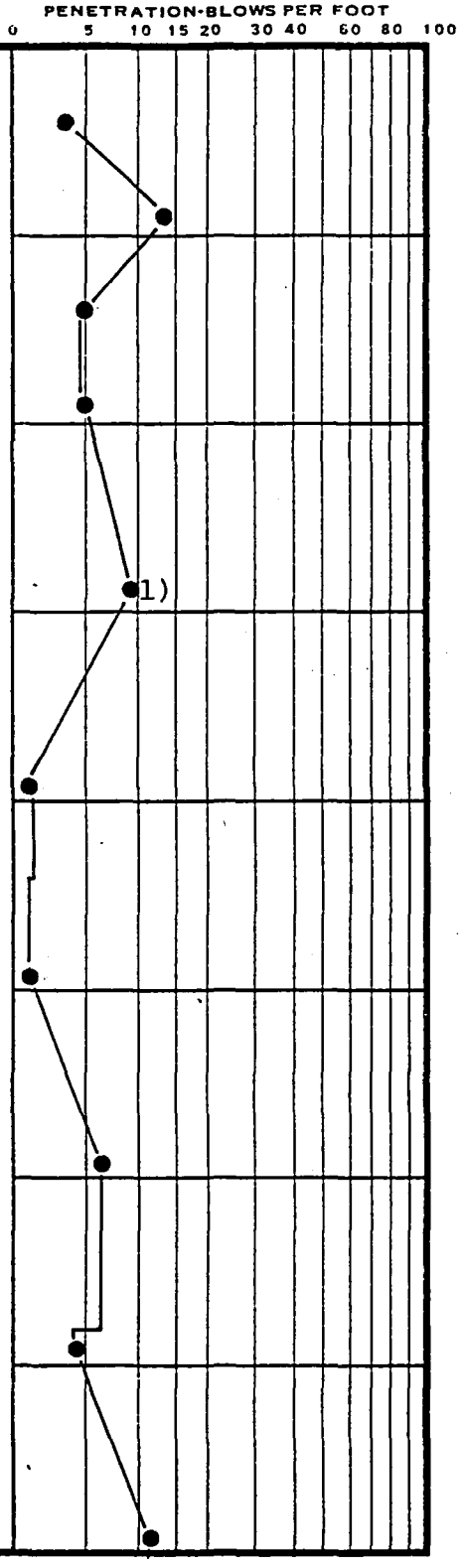
APPENDIX 1

SOIL TEST BORING RECORDS

(EXPLORATORY DRILLING)

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
91.8		Topsoil
	1.5	Brown Silty Fine SAND
86.8	3.5	Gray Silty Fine SAND with Some Medium to Coarse Sand.
	6.0	Gray Mottled Very Silty Fine SAND with Some Clay and Wood Fragments.
81.8		
76.8	12.0	Gray-Green Fine SAND Interbedded with Silty Clay.
71.8	17.0	Gray to Light Brown Fine SAND with Some Clayey Silt.
66.8	22.0	Gray SILT Interbeded with Medium to Fine Sand. Contains Some Wood Fragments.
61.8		
56.8	34.0	Shell Fragments in Dark Gray Silt Matrix with Some Fine to Coarse Sand.
51.8		



REMARKS:

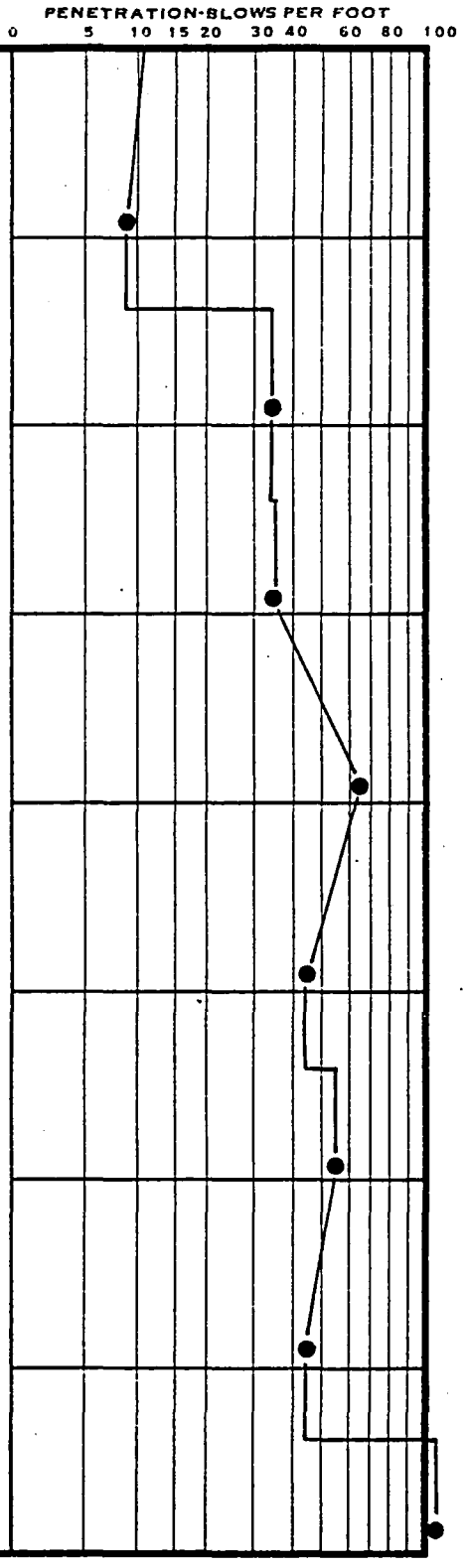
Mud-Wash Boring Using 4.5 Inch Diameter Bit. No Water Level Measured. No Monitoring Well Installed. Grouted boring.
1) Laboratory Analysis of Barium and Chromium

DRILLED BY Pendley
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER B-1
DATE STARTED 12-22-82
DATE COMPLETED 12-23-82
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
51.8		As Above
	42.0	
46.8		Olive Gray Sandy SILT with Shell Fragments.
	47.0	
41.8		Buff-Gray and Green Mottled Fine Sandy SILT. Occassional Phosphate Pebbles.
	52.0	
36.8		Dark Gray SILT.
31.8		
	62.0	
26.8		Dark Gray Fine Sandy SILT.
	67.0	
21.8		Gray Micaceous Silty Fine SAND
	72.0	
16.8		Gray Fine to Medium SAND Interbedded with Gray Silt.
	77.0	
11.8		Gray Fine Sandy SILT



REMARKS:

