Johnston Co. 51-01

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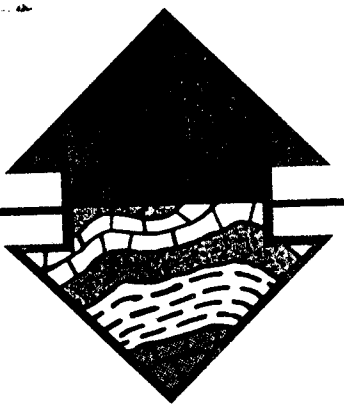
-Booklet-

Geologic and Hydrologic Site Evaluation
Johnston County Landfill Expansion
Smithfield, North Carolina

Rcvd. June 25th, 1983

SCAN MAP

SOIL & MATERIAL ENGINEERS INC.



GEOLOGIC AND HYDROLOGIC SITE EVALUATION
JOHNSTON COUNTY LANDFILL EXPANSION
SMITHFIELD, NORTH CAROLINA
S&ME JOB NO. 051-82-104-A

SOIL & MATERIAL ENGINEERS INC. ENGINEERING-TESTING-INSPECTION

3109 Spring Forest Road, Box 58069, Raleigh, NC 27658-8069, Phone (919) 872-2660

December 9, 1982

Ragsdale Consultants, P.A.
310 E. Johnston Street
Post Office Box 1749
Smithfield, North Carolina 27577

Attention: Mr. Gene B. Cobb, P.E.

Reference: Geologic and Hydrologic Site Evaluation
Johnston County Landfill Expansion
Smithfield, North Carolina
S&ME Job No. 051-82-104-A

Gentlemen:

Soil and Material Engineers, Inc. has completed a geologic and hydrologic evaluation of two tracts of land for sanitary landfilling purposes. Both tracts are located adjacent to the existing Johnston County Landfill off North Carolina Highway 210 near Smithfield, North Carolina (see Figure 1). This study has been performed in accordance with the Solid Waste Management Rules (April 1, 1982) established by the North Carolina Department of Human Resources, Solid and Hazardous Waste Management Branch (Paragraph .0504 (1) (c)).

The purpose of this report is to describe the groundwater, topographic, geologic and subsurface soil conditions encountered by the test borings or otherwise observed, and to present the results of the laboratory testing program and engineering evaluation. Discussions are also provided regarding the suitability and/or limitations of the sites for landfilling purposes, as indicated by these data.

PROJECT DESCRIPTION

The existing Johnston County Sanitary Landfill is located off North Carolina Highway 210 west of Smithfield, North Carolina and is approaching its capacity. Plans are to expand landfilling operations onto two adjacent tracts of land. Tract One is located to the south of the existing landfill area and Tract Two is located directly to the north (Figure 3). Tract One has a total area of about 87 acres, of which about 70 acres are to be used for landfilling. At this time, this tract is primarily an overgrown field with woods at the lower elevations. Topographic relief across the tract is about 79 feet with ground surface elevations ranging between about 219 and 140 feet mean sea level (MSL). Tract Two encompasses about 52 acres with about 40 acres to be landfilled. This tract is entirely wooded and shows about 87 feet of relief, with elevations ranging between elevation 217

and 130 feet (MSL).

The existing landfilled area and both proposed new tracts drain to the northwest into Middle Creek. Overall site drainage is good with adequate relief and several well developed natural and man made channels to facilitate the movement of surface water off the site to the creek. According to National Oceanic and Atmospheric Administration Records through 1981, mean annual rainfall in the Smithfield area is 48.1 inches.

Soil and Material Engineers, Inc. performed an engineering site study for the entire property in 1974, from which the existing landfill was designed. In 1981, a subsequent hydrogeology study was performed for a part of the existing landfill site in order to re-evaluate depths of excavation. The locations and elevations of the 1972 test borings are not accurately known and these borings have been used for general site evaluation only. The 1981 observation wells have been referenced to the existing survey by Ragsdale Consultants and have been used in the groundwater hydrology analysis of Tract Two.

GEOLOGIC SETTING

Johnston County is located at the western edge of the Central Coastal Plains of North Carolina. The major portion of the county is underlain by Coastal Plain sediments, and the proposed landfill sites are located in this area. Figure 2 presents a generalized geologic map of the County.

The Coastal Plain sediments in the landfill area belong to the Tuscaloosa geologic formation. These sediments were deposited as near shore continental deposits during Cretaceous geologic times (about 70 million years ago). The Tuscaloosa deposits consist of unconsolidated silty and clayey sands with some silt and clay layers and localized gravel deposits. Thin, isolated iron cemented (limonite) zones exist within the Tuscaloosa sediments.

The thickness of the Coastal Plain sediments in Johnston County ranges from in excess of 100 feet to the east and southeast to a feather edge to the west. The sediments are underlain by weathered felsic volcanic and metamorphic rocks and residual soils similar to those exposed at the surface throughout many areas of the Piedmont. The residual soils are generally silty in composition and may still retain the original structure of the parent rocks. Since the top of the bedrock/residual soil represents an erosional surface, the contact between the residual materials and Coastal Plain sediments is generally irregular in elevation.

FIELD EVALUATION

Prior to the start of the field testing program, a field reconnaissance of both sites was made with representatives of Johnston

County and Ragsdale Consultants. The boring locations were established in the field at that time.

The field exploration consisted of seven test borings an Tract One and six test borings on Tract Two. The borings were generally drilled to depths of about 25 feet below land surface; however, several of the borings at lower elevations were drilled to depths of about 20 feet.

The test borings were drilled with a CME 45 all-terrain mounted drill rig, and were advanced by means of continuous-flight hollow-stem augers. Soil samples were obtained at regular intervals by means of the Split Barrel Sample Procedure, (ASTM D-1586). Additionally, several unsuccessful attempts were made to obtain undisturbed samples by the Shelby Tube sampling procedure. Bulk bag samples of near surface soils were collected for analysis as potential cover soils. Test Boring Records are included in the Appendix and present visual descriptions of the materials penetrated.

Since the Shelby Tube sampling was unsuccessful, laboratory hydraulic conductivity testing could not be performed on undisturbed soil samples. Therefore, after analysis of the test boring and laboratory testing programs, a drill rig returned to the site and performed field hydraulic conductivity testing at both tracts (near test borings T-4 and S-4). The results of these tests are presented on Table II.

Observations were made for accumulated water in the boreholes at the completion of drilling each boring and other times as noted Table I, "Borehole Water Levels".

LABORATORY TESTING PROGRAM

All soil samples collected were placed in glass jars in the field and returned to our laboratory for visual examination and engineering classification. Representative soil samples were tested to determine their moisture contents.

Representative portions of the three bulk samples collected were tested to determine their particle size distributions, natural moisture contents and Atterberg Limits. Based on these results, two samples were selected for laboratory compaction testing (ASTM D-698) and remolded hydraulic conductivity determination. These test results are attached and have been used in evaluation of the use of these soil types as landfill cover.

Additional laboratory testing was performed on the disturbed samples collected in the areas of the field hydraulic conductivity testing. This testing consisted of determining specific gravity of solids, moisture content, and particle size distribution on representative samples. The results of all laboratory testing are included in the Appendix, and are summarized on Table II, "Test Data Summary".

SUBSURFACE CONDITIONS

The specific soil conditions found at each borehole location are indicated on the attached Test Boring Records and summarized on Figures 4 through 8. The soil overburden found at the test borings consists primarily of Coastal Plain deposits. The soil mass is characteristic of Tuscaloosa formation sediments, with variations in soil consistency and composition from borehole to borehole but with no distinct trends or well developed stratigraphy.

Three general soil types are found at the sites and are classified as fine to medium slightly silty to clayey sands, clayey fine to medium sands and slightly sandy silts and clays. The fine to medium sands are generally tan to brown in color and loose to firm in consistency with standard penetration resistances ranging between 6 and 25 blows per foot (bpf). The tan and orange clayey and silty sands form transitions from the coarser to finer grained sediments and are generally firm to dense with typical standard penetration resistances of 20 to 25 bpf. The silts and clays are thought to occur as discontinuous layers and lenses in the overall granular matrix and have standard penetration resistances between 14 and 39 bpf (stiff to hard).

Where the test borings penetrated the Coastal Plain sediments, residual soil was found. These soils rapidly transition to weathered felsic volcanic rock. In disturbed samples, the rock appeared as tan to gray silty fine sand to fine sandy silt. Standard penetration resistances were generally in excess of 50 bpf.

Water levels in the boreholes were measured at the time of completion of each test boring and several times thereafter. A summary of the water levels measured and the times the measurements were made are indicated on Table I, "Borehole Water Levels". At the higher elevations, the water generally occurs 16 to 20 feet below land surface. This data is compatible with the water level data from both the 1974 field program and the 1981 wells. At the lower elevations on Tract Two, the water appears to be located about 6 to 9 feet below the surface.

An approximate potentiometric map (Figure 9) is attached and shows the estimated groundwater levels across the site. These estimates were developed from the stabilized borehole water levels and interpreted data from the 1974 and 1981 studies.

EVALUATION AND ANALYSIS

In evaluating a site for landfilling use, the primary geologic and hydrological considerations are that the landfill can be designed and operated to minimize effects on the environment and that the landfilling operations can be performed at a reasonable cost. Evaluation of these considerations involves examining a number of site characteristics. Among these factors are: 1) surface topography and drainage, 2) the occurrence, depth and movement of groundwater, 3) the occurrence, depth and nature of rock,

and 4) overall soil characteristics and consistency. Each of these factors have a significant impact on the suitability of the site. Where sites are determined to be satisfactory, these factors affect appropriate methods for optimum site use. For convenience, each of these site characteristics is discussed separately below:

Surface Topography and Drainage: The greatest potential for a landfill to adversely affect the environment is by the movement of contaminants through surface and groundwater. Surface water moving through a landfill contributes to both problems, either by direct transport of contaminants or by providing a source of water for the generation of leachate. Therefore, site topography and its use to direct surface water away from landfill areas are important factors in the evaluation of a proposed site.

Surface drainage on this property is relatively good, and the topographic relief is adequate for the rapid and controlled removal of surface water. Surface water from the existing landfill area is generally directed to natural drainage swales and excavated drainage ditches along either side of the area, and drains into Middle Creek. Since each of the two tracts form low ridges, surface water on these tracts generally flows to the sides of the tracts. Where the proposed tracts adjoin the existing landfill areas, surface water is removed by the swales and ditches that drain the existing landfill. Tract Two is bounded by a natural drainage swale on the north side. The existing topography along the southern border of Tract One lends itself to the excavation of drainage ditches to remove surface water flowing toward that boundary.

Groundwater: The potentiometric map (Figure 9) indicates the estimated groundwater elevations across the site. This map was constructed using the stabilized highest recorded levels of water in the boreholes over a period of two months. Fluctuations in groundwater levels may occur due to variations in rainfall, evaporation rates, changes in surface drainage and other factors. However, the general groundwater patterns indicated by the previous studies are relatively consistent with the levels of water observed during this study.

Groundwater flows from areas of higher potential to areas of lower potential much as surface water flows from higher topography to lower topography. Similarly, groundwater flow is perpendicular to potentiometric contours as surface water flow is perpendicular to topographic contours. Using this as a basis, examination of the potentiometric map (Figure 9)indicates that the direction of groundwater flow generally corresponds with surface water flow. The general direction of flow is toward existing drainage swales and Middle Creek. Furthermore, Middle Creek probably forms a hydraulic boundary in the shallow unconfined aquifer, minimizing the potential effect of the landfill on groundwater quality across the stream. Since the landfill site extends to the creek, no potable water wells are anticipated downgradient between the landfill and Middle Creek. However, the property to the south of Tract One is downgradient and may be subject to development. We suggest that one of the landfill monitoring wells be located

along this boundary.

Rock Conditions: Rock was encountered at four borings for the present study. These were test borings T-5, T-6 and T-7, all located at the western (lower) end of Tract One, and boring S-6 on Tract Two. This rock is a weathered felsic volcanic, appearing in disturbed samples as tan to gray silty sand and sandy silt. At boring T-7, rock was found at about elevation 158 feet (MSL), while at the other three borings, rock occurred close to elevation 150 feet (MSL).

Thin localized, iron-cement zones (limonite) are characteristic of the Tuscaloosa sediments. One such zone was found at Boring T-1 between the depths of 16.5 and 17 feet, and others were found during previous studies. However, these zones are generally not extensive and should not present major impediments to excavation.

Soil Properties: As previously discussed, the soils at this site generally consist of silty sands, sands and silt-clay mixtures. These soils are gradational, with variations in consistency and composition both horizontally and vertically. However, the overall composite soil mass is relatively uniform from one area to another.