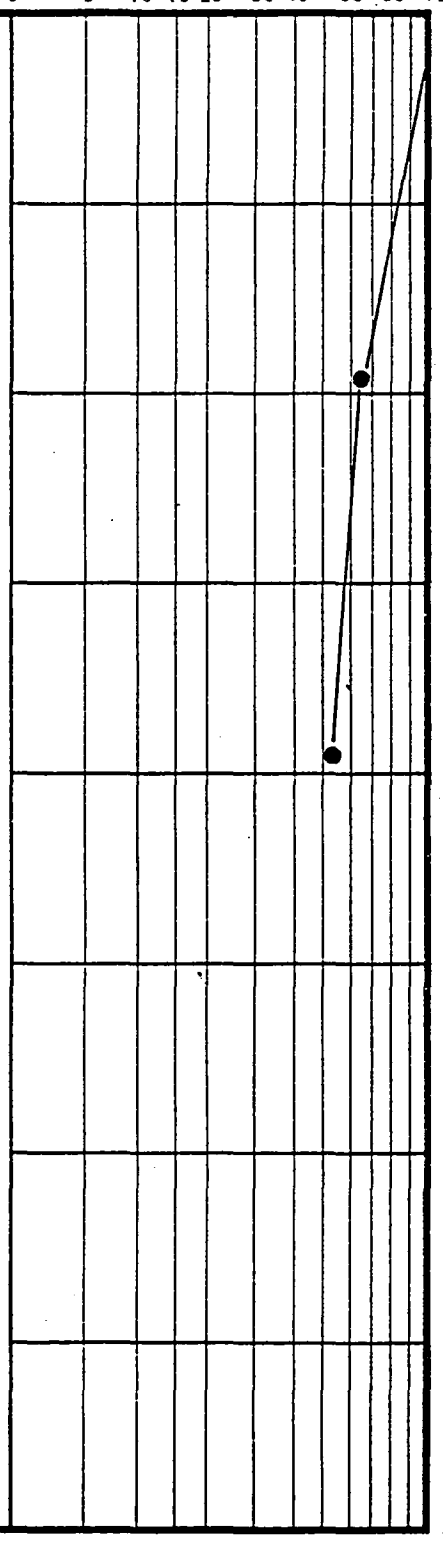
DRILLED BY Pendley
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER B-1
DATE STARTED 12-22-82
DATE COMPLETED 12-23-82
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
11.8		Gray Fine Sandy SILT
6.8	85.0	
1.8		Gray-Brown Clayey SILT
MSL		
-3.2		
-8.2	99.8	
	100.0	Coarse Silty SAND and GRAVEL
		Boring Terminated at 100.0 Feet
		Boring Grouted from Bottom to Ground Surface

PENETRATION-BLOWS PER FOOT



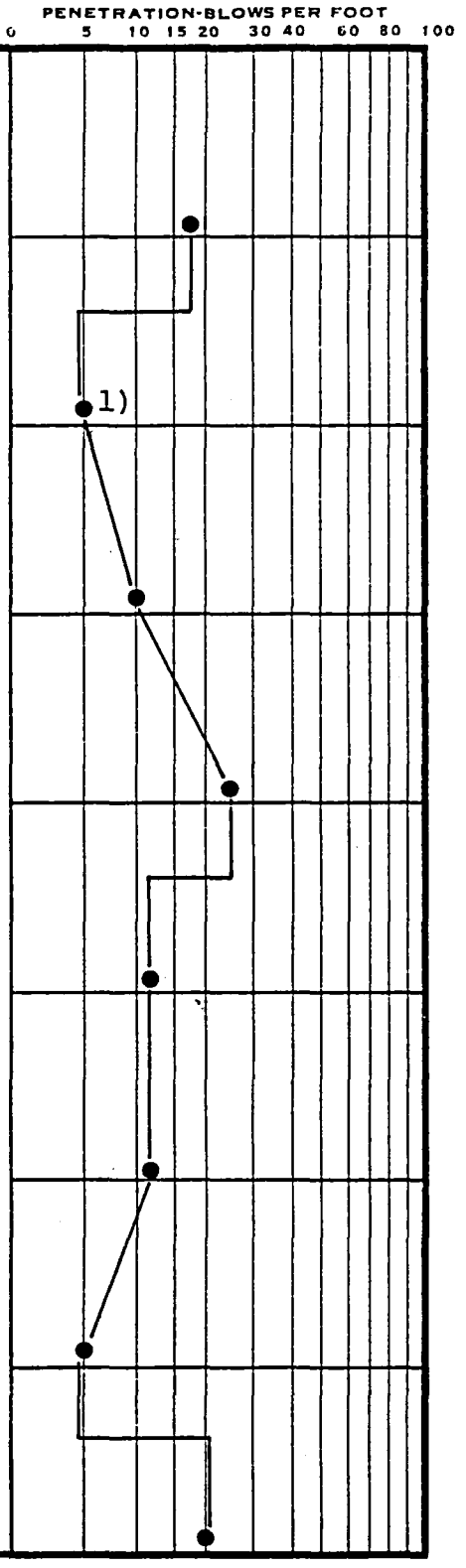
REMARKS:

DRILLED BY Pendley
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER B-1
DATE STARTED 12-22-82
DATE COMPLETED 12-23-82
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
93.0		Topsoil
	1.5	
		Light Gray Silty Fine SAND
88.0		
	7.0	
		Light Gray and Brown Fine Sandy SILT
83.0		
	12.0	
		Gray-Green Clayey Silt Interbedded with Fine to Medium SAND
78.0		
	17.0	
		Gray-Green Fine to Medium SAND Interbedded with Clayey SILT
73.0		
	22.0	
		Dark Gray Silty Fine Sand Interbedded with SILT
68.0		
63.0		
	32.0	
		Dark Gray Silty Coarse to Fine SAND Interbedded with SILT. Occassional Phosphate Pebbles.
58.0		
	37.0	
		SHELL Fragments in Dark Gray Silty Fine to Medium SAND.
53.0		



REMARKS:

Mud-Wash Boring Using 4.5 Inch Diameter Bit. No Water Level Measured. No Monitoring Well Installed. Grouted Boring.

1) Laboratory Analysis of Barium and Chromium.

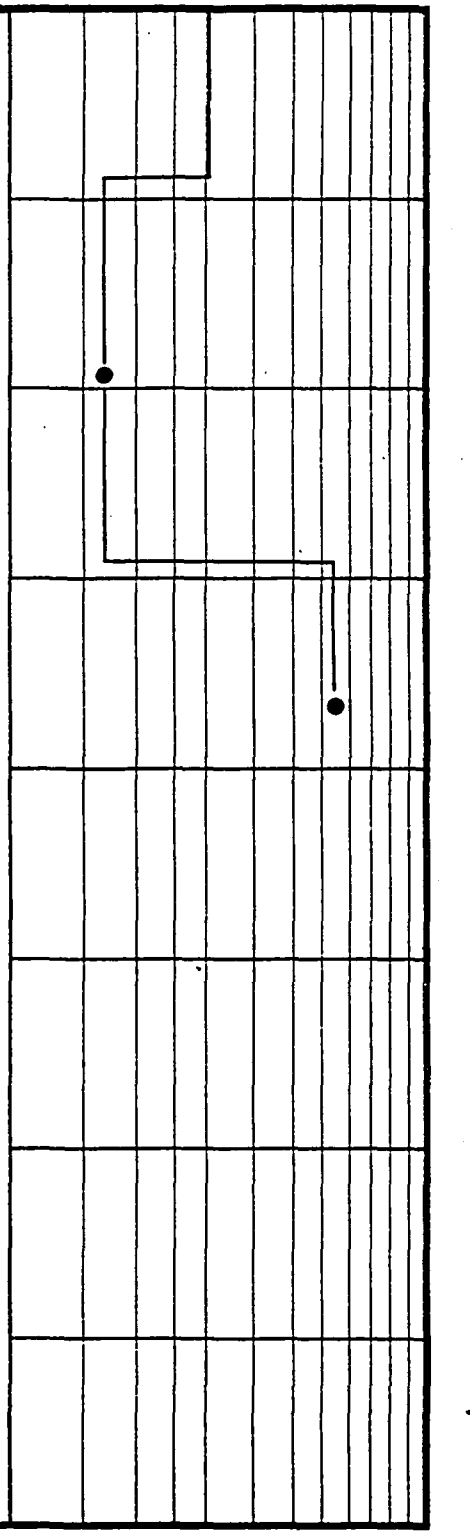
DRILLED BY Pendley
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER B-2
DATE STARTED 12-23-82
DATE COMPLETED 12-23-82
JOB NUMBER MH2303

TEST BORING RECORD

ELEV. FT.	DEPTH FEET	DESCRIPTION
53.0		SHELL Fragments in Dark Gray Silty Fine to Medium SAND
48.0	44.5	
43.0		Gray-Green SILT with Some Fine to Coarse Sand and Shell Fragments
38.0	54.5	
		Dark Gray SILT
33.0	59.0	Boring Terminated at 59.0 FEET Boring Grouted from Bottom to Ground Surface

PENETRATION-BLOWS PER FOOT



REMARKS:

DRILLED BY Pendley
LOGGED BY Alexander
CHECKED BY Seymour

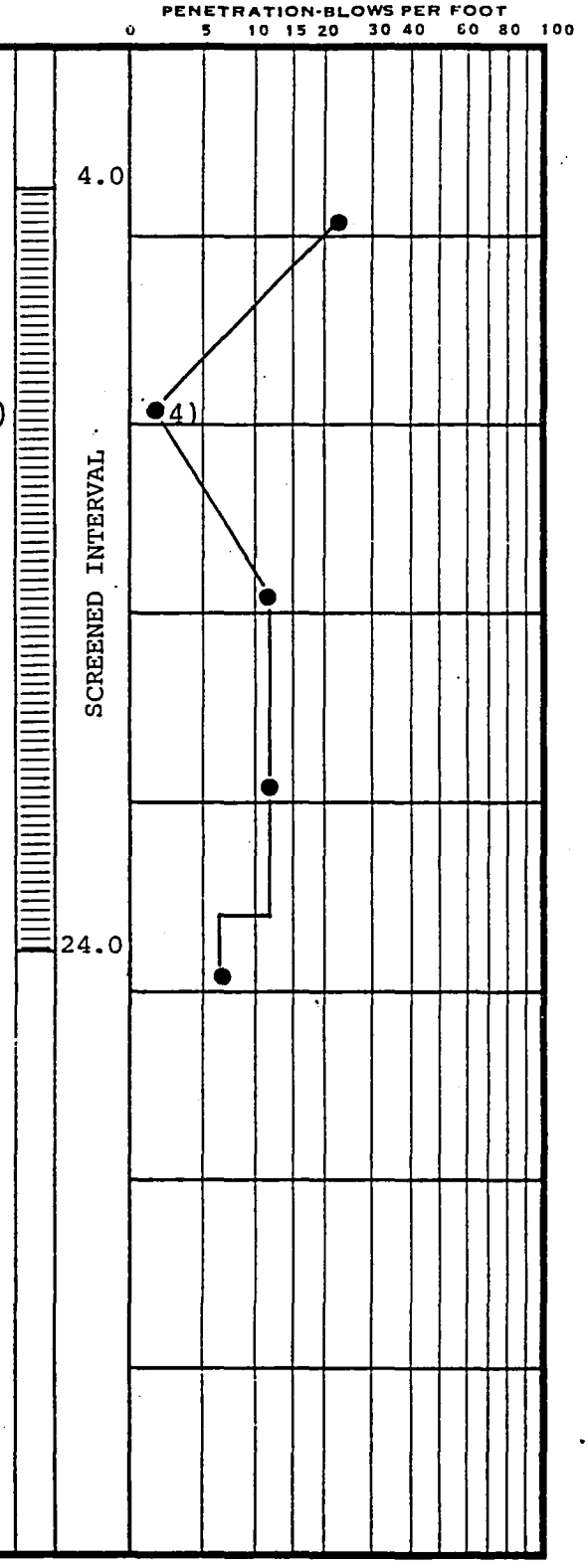
BORING NUMBER B-2
DATE STARTED 12-23-82
DATE COMPLETED 12-23-82
JOB NUMBER MH2303

APPENDIX 2

SOIL TEST BORINGS AND MONITORING WELL DETAILS

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
93.0	1.5	Topsoil
88.0	7.0	Black-Gray Silty Fine SAND (1) (2)
83.0	12.0	Gray Slightly Silty Very Clayey Medium to Fine SAND (3)
78.0	17.0	Silty Medium to Fine SAND
73.0	23.0	Gray and Tan Silty Fine SAND
68.0	25.0	Gray SILT
		Boring Terminated at 25.0 Feet



REMARKS:

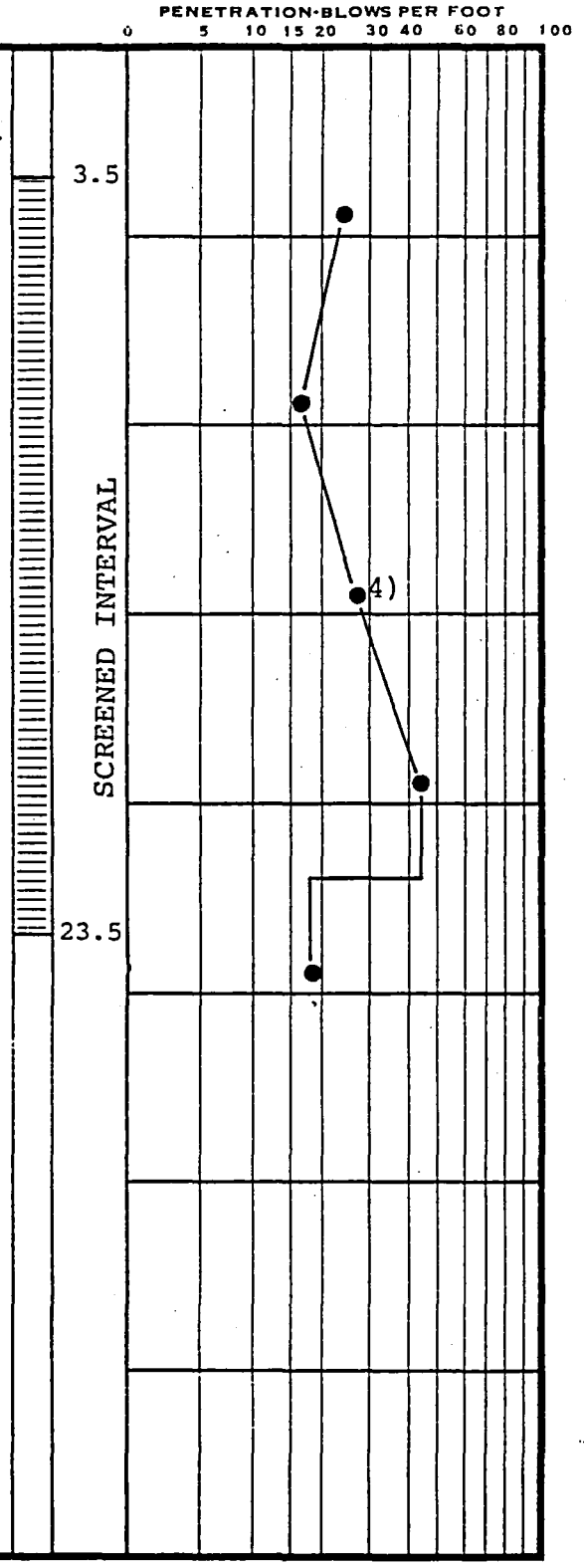
1) Ground-Water Elevation 90.32 on 4-6-83
2) Ground-Water Elevation 89.55 on 5-26-83
3) Cation Exchange Capacity 10 meq/100gm
4) Grain Size Analysis