Soil properties are important to landfilling operations in several respects. The hydraulic conductivity of the base of the landfill will largely determine the rate at which leachate will move out of the landfill and the rate of groundwater movement under the landfill. Furthermore, adequate volumes of soils must be available for use as daily and final cover to minimize wind-blown debris, rodent problems and the infiltration of surface water into the landfill. The design of embankments and difficulties in excavation will affect both the operations and costs of the landfill.

The results of the field permeability testing performed as part of this study are shown on Table II, "Test Data Summary". These tests indicate that the undisturbed soils at this site have lateral hydraulic conductivities on the order of 1×10^{-5} to 6×10^{-5} cm/sec.

Laboratory compaction testing (ASTM D-698) was performed on bulk samples collected from the proposed tracts. Representative portions of these samples were compacted to 90% of the maximum laboratory densities. These samples had hydraulic conductivities of about 1.5×10^{-5} cm/sec.

Conclusions: Based on the evaluation of the data presented above, it is our opinion that both Tracts One and Two are suitable for landfilling use. The two drainage areas bordering the existing landfill site should be preserved to maintain good drainage from both the existing and proposed landfills. Construction of additional drainage ditches will be necessary around the exterior boundaries of the property to improve and better control existing surface drainage. Use of these measures should result in efficient removal of surface water.

Groundwater levels will generally limit the depths of excavation

for the landfills. However, at the lower elevations, the rock surface will be the limiting factor. The state regulatory agency requires a four foot minimum separation between the base of the landfill and groundwater and/or rock. This should be adequate to minimize the potential for groundwater rise into the landfill or for encountering unanticipated excavation problems.

Excavation for the landfills is not expected to create unusual difficulties for normal earth moving equipment. With the exception of local iron-cemented zones, rock excavation is not anticipated above the proposed landfill base. Temporary excavation slopes should perform adequately if they are constructed no steeper than 1(v):1(h) for excavations up to 20 feet high. Some sloughing of slopes this steep may occur during wet seasons. Permanent slopes should be grassed or otherwise protected from erosion and should be no steeper than 1(v):3(h). The top of the landfills should be graded to maintain positive drainage to the surface water control features.

The soils to be excavated should be suitable for use as daily and final cover. The more granular soils should be used for daily cover and the finer grained soils should be stockpiled for final cover. The volume of soil for both daily and final cover appears to be adequate.

A minimum of one foot of sandy soil should be used as daily cover. This sand should help to control wind-blown trash, odors and rodents. We suggest that the final cover consist of a minimum of 3 feet of silty to clayey sand or finer grained soil, placed in lifts not exceeding one foot. All final cover should be compacted at least 90 percent of the maximum laboratory density as determined by ASTM D-698.

The development of the operational plan for this site will require careful design of both surface drainage and final cover. Periodic maintenance of the landfill after closure will be required to correct irregularities in the surface as the wastes compress, to minimize surface water ponding. Adequate supervision and periodic inspection will be necessary to assure that the intent of the operational plan is carried out.

The boreholes for this study have been left open temporarily to facilitate water levels measurements. Prior to construction of the landfills, the boreholes must be grouted closed to a level above the base level of the landfill. Otherwise the open boreholes may provide a direct conduit for contamination to move to the groundwater.

In order to evaluate natural groundwater quality passing beneath the landfills and to detect any contamination of groundwater by leachate from the landfills, a series of permanent groundwater monitoring wells must be constructed. We suggest a minimum of five wells be installed for this property, one upgradient and four downgradient.

It has been a pleasure working with you on this project. If we can be of further service or if you have any questions, please contact us.

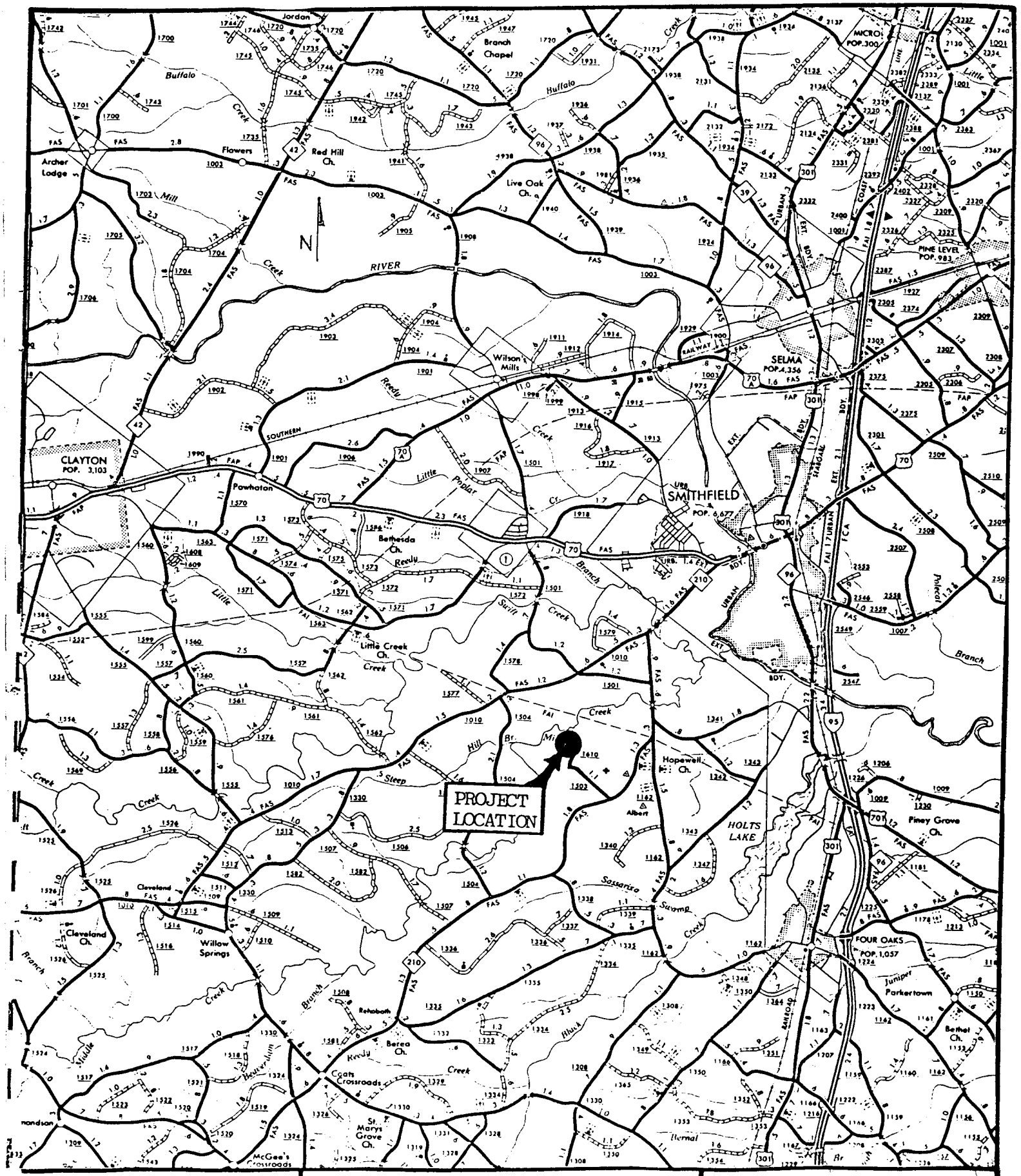
Sincerely,

SOIL & MATERIAL ENGINEERS, INC.

Ernest F. Parker, Jr., P.E.
N. C. Registration No. 7950

Everett W. Glover, Jr., P.E.
N. C. Registration No. 8641

EFP/EWG/bsp



PROJECT
Johnston County
Landfill Expansion

SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

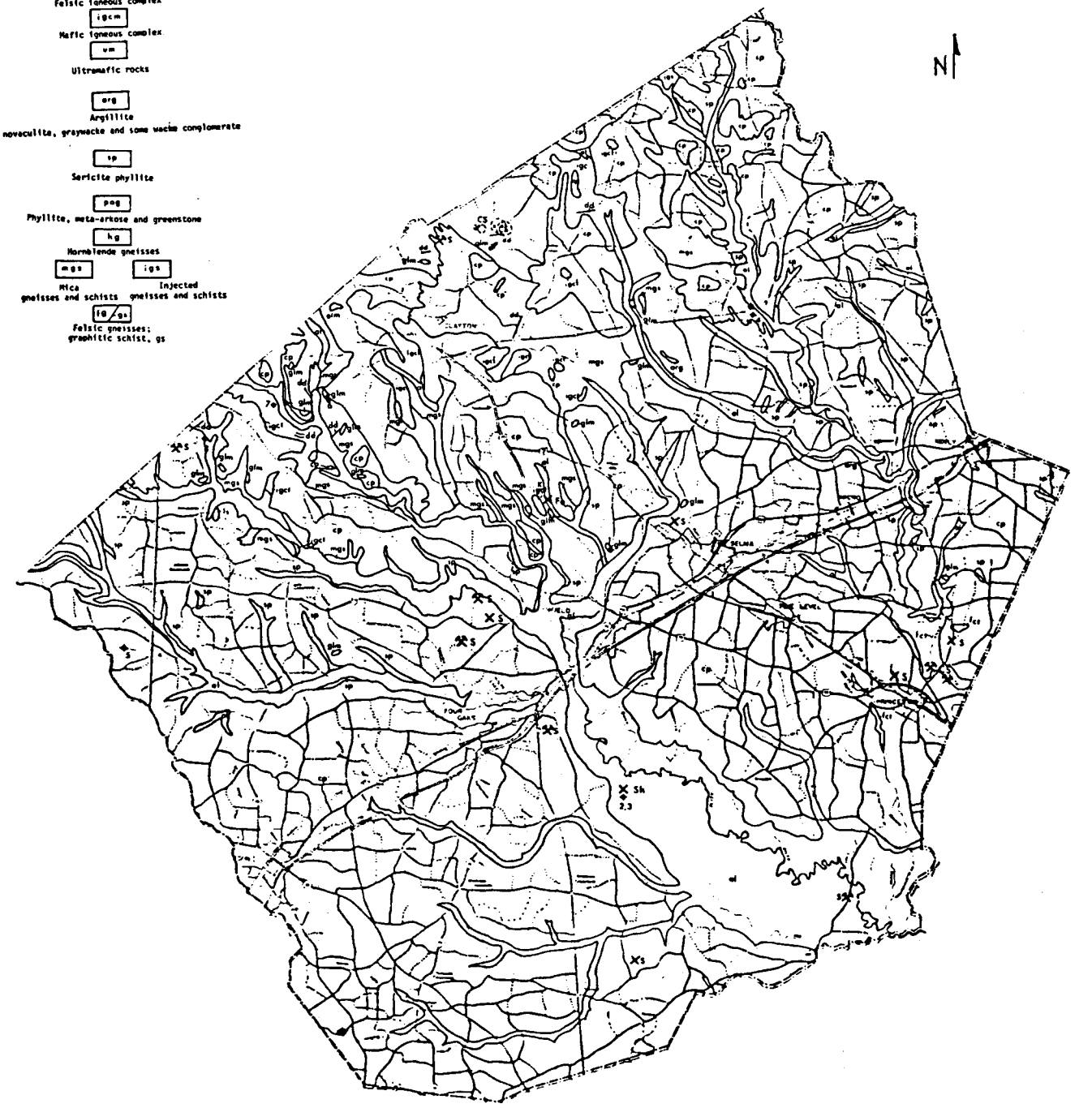
SCALE: 1" = 2 Miles
JOB NO: 51-82-104-A
FIG. NO: 1

DUNCAN-PARNELL, INC., RALEIGH 779

TAKEN FROM:
Region J Geology: A Guide for North Carolina Mineral Resource Development and Land Use Planning, N.C. Dept. of Natural and Economic Resources, 1975.