DRILLED BY Corbin
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER MW-1
DATE STARTED 4-4-83
DATE COMPLETED 4-5-83
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
92.8	1.5	Topsoil
87.8		Light Gray Silty Fine SAND
82.8	12.0	
77.8		Light Gray Slightly Silty and Clayey Medium to Fine SAND
72.8	22.0	
		Dark Gray Very Silty Fine SAND
67.8	25.0	
		Boring Terminated at 25.0 Feet



REMARKS:

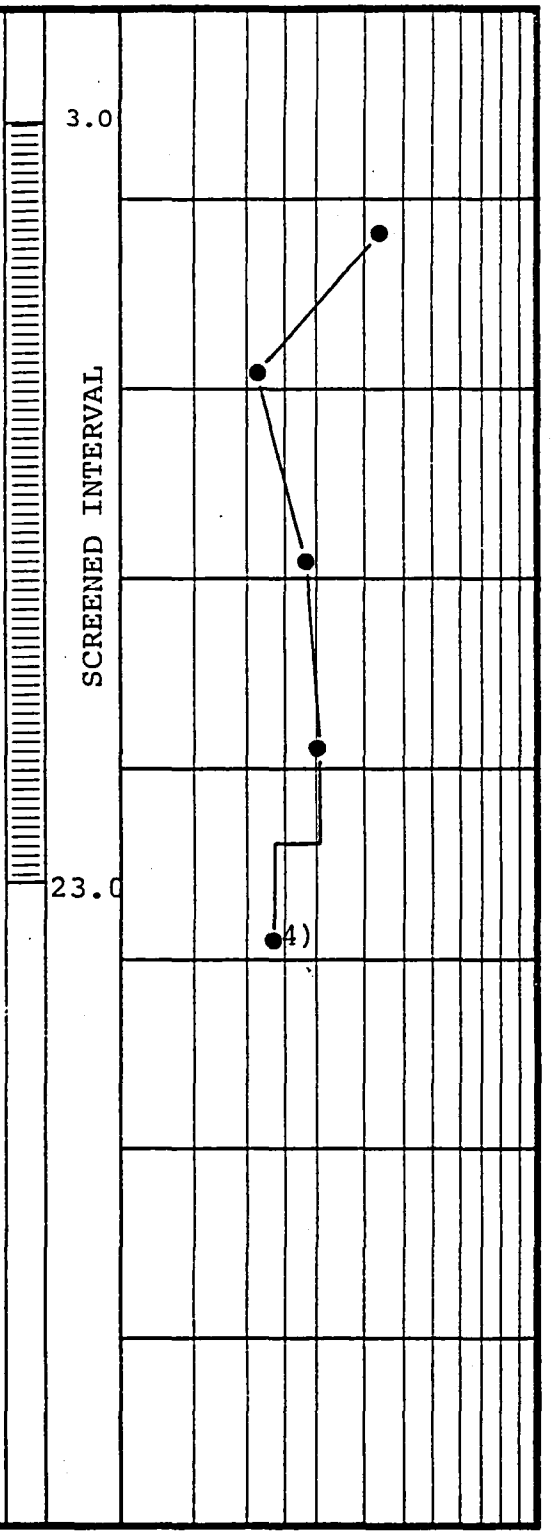
1) Ground-Water Elevation 90.88 on 4-6-83
2) Ground-Water Elevation 90.39 on 5-26-83
3) Cation Exchange Capacity 4.1 meq/100gm
4) Grain Size Analysis

DRILLED BY Corbin
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER MW-2
DATE STARTED 4-5-83
DATE COMPLETED 4-6-83
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
93.0		Topsoil
	1.5	
88.0		Light Gray Silty Fine SAND
	7.5	
83.0		Gray Very Clayey Fine SAND
	12.0	
78.0		Tan Slightly Silty Fine to Coarse SAND
	17.0	
73.0		Orange and Tan Slightly Silty Fine to Medium SAND
	22.0	
68.0		Dark Gray Very Silty Fine SAND
	25.0	Boring Terminated at 25.0 Feet



REMARKS:

1) Ground-Water Elevation 90.38 on 4-6-83
2) Ground-Water Elevation 89.65 on 5-26-83
3) Cation Exchange Capacity 6.3 meq/100gm
4) Grain Size Analysis