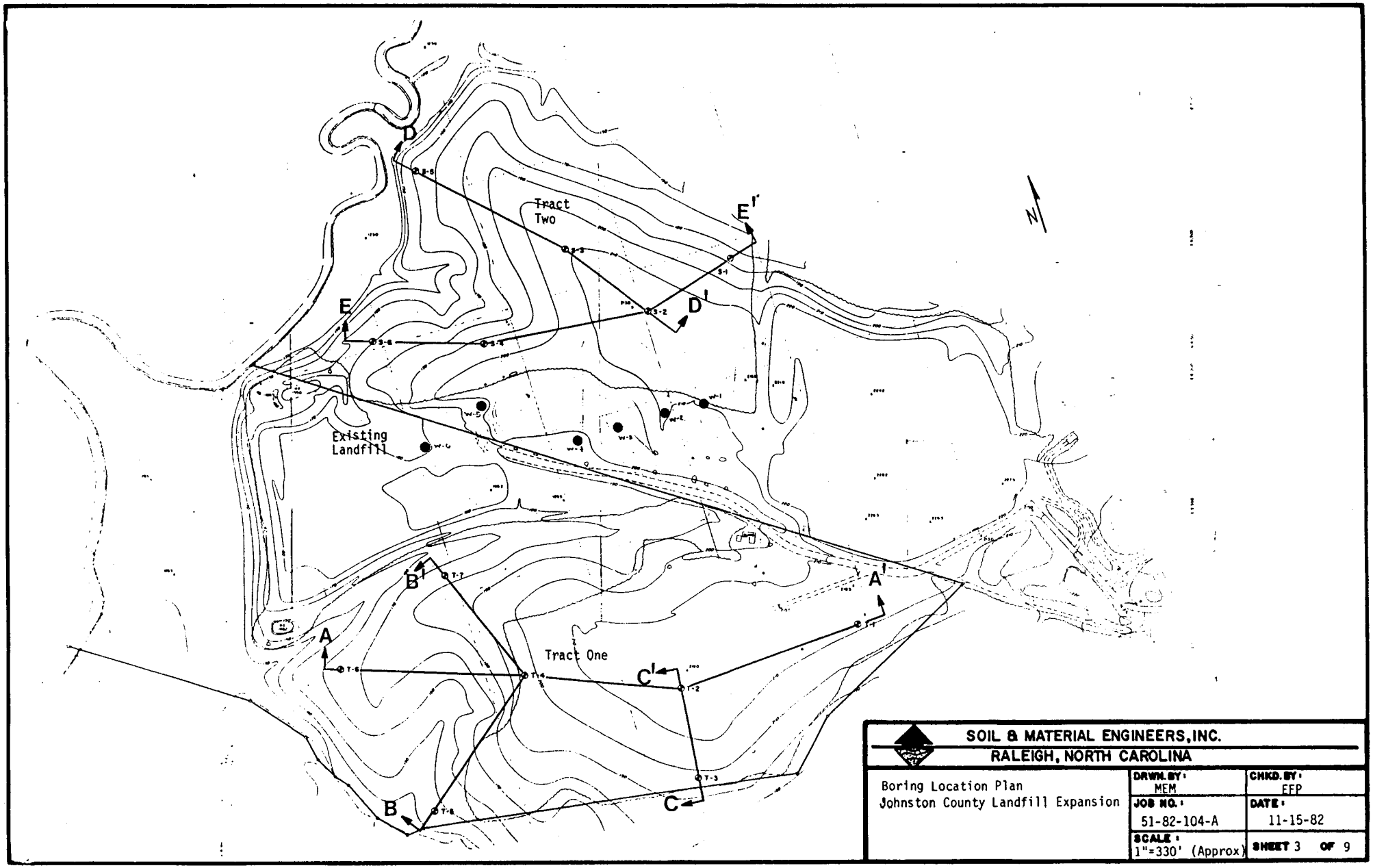
LEGEND

- al — Floodplain alluvium
- gl — Gravel deposit (alluvial)
- cp — Coastal Plain sands and clays, unconsolidated
- glm — Gravel deposits (marine ?)
- igcf — Felsic igneous complex
- igcm — Mafic igneous complex
- um — Ultramafic rocks
- arg — Argillite
  Includes novaculite, graywacke and some waclke conglomerate
- sp — Sericite phyllite
- pag — Phyllite, meta-arkose and greenstone
- hg — Hornblende gneisses
- mgs — Mica gneisses and schists
- igs — Injected gneisses and schists
- fg/gs — Felsic gneisses; graphitic schist, gs



PROJECT	SOIL & MATERIAL ENGINEERS, INC.	SCALE: 1" = 5.5 Miles (Approx.)
Geologic Map Johnston County, N.C.	RALEIGH, NORTH CAROLINA	JOB NO: 51-82-104-A FIG. NO: 2

DUNCAN-PARNELL, INC., RALEIGH 779



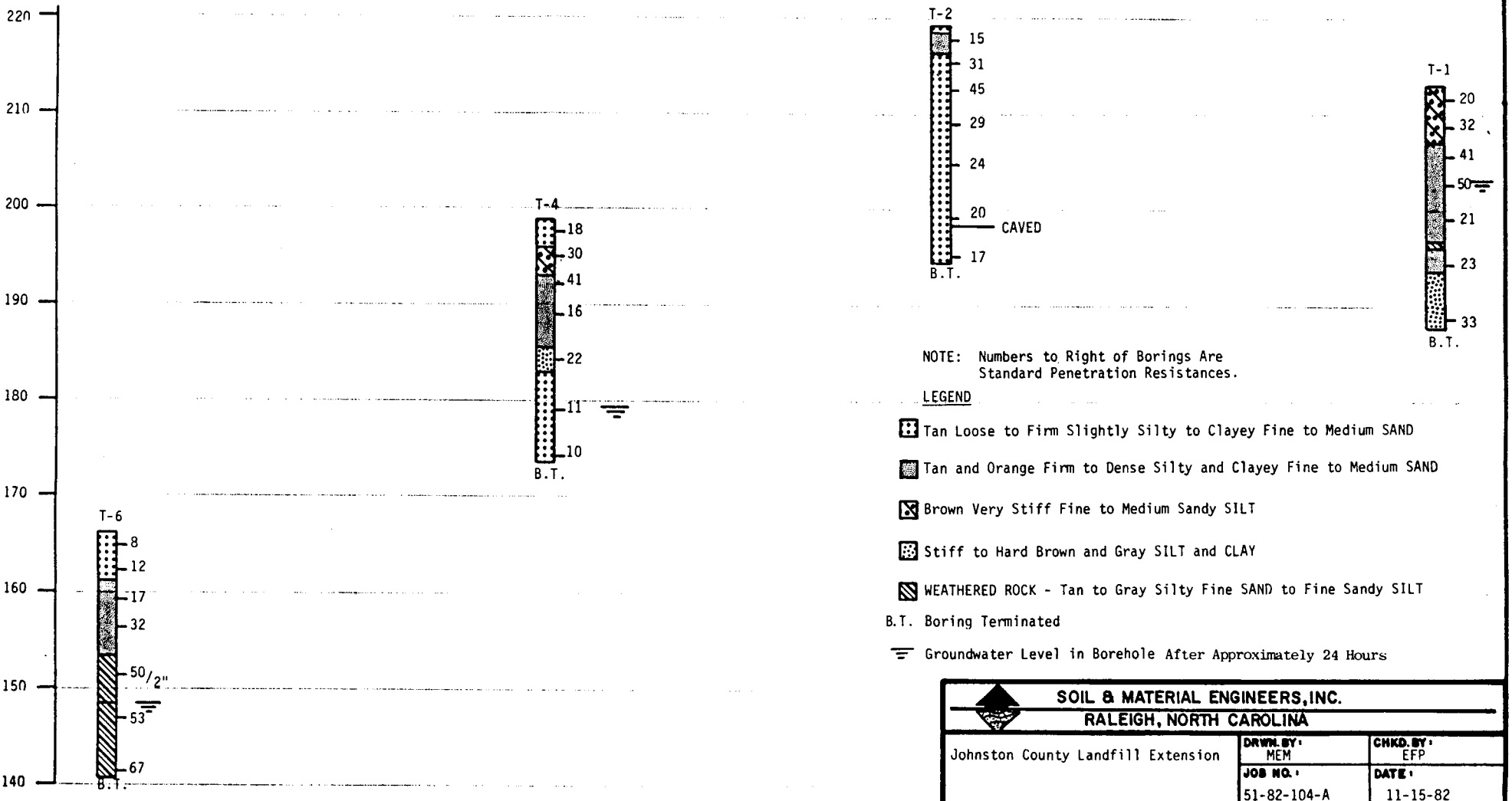
SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

Boring Location Plan
Johnston County Landfill Expansion

DRWN. BY: MEM	CHKD. BY: EFP
JOB NO.: 51-82-104-A	DATE: 11-15-82
SCALE: 1"=330' (Approx)	SHEET 3 OF 9

SECTION A - A'

SCALE: Horizontal: 1" = 150'
Vertical: 1" = 10'



NOTE: Numbers to Right of Borings Are Standard Penetration Resistances.

LEGEND

- Tan Loose to Firm Slightly Silty to Clayey Fine to Medium SAND
- Tan and Orange Firm to Dense Silty and Clayey Fine to Medium SAND
- Brown Very Stiff Fine to Medium Sandy SILT
- Stiff to Hard Brown and Gray SILT and CLAY
- WEATHERED ROCK - Tan to Gray Silty Fine SAND to Fine Sandy SILT

B.T. Boring Terminated

Groundwater Level in Borehole After Approximately 24 Hours

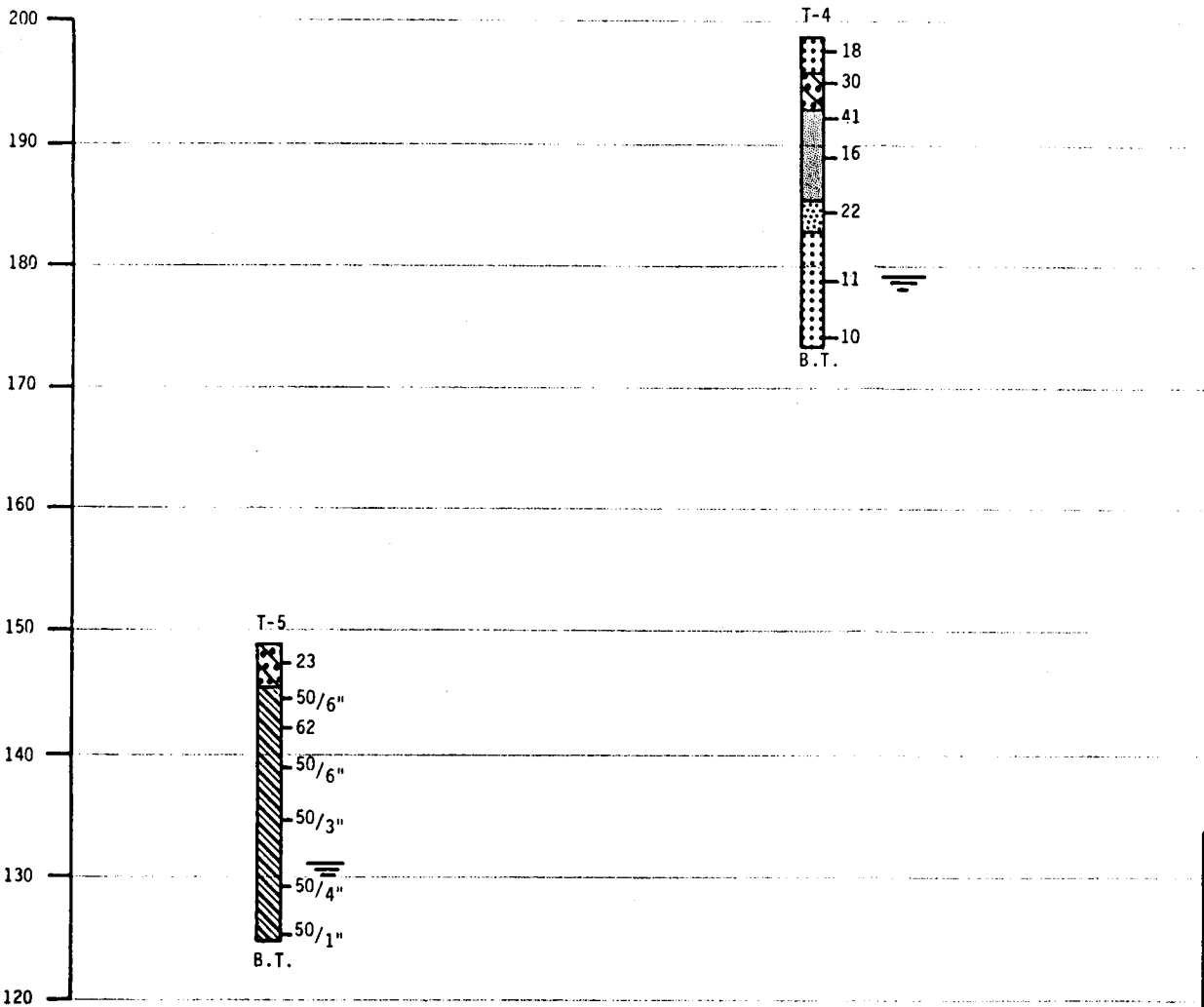
SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

Johnston County Landfill Extension	DRWN. BY: MEM	CHKD. BY: EFP
	JOB NO.: 51-82-104-A	DATE: 11-15-82
	SCALE: As Shown	SHEET 4 OF 9

SECTION B - B'

SCALE: Horizontal: 1" = 150'
Vertical: 1" = 10'

SEE SHEET 2 FOR LEGEND

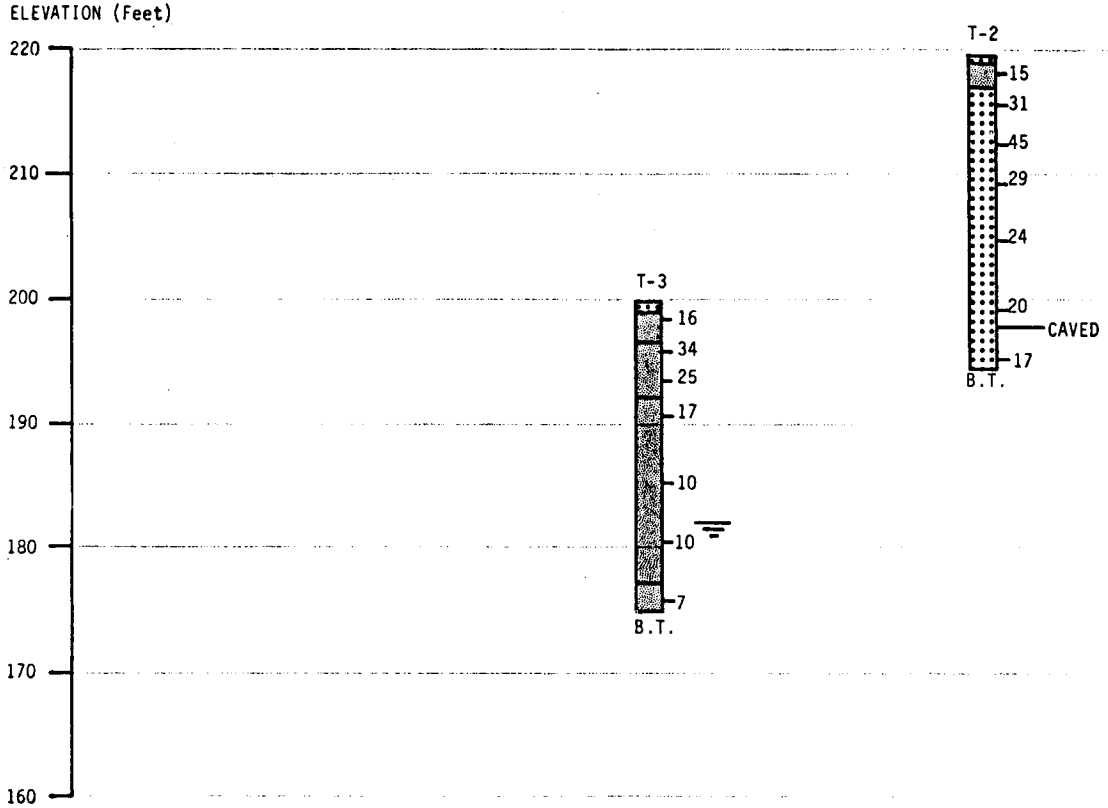


SOIL & MATERIAL ENGINEERS, INC. RALEIGH, NORTH CAROLINA		
Johnston County Landfill Expansion	DRWN. BY: MEM	CHKD. BY: EFP
	JOB NO.: 51-82-104-A	DATE: 11-15-82
	SCALE: As Shown	SHEET 5 OF 9

SECTION C-C'

SCALE: Horizontal: 1" = 150'
Vertical: 1" = 10'

SEE SHEET 2 FOR LEGEND



SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

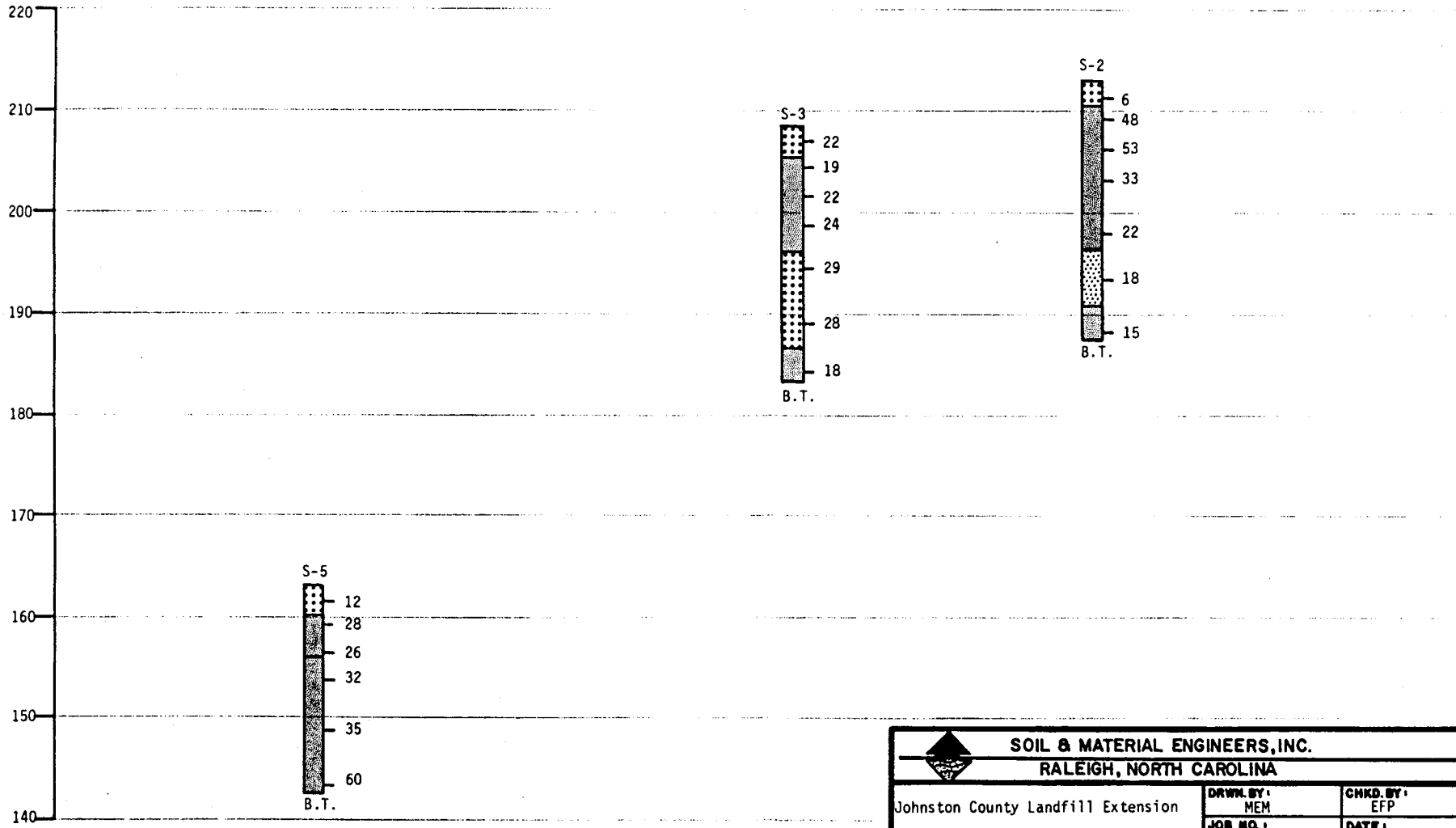
Johnston County Landfill Expansion	DRWN. BY: MEM	CHKD. BY: EFP
	JOB NO.: 51-82-104-A	DATE: 11-15-82
	SCALE: As Shown	SHEET 6 OF 9

DUNCAN-PARNELL, INC., RALEIGH 681

SECTION D-D'

SCALE: Horizontal: 1" = 150'
Vertical: 1" = 10'

SEE SHEET 2 FOR LEGEND



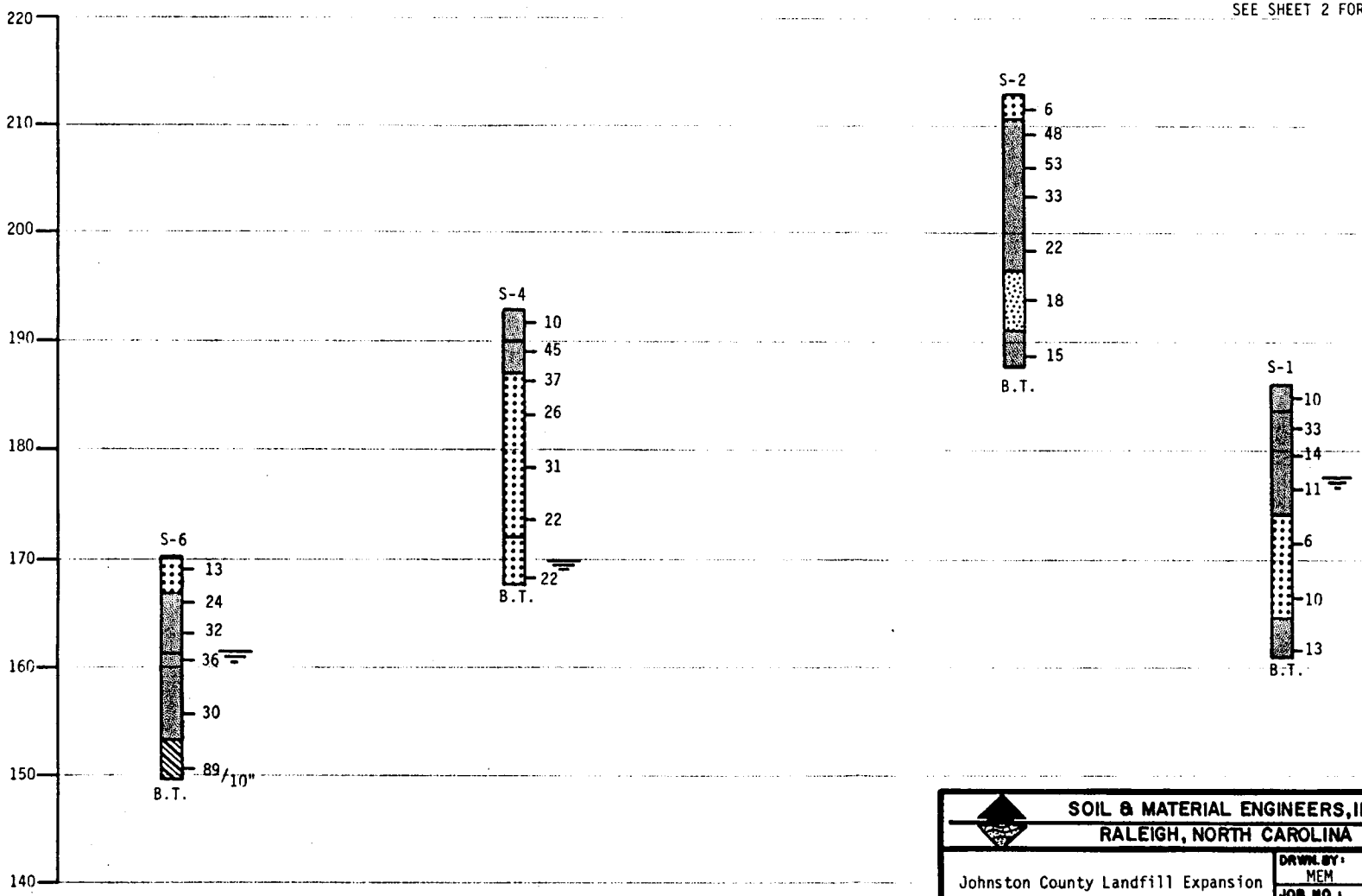
SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

Johnston County Landfill Extension	DRWN. BY: MEM	CHKD. BY: EFP
	JOB NO.: 51-82-104-A	DATE: 11-15-82
	SCALE: As Shown	SHEET 7 OF 9