DRILLED BY Corbin
LOGGED BY Alexander
CHECKED BY Seymour

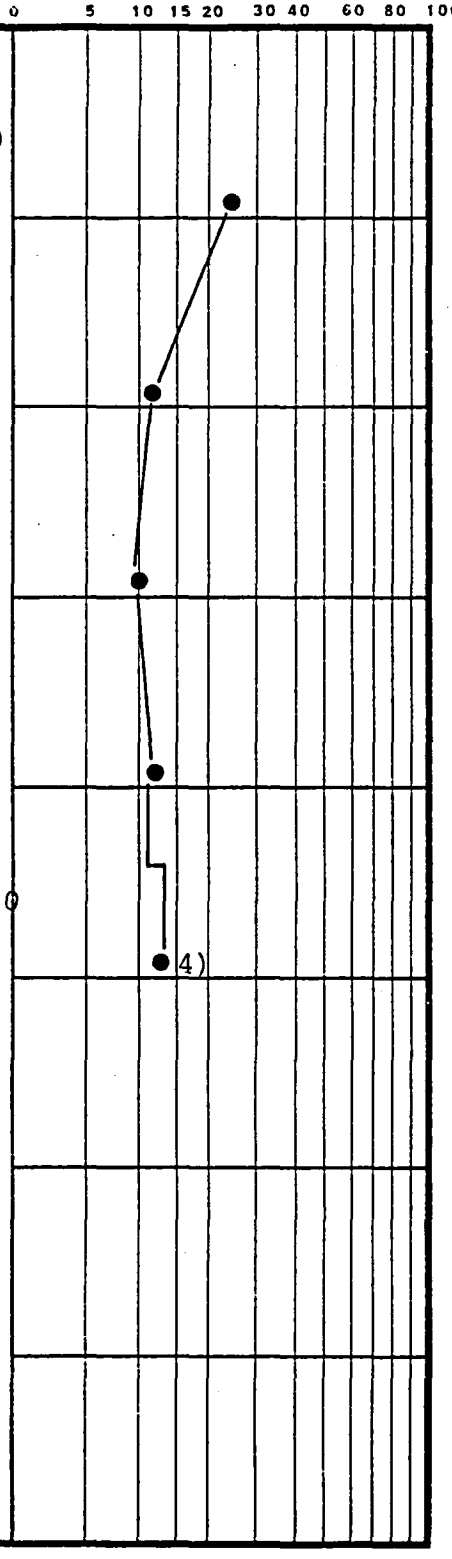
BORING NUMBER MW-3
DATE STARTED 4-5-83
DATE COMPLETED 4-6-83
JOB NUMBER MH2303

TEST BORING RECORD

ELEV.	DEPTH FEET	DESCRIPTION
93.1		
	1.5	Topsoil
		Tan Silty Fine SAND (1) (2)
88.1		
	7.0	
		Light Gray Silty-Clayey Fine SAND
83.1		
	12.0	
		Orange Slightly Silty Medium to Fine SAND
78.1		
	17.0	
		Orange and Gray Silty Medium to Fine SAND
73.1		
	22.0	
		Gray Very Silty Medium to Fine SAND (3)
68.1	25.0	
		Boring Terminated at 25.0 Feet

SCREENED INTERVAL: 3.0 – 23.0

PENETRATION-BLOWS PER FOOT: 0, 5, 10, 15, 20, 30, 40, 60, 80, 100



REMARKS:

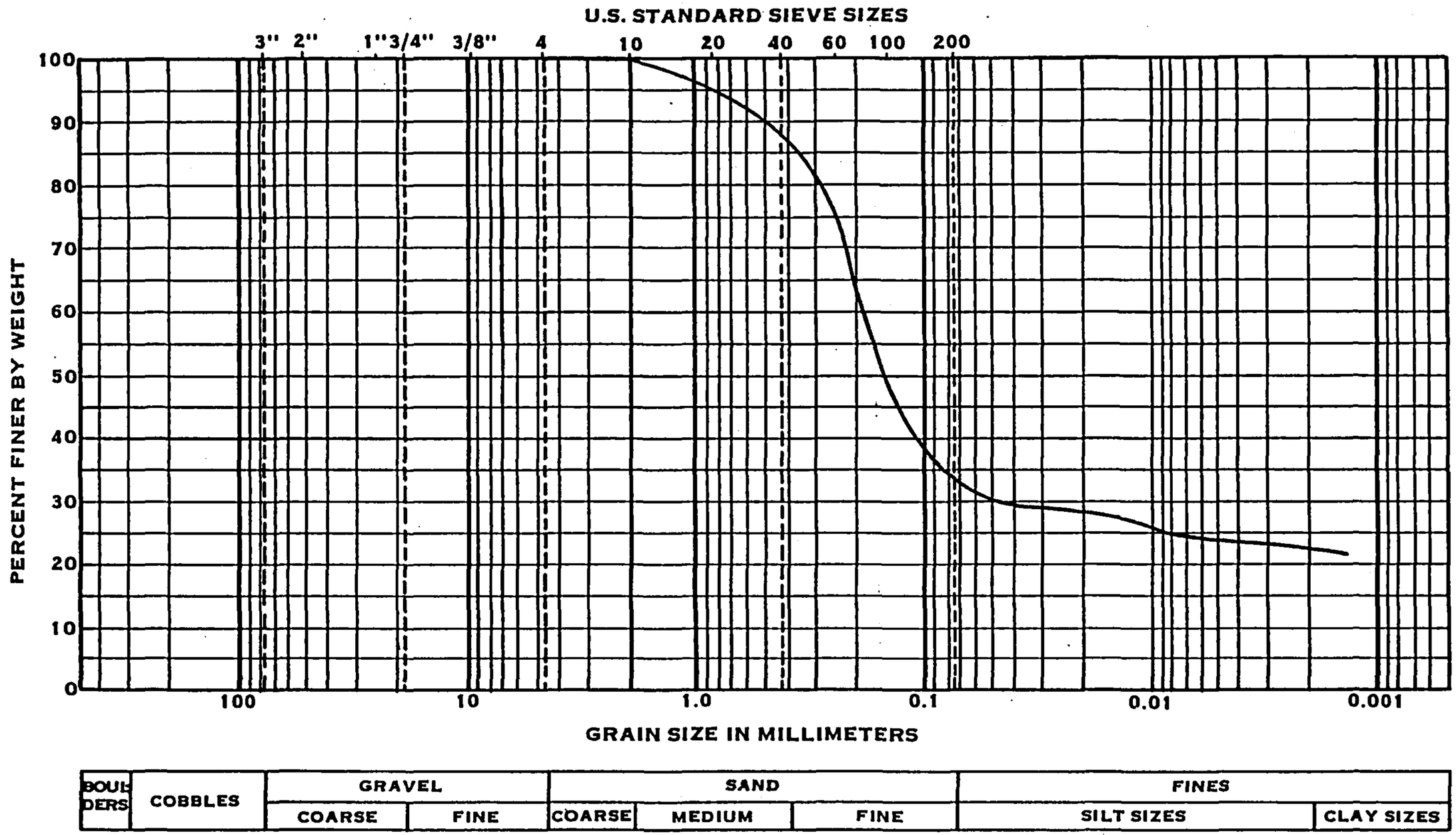
1) Ground-Water Elevation 90.31 on 4-6-83
2) Ground-Water Elevation 89.62 on 5-26-83
3) Cation Exchange Capacity 7.4 meq/100 gm
4) Grain Size Analysis