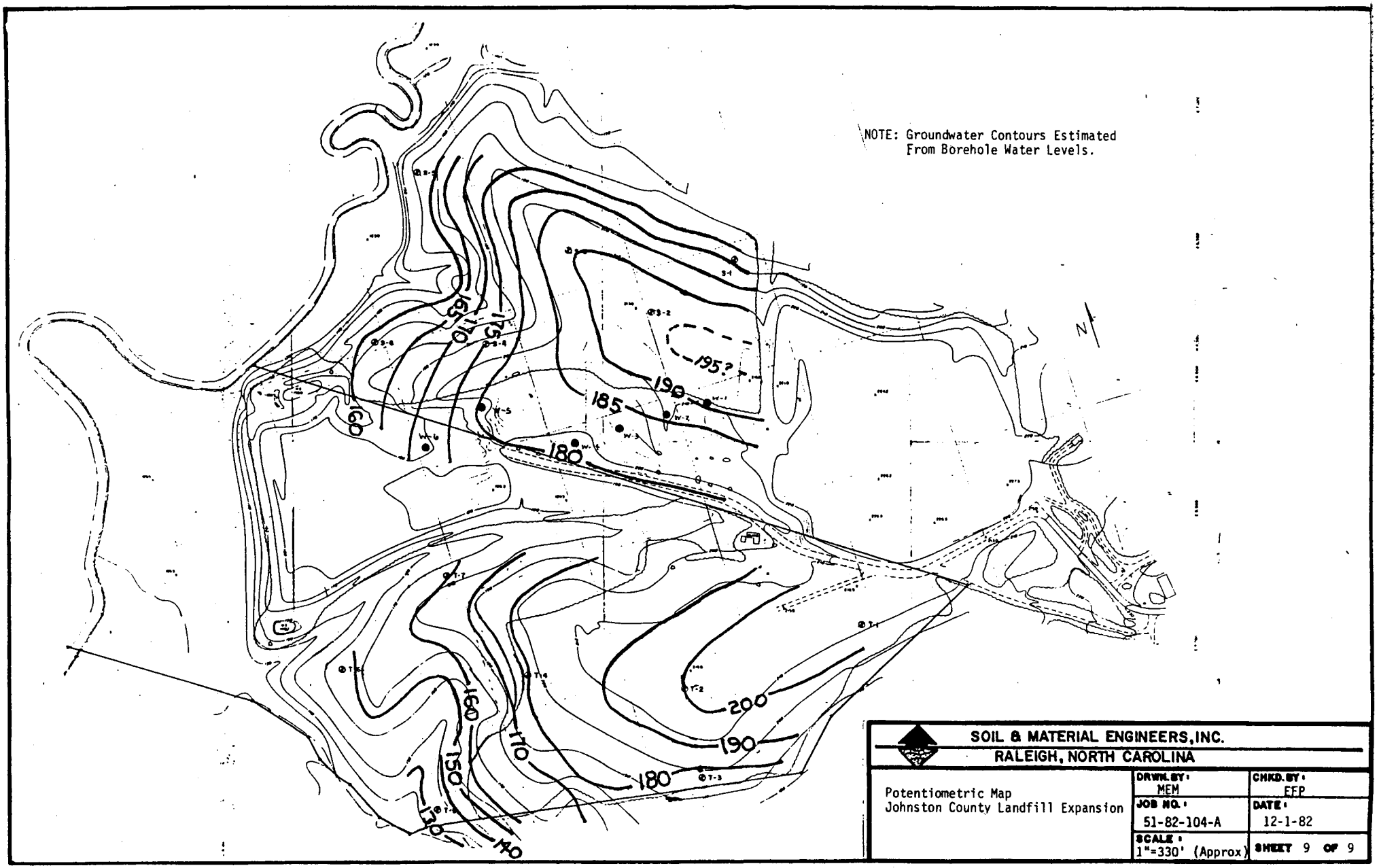
SECTION E - E'

SCALE: Horizontal: 1" = 150'
Vertical: 1" = 10'

SEE SHEET 2 FOR LEGEND



SOIL & MATERIAL ENGINEERS, INC. RALEIGH, NORTH CAROLINA		
Johnston County Landfill Expansion	DRWN. BY: MEM	CHKD. BY: EFP
	JOB NO.: 51-82-104-A	DATE: 11-15-82
	SCALE: As Shown	SHEET 8 OF 9



SOIL & MATERIAL ENGINEERS, INC.
RALEIGH, NORTH CAROLINA

Potentiometric Map
Johnston County Landfill Expansion

DRWN. BY: MEM	CHKD. BY: EFP
JOB NO.: 51-82-104-A	DATE: 12-1-82
SCALE: 1"=330' (Approx)	SHEET 9 OF 9

DUNCAN-PARNELL, INC., RALEIGH NC

TABLE I
BORE HOLE WATER LEVELS
JOHNSTON COUNTY LANDFILL EXPANSION
S&ME JOB NO. 051-82-104-A

WATER LEVELS (FEET)

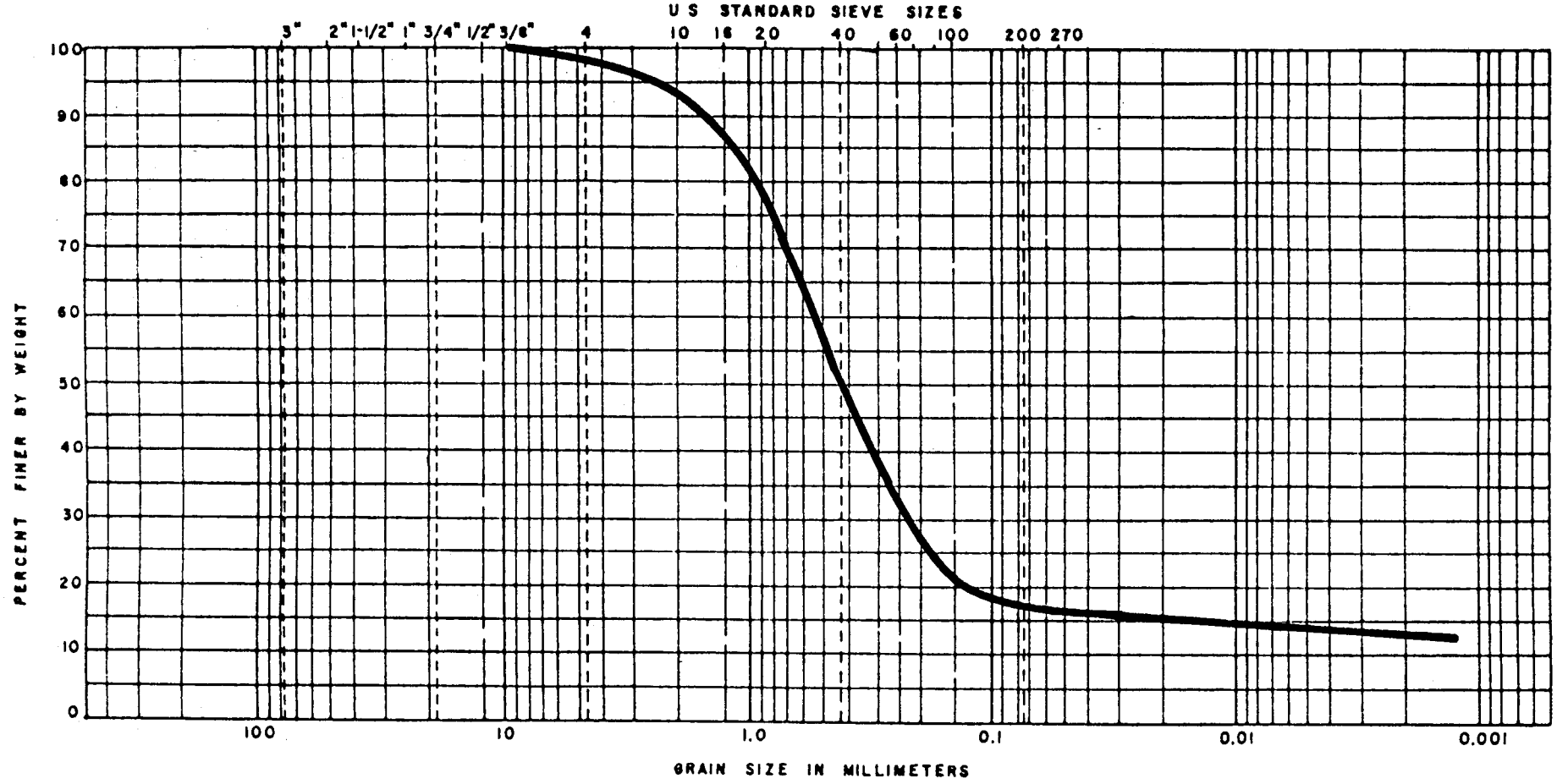
Test Boring	Surface Elev.	0 Hours		Follow up Reading			9-27-82		10-6-82		11-22-82	
		Depth	Elev.	Time	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
T-1	212.99	12.5	200.5	3 HR	10.0	203.0	---	---	9.5	203.5	9.2	203.8
T-2	219.72	22.5*	197.2	24 HR	19.2*	200.5	---	---	19.2*	200.5	---	---
T-3	199.81	19.0	180.8	24 HR	18.0	181.8	---	---	19.0*	180.8	18.0	181.8
T-4	199.00	22.0	177.0	24 HR	19.5	179.5	19.0	180.0	22.0	177.0	20.2*	178.8
T-5	149.16	**	---	---	---	---	18.0	131.2	18.0	131.2	14.5	134.7
T-6	166.22	**	---	---	---	---	16.5	149.7	18.0	148.2	18.4*	147.8
T-7	176.02	18.5	157.5	---	---	---	19.0	157.0	18.0	158.0	16.7	159.3
S-1	186.10	8.5	177.6	---	---	---	8.0	178.1	8.5	177.6	---	---
S-2	213.09	**	---	---	---	---	19.0	194.1	21.5*	191.6	---	---
S-3	208.75	**	---	---	---	---	22.0*	164.8	22.0*	164.8	19.0*	167.8
S-4	192.99	23.0	170.0	10 HR	18.0	175.0	---	---	19.0*	174.0	19.0*	174.0
S-5	163.14	**	---	5 HR	**	---	16.5	146.6	---	---	6.5	156.6
S-6	170.10	**	---	4 HR	**	---	17.5	152.6	9.0	161.1	9.0	161.1

* Borehole Caved To Depth Indicated With No Water
**No Water In Borehole To Depth Drilled

TABLE II
TEST DATA SUMMARY
JOHNSTON COUNTY LANDFILL EXPANSION
S&ME JOB NO. 051-82-104-A

Boring No.	Type Sample	Depth (FT.)	Natural Moisture (%)	Specific Gravity	Liquid Limit	Plasticity Index	Saturated Hydraulic Conductivity (cm/sec)	Porosity
T-2	Bulk	0-10	11.9	2.67	34.5	13.1	1.2×10^{-5}*	0.351*
T-4	Bulk	0-10	12.7	--	22.1	3.4	--	--
S-2	Bulk	0-10	9.5	2.67	N.P	N.P	1.5×10^{-5}*	0.433*
T-4	Split Spoon	17.5-18.0	24.0	2.67	--	--	2.4×10^{-5}**	--
S-4	Split Spoon	16.5-17.0	19.4	2.67	--	--	6.2×10^{-5}**	--

* : Remolded Sample Compacted To Approximately 90% Of Maximum Dry Density
** : Field Test Results At Sample Location



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
S-2	0.0'-10.0' (Bag Sample)	9.5%	N.P.	N.P.	---	Tan Slightly Clayey Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