DRILLED BY Corbin
LOGGED BY Alexander
CHECKED BY Seymour

BORING NUMBER MW-4
DATE STARTED 4-5-83
DATE COMPLETED 4-6-83
JOB NUMBER MH2303

APPENDIX 3

GRAIN SIZE ANALYSES

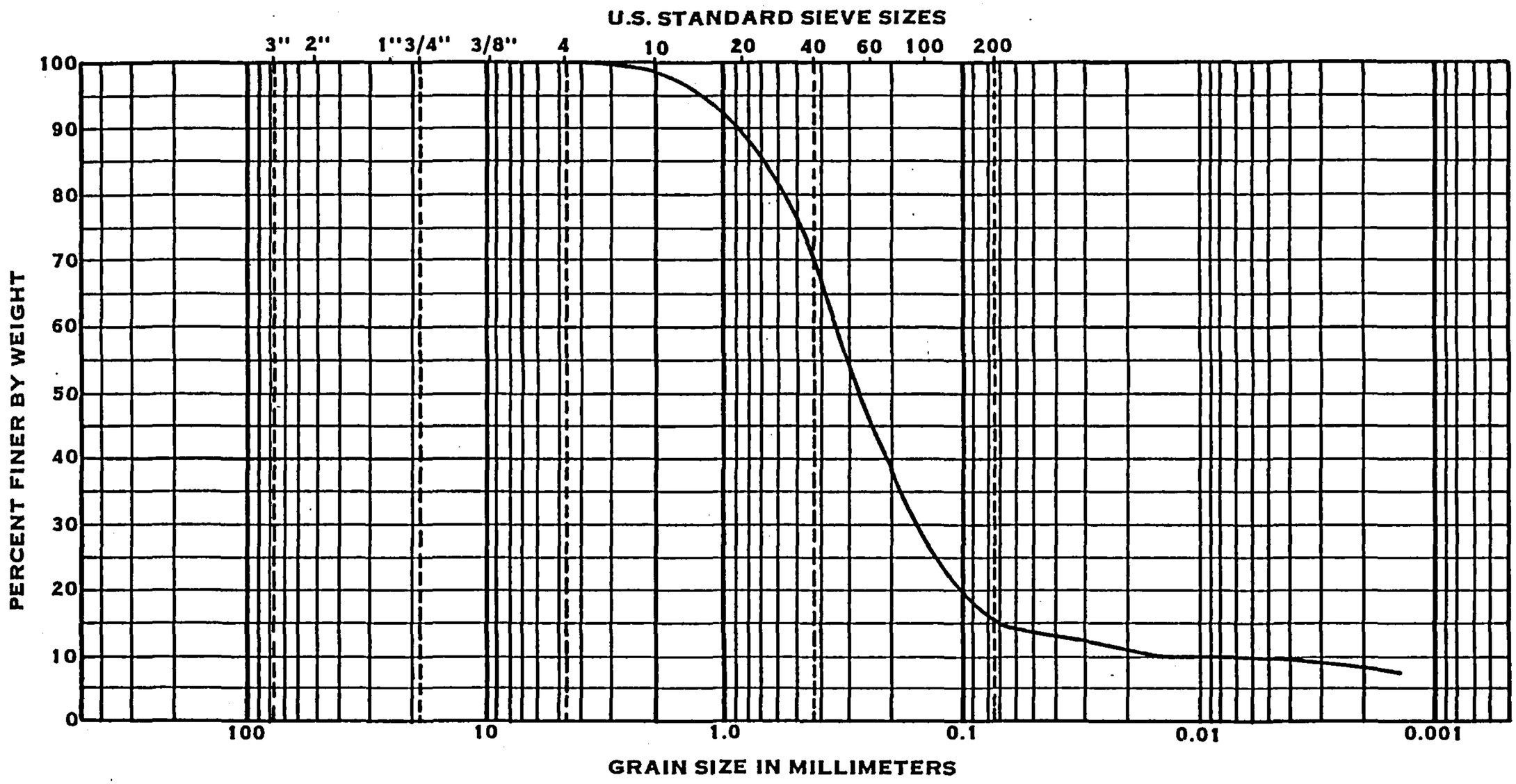


BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
MW-1 S-2	10.0'					Slightly Silty Very Clayey Medium To Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. MH2303

LAW ENGINEERING TESTING COMPANY



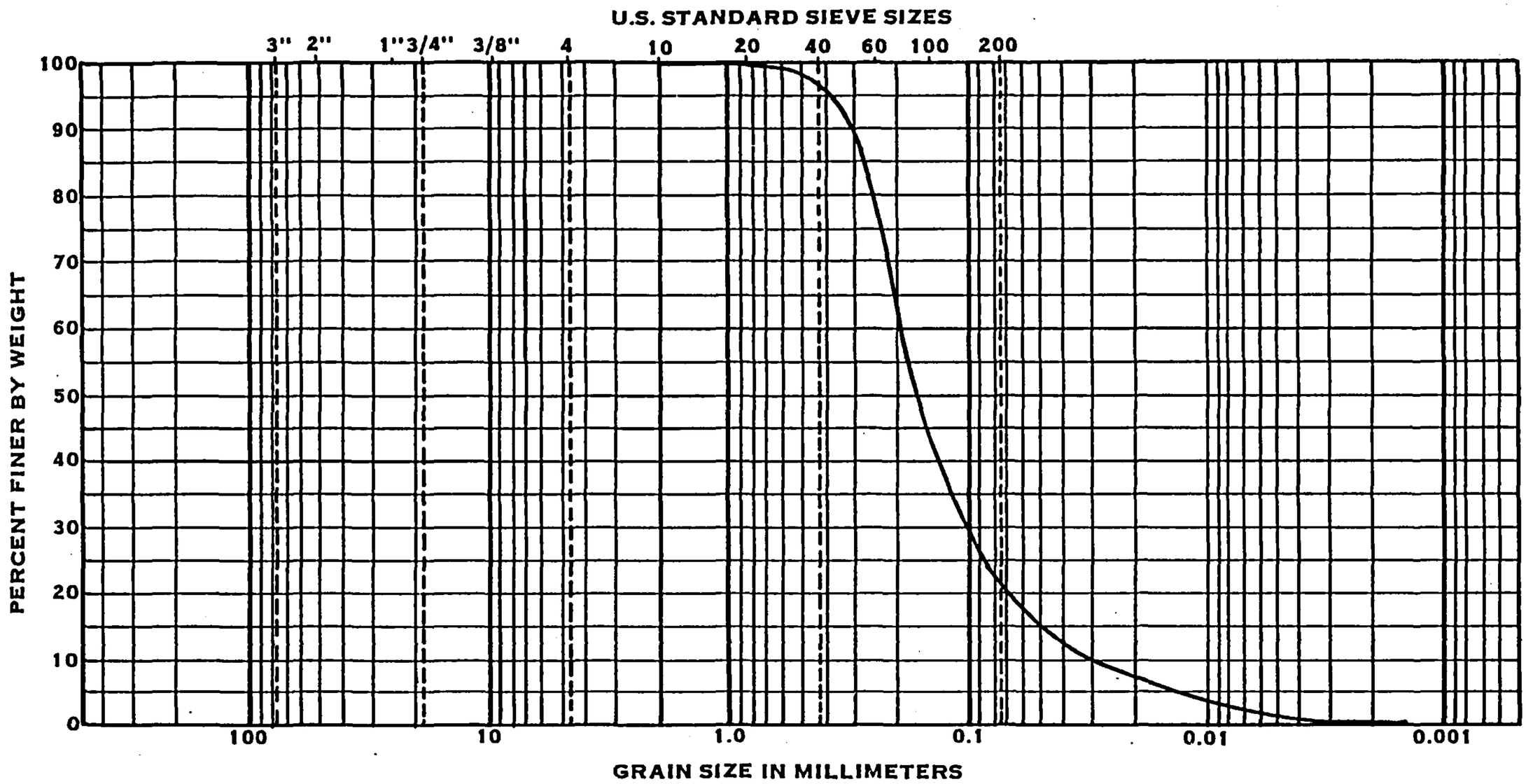
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
MW-2 S-3	15.0'					Slightly Silty and Clayey Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. MH2303