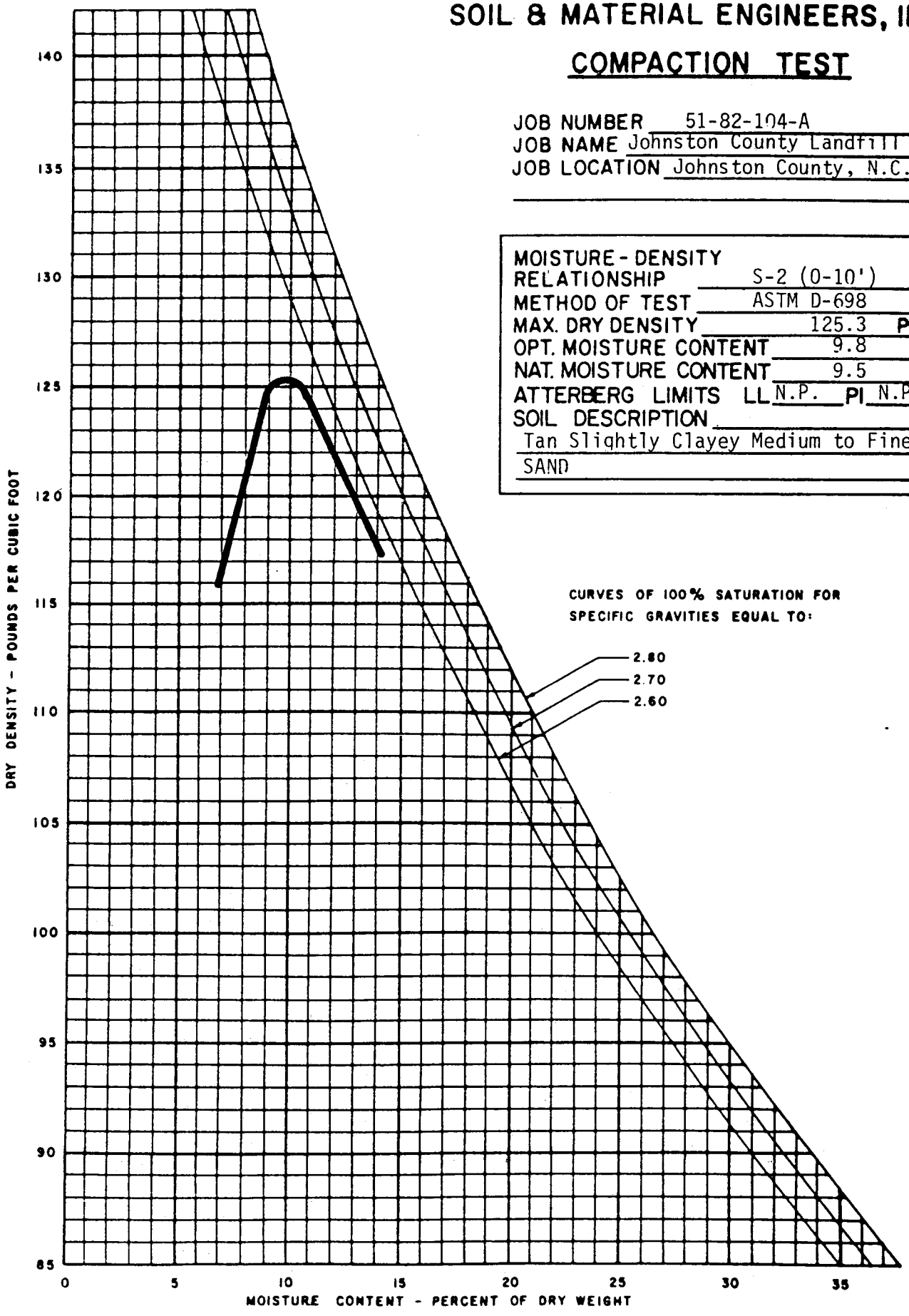
DUNCAN-PARNELL, INC., RALEIGH 781

SOIL & MATERIAL ENGINEERS, INC.

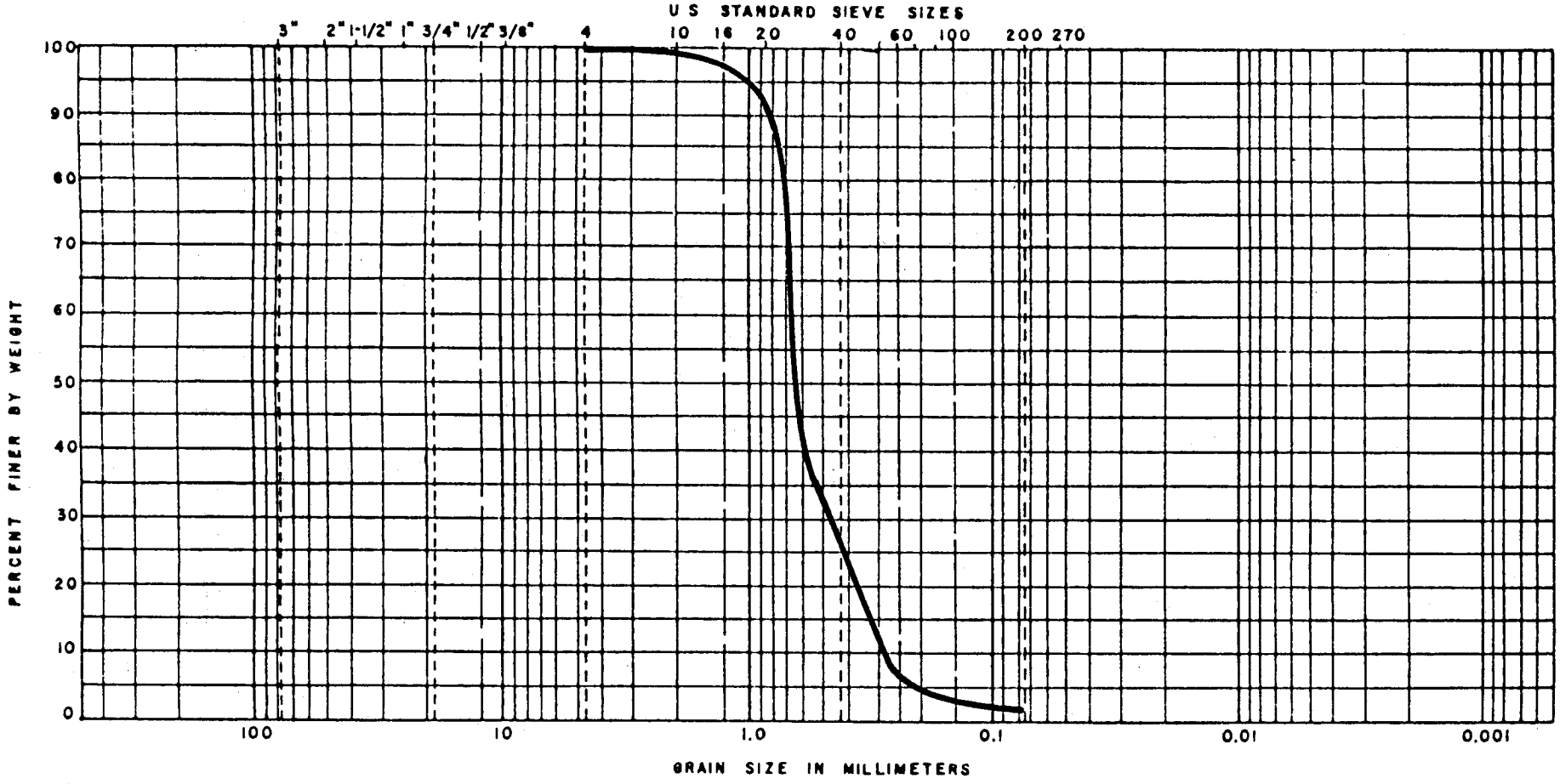
COMPACTION TEST

JOB NUMBER 51-82-104-A
JOB NAME Johnston County Landfill Expansion
JOB LOCATION Johnston County, N.C.

MOISTURE - DENSITY RELATIONSHIP	S-2 (0-10')	
METHOD OF TEST	ASTM D-698	
MAX. DRY DENSITY	125.3	PCF
OPT. MOISTURE CONTENT	9.8	%
NAT. MOISTURE CONTENT	9.5	%
ATTERBERG LIMITS LL	N.P. PI	N.P.
SOIL DESCRIPTION	Tan Slightly Clayey Medium to Fine SAND	



DUNCAN-PARNELL, INC., RALEIGH 980



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

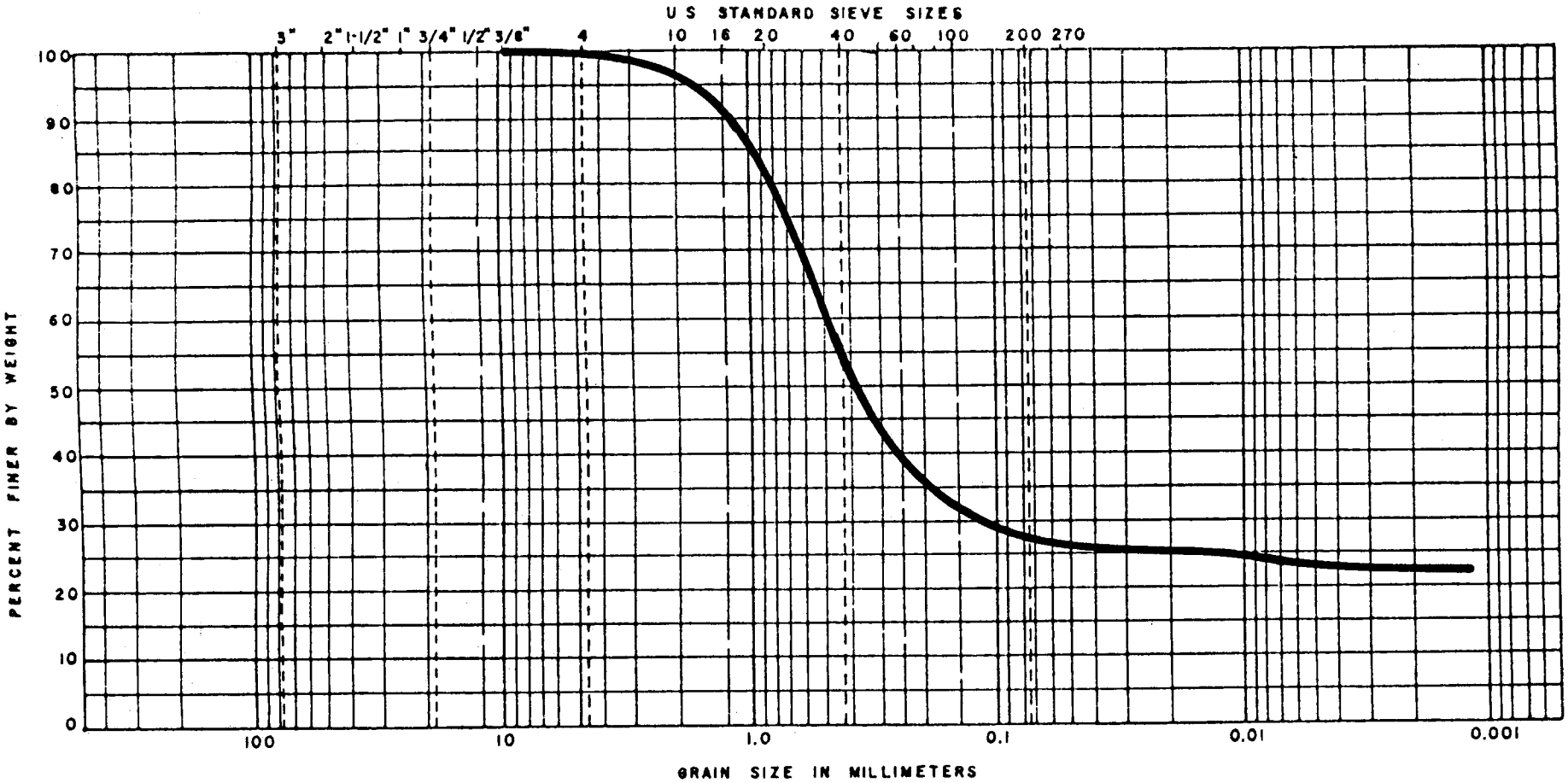
BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
S-4	16.5'-17.0'	19.4				Brown Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DUNCAN-PARNELL, INC., RALEIGH 982



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
T-2	0.0'-10' (Bag Sample)	11.9%	34.5	21.4	13.1	Red to Tan Clayey Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