LAW ENGINEERING TESTING COMPANY



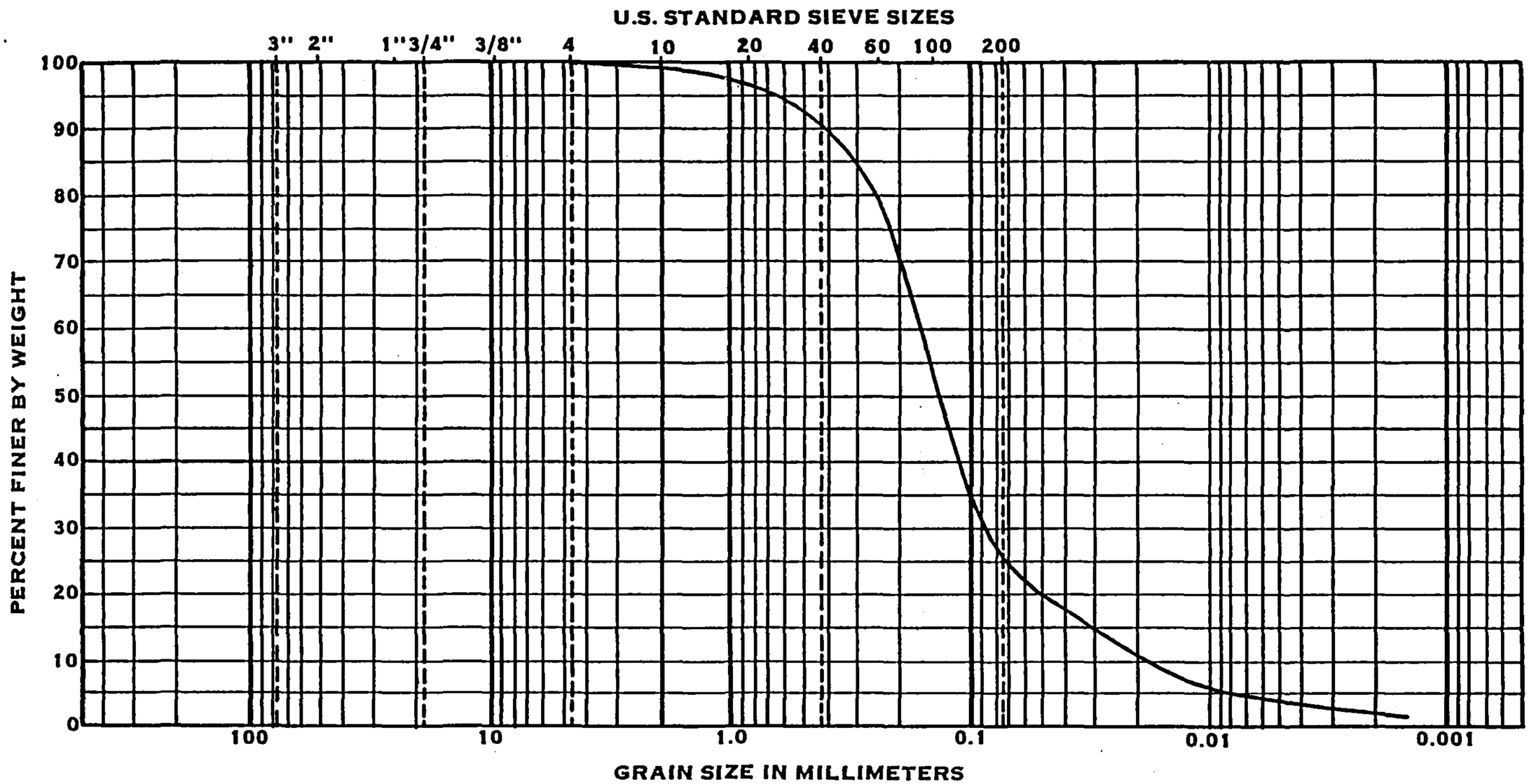
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
MW-3 S-5	25.0'					Very Silty Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. MH2303

LAW ENGINEERING TESTING COMPANY



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
MW-4 S-5	25.0'					Very Silty Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. MH2303

LAW ENGINEERING TESTING COMPANY

APPENDIX 4

MONITORING WELL VARIANCE

North Carolina Department of Natural Resources & Community Development
James B. Hunt, Jr., Governor
Joseph W. Grimsley, Secretary

DIVISION OF ENVIRONMENTAL MANAGEMENT
Robert F. Helms
Director
Telephone 919 733-7015

March 18, 1983

Mr. W. J. Alexander, P.G.
Law Engineering Testing Company
2749 Delk Road, S.E.
Marietta, Georgia, 30067

Dear Mr. Alexander:

Reference is made to your request on behalf of the Union Carbide Corporation for a variance to 15 NCAC 2C .0108(b)(2) for the construction of six (6) permanent observation wells to be located on their disposal site near Farmville, Pitt County.

Permission is granted to construct the observation wells at the facility in variance to 15 NCAC 2C .0108(b)(2) based on the following conditions:

1. The entrance into each wall casing shall be secured with a lockable top and lock.

2. Each well shall be labeled to show that it is for monitoring only and not to be used for drinking purposes.

If you have any questions or require any additional information concerning this matter, please contact Jim Mulligan, Regional Supervisor, or Bill Jeter, Regional Hydrologist, Washington Regional Office, PO Box 1507, Washington, NC 27889, telephone 919/946-6481.

Sincerely yours,

for Perry F. Nelson
Robert F. Helms
Director

cc: Washington Regional Office

APPENDIX 5

PREVIOUS CHEMICAL DATA

(SURFACE AND GROUND-WATER ANALYSES)

EAST CAROLINA UNIVERSITY

GREENVILLE, NORTH CAROLINA 27834

SCHOOL OF
ALLIED HEALTH AND SOCIAL PROFESSIONS
TELEPHONE 919-757-6961

Office of the Dean

Biostatistics/Epidemiology
Community Health
Environmental Health
Medical Record Science
Medical Technology
Occupational Therapy
Physical Therapy
Rehabilitation Counseling
Social Work and Correctional Services
Speech, Language and Auditory Pathology

MEMORANDUM

TO: Willie Pate
Sanitarian Supervisor
Pitt County Health Department

FROM: Barney Kane
Lab Director
Department of Environmental Health

DATE: April 9, 1982

SUBJECT: Results of Analyses for toxic metals in water samples

Samples received April 2, 1982, submitted by: Mr. Willie Pate

Source All concentrations reported as mg/l (ppm)

	Cadmium	Chromium	Silver	Lead
Nursery	$\leq$ 0.025	$\leq$ 0.15	$\leq$ 0.10	$\leq$ 0.2
Hog Pen	$\leq$ 0.025	$\leq$ 0.15	$\leq$ 0.10	$\leq$ 0.2
Mercer Res.	$\leq$ 0.025	$\leq$ 0.15	$\leq$ 0.10	$\leq$ 0.2
Fulford Res.	$\leq$ 0.025	$\leq$ 0.15	$\leq$ 0.10	$\leq$ 0.2
Starling Res.	$\leq$ 0.025	$\leq$ 0.15	$\leq$ 0.10	$\leq$ 0.2

Method: Air/Acetylene Flame Atomic Spectrophotometry

Comment: These levels indicate that the presence of metals was below detection level for the method used. Time did not permit use of the Carbon Rod method which would have been roughly 10 times more sensitive.