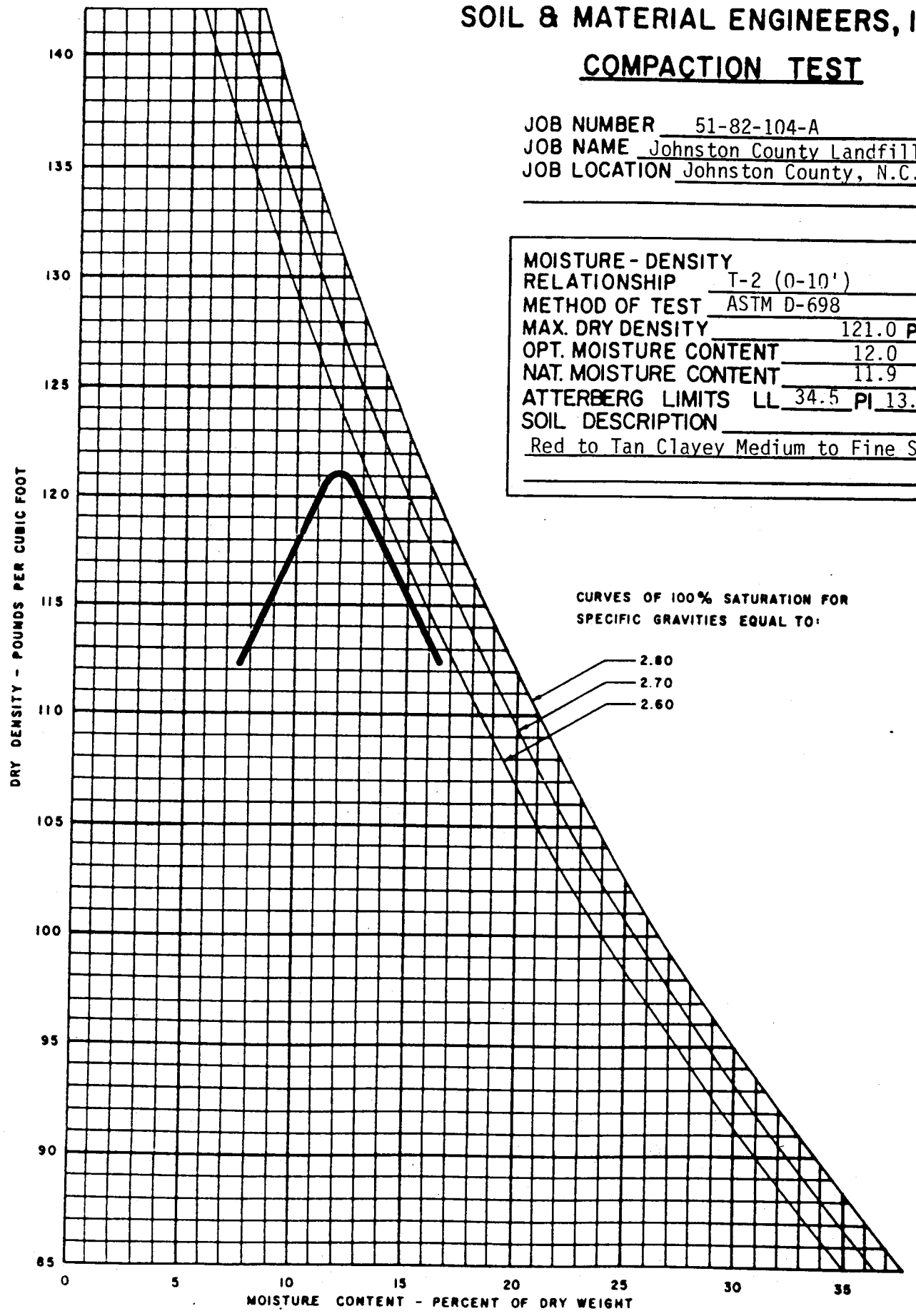
DUNCAN-PARNELL, INC., RALEIGH 982

SOIL & MATERIAL ENGINEERS, INC.

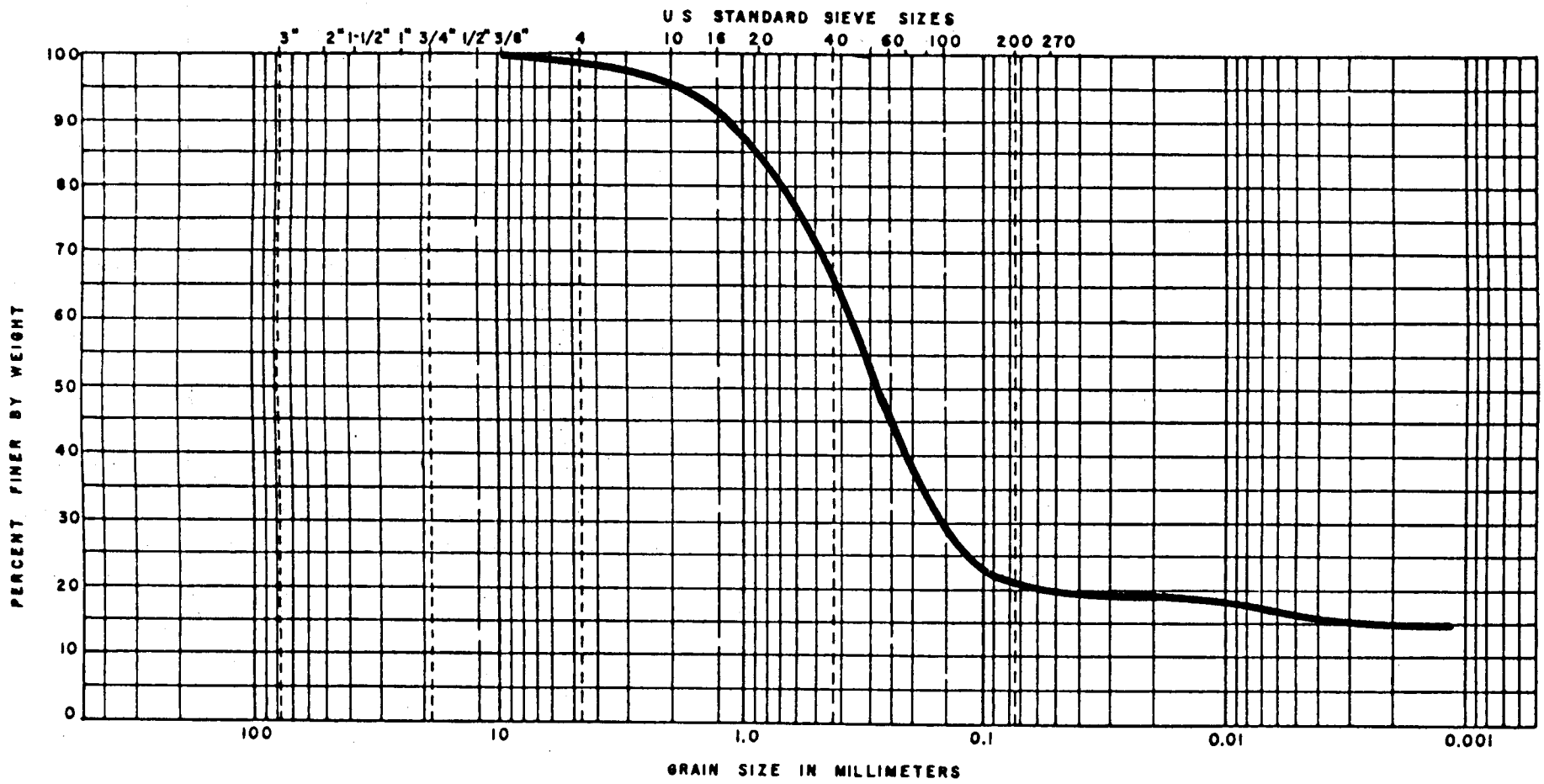
COMPACTION TEST

JOB NUMBER 51-82-104-A
JOB NAME Johnston County Landfill Expansion
JOB LOCATION Johnston County, N.C.

MOISTURE - DENSITY RELATIONSHIP	T-2 (0-10')
METHOD OF TEST	ASTM D-698
MAX. DRY DENSITY	121.0 PCF
OPT. MOISTURE CONTENT	12.0 %
NAT. MOISTURE CONTENT	11.9 %
ATTERBERG LIMITS	LL 34.5 PI 13.1
SOIL DESCRIPTION	Red to Tan Clayey Medium to Fine SAND



DUNCAN-PARNELL, INC., RALEIGH 980



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
T-4	0.0'-10.0' (Bag Sample)	12.7	22.1	18.7	3.4	Tan Slightly Clayey Medium to Fine SAND

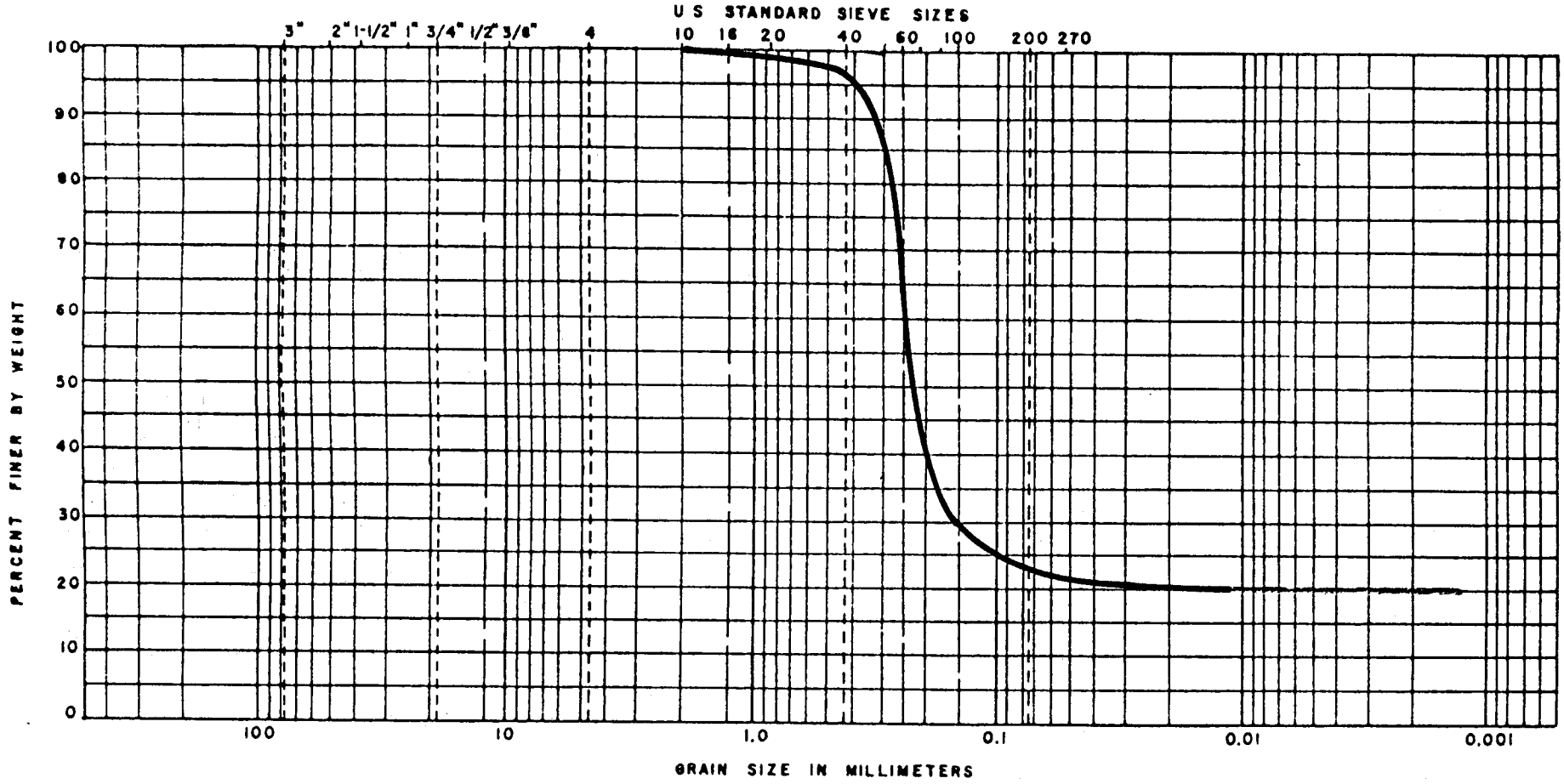
GRAIN SIZE DISTRIBUTION

JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DUNCAN-PARNELL, INC., RALEIGH 781