STARLING FARM SUPERFUND INVESTIGATION

PERSONAL WELL MONITORING SUMMARY

STATE LABS

CONTAMINANT	EPA STANDARD	FULFORD WELL	MERCEL WELL	NURSERY WELL	HOG PEN	STARLING HOUSE WELL
Barium	1.0 mg/1	.2 mg/1	<.1	<.1	<.1	.2
Cadmium	.01 mg/1	<.005	<.005	<.005	<.005	<.005
Chromium	.05 mg/1	<.01	<.01	<.01	<.01	<.01
Lead	.05 mg/1	<.03	<.03	<.03	<.03	<.03
Silver	.05 mg/1	<.02	<.02	<.02	<.02	<.02
Iron	--	1.07	.24	.53	.14	.38
Manganese	--	<.06	<.03	<.03	<.03	<.03
Arsenic	.05 mg/1	--	--	--	--	--
Mercury	.002 mg/1	<.0002	<.0002	<.0002	<.0002	<.0002
Selenium	.01 mg/1	--	--	--	--	--
Sulfate	--	<1	18	4	6	4
PH	--	7.4	5.0	7.4	7.0	7.9
Fluoride	1-42-4 mg/1	.23	<.1	.23	.23	.40
Phosphate	--	.75	.06	1.13	.87	.45
Nitrate	--	1.95	1.05	<.05	<.05	<.05
Sodium	--	4.7	17.9	47.8	49.9	14.6

STARLING FARM SUPERFUND INVESTIGATION

PERSONAL WELL MONITORING SUMMARY

EDGEWATER LABS

CONTAMINANT	EPA STANDARD	FULFORD WELL	MERCER WELL	NURSERY WELL	HOG PEN	STARLING HOUSE WELL
Barium	1.0 mg/1	.2 mg/1	.5 mg/1	.1 mg/1	.1 mg/1	.3 mg/1
Cadmium	.01 mg/1	<.02	<.02	<.02	<.02	<.02
Chromium	.05 mg/1	<.1	<.1	<.1	<.1	<.1
Lead	.05 mg/1	<.03	<.03	<.03	<.03	<.03
Silver	.05 mg/1	.09	<.07	<.07	<.07	<.07
Iron	--	.93	.10	.65	.18	.25
Manganese	--	.05	<.01	.02	<.01	.02
Arsenic	.05 mg/1	<.001	<.001	<.001	<.001	<.001
Mercury	.002 mg/1	<.0001	<.0001	<.0001	.0002	<.0001
Selenium	.01 mg/1	<.001	<.001	<.001	<.001	<.001
Sulfate	--	2.1	11	4.5	3.8	3.5
PH	--	6.95	4.65	6.85	6.66	7.28
Fluoride	1.4-2.4	.4	.4	1.0	.4	.7
Phsophate	--	<1	<1	1.3	<1	<1
Nitrate	--	<.6	4.6	<.6	1.1	<.6
Sodium	--	6.5	22	53	57	18

SURFACE WATER

ANALYSIS

STARLING FARM

EDGEWATER LAB

CONTAMINANT	EPA STANDARD	SURFACE PUDDLE	LAGOON	DRAINAGE DITCH
Lead	.05 mg/1	.10 mg/1	<.01 mg/1	.03 mg/1
Chromium	.05 mg/1	.03	<.01	.02
Barium	1.0 mg/1	20	.04	1.2
Mercury	.002 mg/1	<.0001	<.0001	.0001

E 2,405,000 E 2,406,000 E 2,407,000 E 2,408,000 E 2,409,000 E 2,410,000 E 2,411,000

N 692,000 N 691,000 N 690,000 N 689,000 N 688,000 N 687,000 N 686,000

See Inset "A" for Detail

PT. NO. 66 92.59 93.78

PT. NO. 65 90.34 89.48

PT. NO. 64 90.18 89.23

PT. NO. 63 89.29 88.04

PT. NO. 62 89.19 87.7

PT. NO. 45 92.73 9.78

PT. NO. 46 92.96 91.41

PT. NO. 47 WELL NO. 3 95.67

PT. NO. 44 93.02 91.82

PT. NO. 43 BORE NO. 2 92.99

PT. NO. 86 MW 3 93.91

PT. NO. 87 MW 4 93.76

PT. NO. 85 MW 2 93.32

PT. NO. 84 MW 1 92.98

PT. NO. 42 WELL NO. 1 93.03

PT. NO. 40 BORE NO. 1 91.82

PT. NO. 41 WELL NO. 2 93.68

PT. NO. 52 89.04 87.71

SUBSURFACE DRAINS

SIGN

PT. NO. 36 WELL NO. 4 91.61

PT. NO. 35 WELL NO. 5 91.83

PT. NO. 33 IRON SET

RUINS

well no. 6 (not surveyed)

well no. 7 (not surveyed)

PT. NO. 48 92.15 90.70

PT. NO. 49 91.63 90.07

PT. NO. 50 90.39 89.03

PT. NO. 51 87.04 85.86

PT. NO. 54 87.65 86.38

N.C.G.S. "EFFIE"

WOODLAND HILLS MOBILE HOME ESTATES

BRUSH

INSET "A"

Scale: 1" = 50'

N690,700

E2,406,700

E2,407,300

N690,300

PT. NO. 65 90.34 89.48

PT. NO. 64 90.18 89.23

FARM PATH

PT. NO. 86 MW 3 93.91

PT. NO. 87 MW 4 93.76

PT. NO. 43 BORE NO. 2 92.99

PT. NO. 85 MW 2 93.32

PT. NO. 84 MW 1 92.98

PT. NO. 61 92.83 91.70

PT. NO. 60 91.7 90.41

PT. NO. 42 WELL NO. 1 93.03

PT. NO. 41 WELL NO. 2 93.68

PT. NO. 40 BORE NO. 1 91.82

PT. NO. 52 89.04 87.71

FARM ROAD

93.0 93.2 93.3 97.4 93.0 94.1 92.8 97.4 93.8 94.3 94.5 93.2 92.8 92.6

LEGEND

- = BORING
- = WELL
- = MONITORING WELL
- (X) = STAKE IN DITCH WITH TOP OF STAKE ELEVATION & WATER LEVEL AS OF SURVEY DATE.
- △ = HORIZONTAL CONTROL POINT
- 100.0 = SPOT ELEVATION
- → = FLOW DIRECTION IN DITCH (APRIL 5,1983)

NOTE: Ground Survey by McDavid Associates, Inc. April 5, 1983

Job No. 3275 Dec. 86

PLANIMETRIC MAP

FARMVILLE, N.C. SITE

N

SCALE 1" = 200'

20 0 200 400

Prepared by

Piedmont Aerial Surveys, Inc.

GREENSBORO, N.C.

DATE OF PHOTOGRAPHY [illegible]

PLATE 1

P.A.S. JOB NO. 2209