SM-19



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

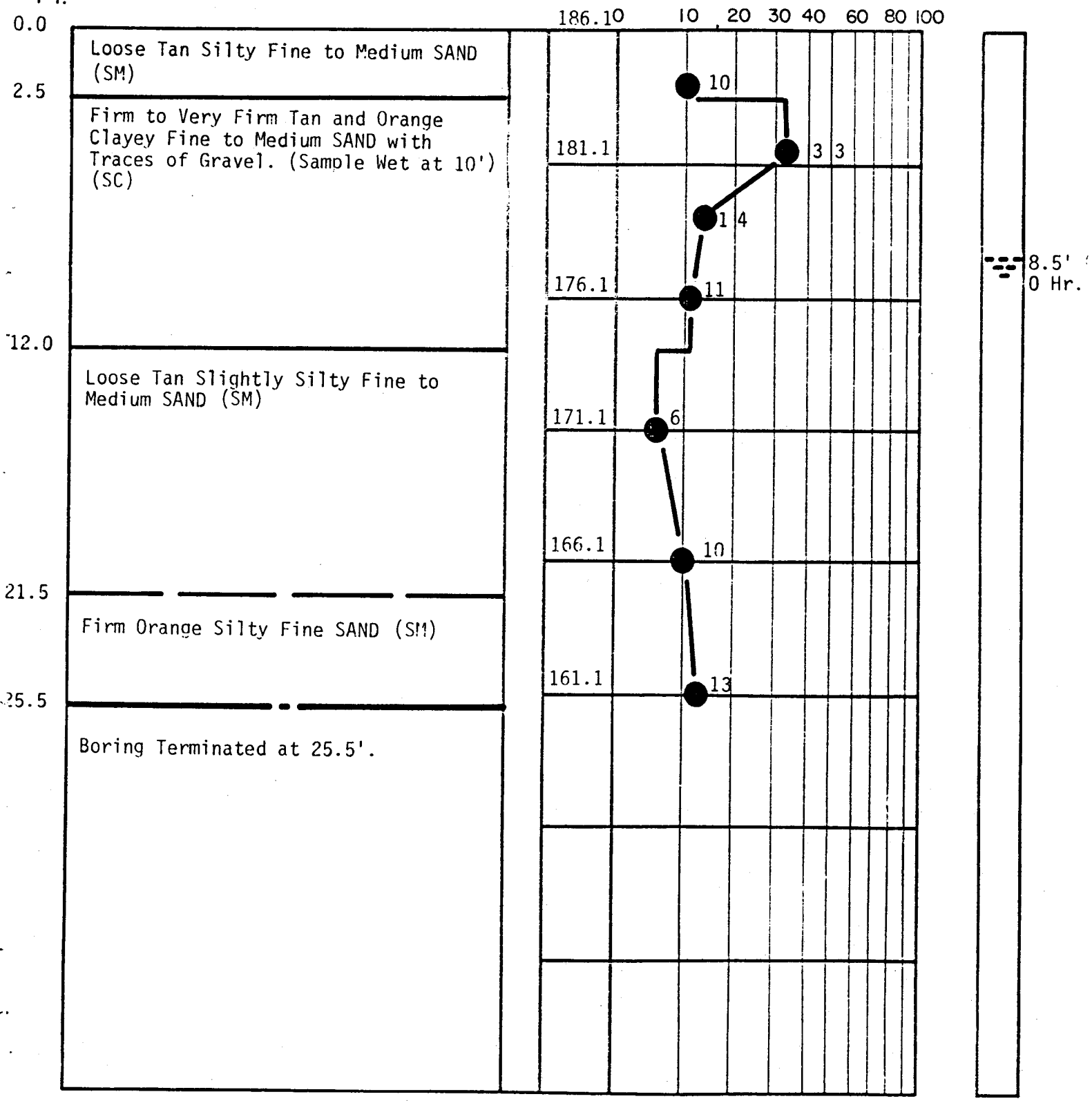
BORING NO	ELEV. OR DEPTH	NAT WC	LL	PL	PI	DESCRIPTION OR CLASSIFICATION
T-4	17.5'-18.0'	24%				Tan Clayey Medium to Fine SAND

GRAIN SIZE DISTRIBUTION

JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DUNCAN-PARNELL, INC., RALEIGH 982



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

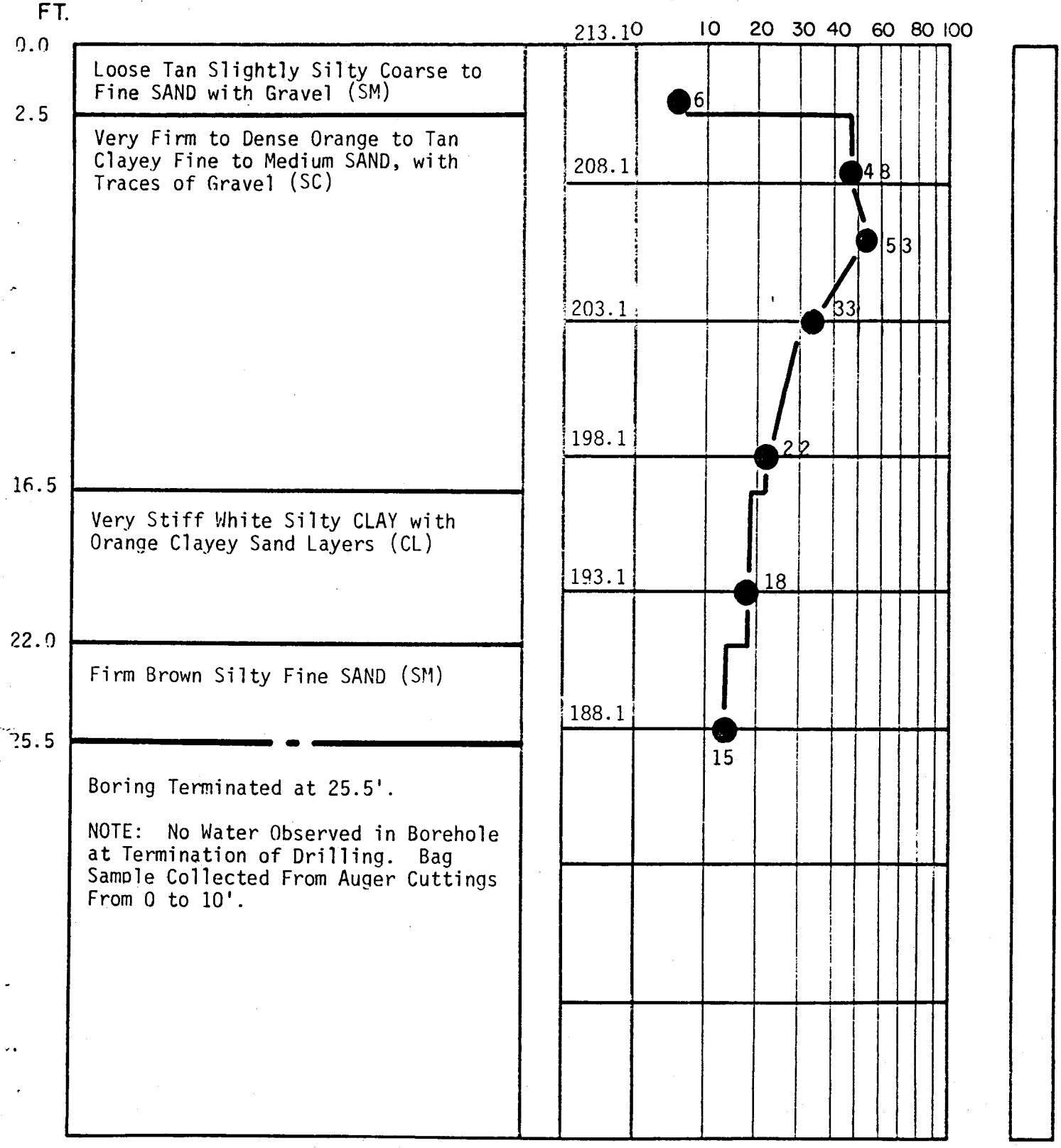
UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. S-1
DATE DRILLED 9-23-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

SM-14



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. S-2
DATE DRILLED 9-23-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION–BLOWS PER FT.
		208.8	0 10 20 30 40 60 80 100
0.0	Firm Tan Slightly Silty Coarse to Fine SAND and GRAVEL (SM)		2 2
3.0	Very Firm Red Clayey Fine to Medium SAND (SC)	203.8	19
			2 2
		198.8	2 4
12.5	Very Firm Orange Slightly Silty Fine to Medium SAND (SM)	193.8	29
		188.8	28
22.0	Firm Orange Silty Fine SAND (SM)	183.8	18
25.5	Boring Terminated at 25.5'. NOTE: No Water Observed in Borehole at Termination of Drilling.		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
◀ LOSS OF DRILLING WATER
WATER TABLE–24 HR.
WATER TABLE–1 HR.

TEST BORING RECORD

BORING NO. S-3
DATE DRILLED 9-23-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION–BLOWS PER FT. 0 10 20 30 40 60 80 100
0.0	Loose Gray Silty Fine to Medium SAND (SM)	193.0	10
3.0	Dense Silty Coarse to Fine SAND (SM)	188.0	4 5
6.0	Very Firm to Dense Orange Slightly Clayey Fine to Medium SAND. (SC) (Sample Wet at 20')	183.0	37 26
		178.0	31
		173.0	22
21.0	Very Firm Tan Slightly Clayey Fine to Medium SAND, with Occasional White Fine Sandy CLAY Layers (SC)	168.0	22
25.5	Boring Terminated at 25.5'. NOTE: Attempted Undisturbed Sample Form 17 to 19'; No Recovery.		

23' @ 0 Hr.

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

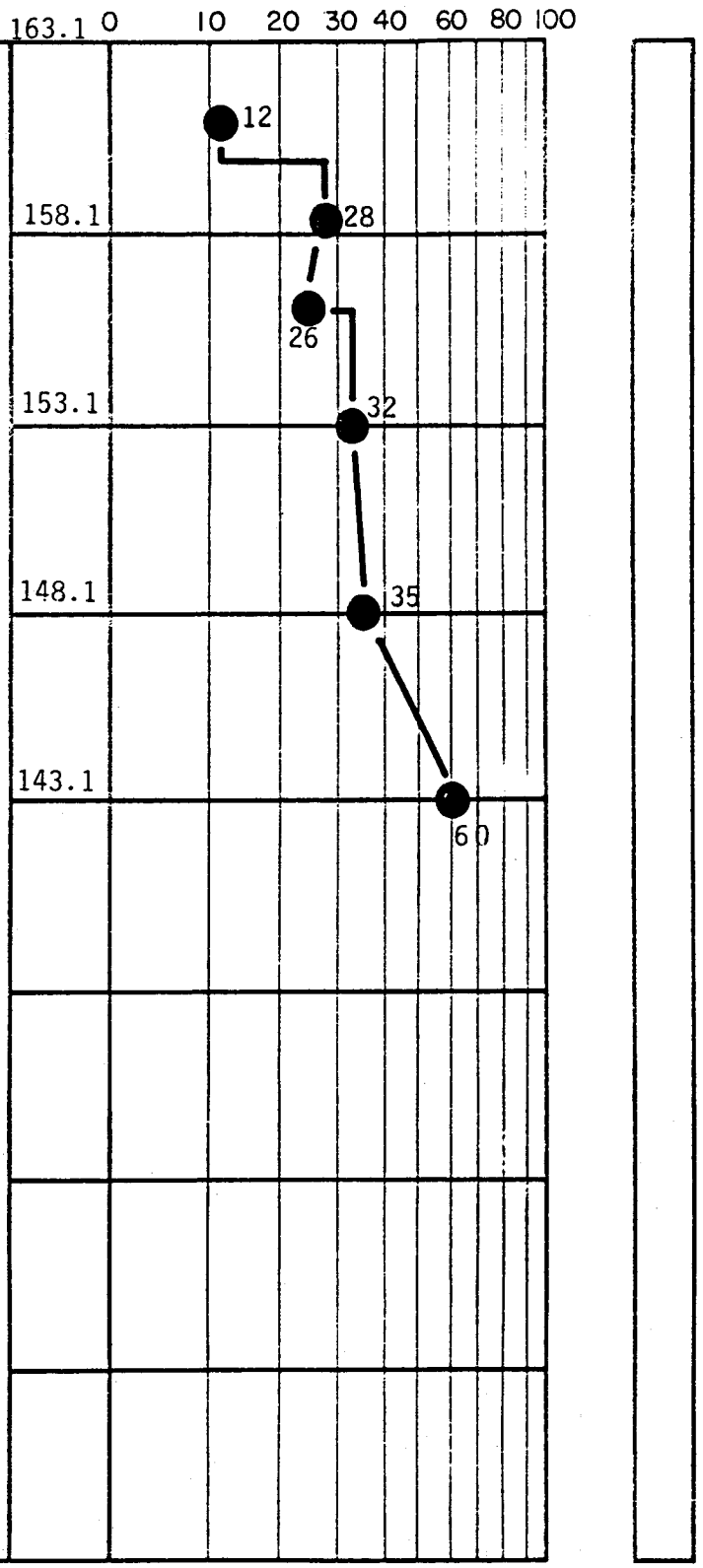
■ UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
◀ LOSS OF DRILLING WATER
WATER TABLE–24HR.
WATER TABLE–1HR.

TEST BORING RECORD

BORING NO. S-4
DATE DRILLED 9-27-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.
0.0	Firm Tan Slightly Silty Fine to Medium SAND (SM)	163.1
3.0	Very Firm Tan and Orange Clayey Fine to Medium SAND (SC)	158.1
7.0	Dense to Very Dense Orange to Yellow Silty Fine SAND. Grades to Gray-Green in Color at 20'. (SM-SC)	153.1
		148.1
		143.1
20.5	Boring Terminated at 20.5'. NOTE: No Water Observed in Borehole at Termination of Drilling and 5 Hours Later. Attempted to Take Undisturbed Sample From 6.0' to 8.0'. No Recovery.	



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

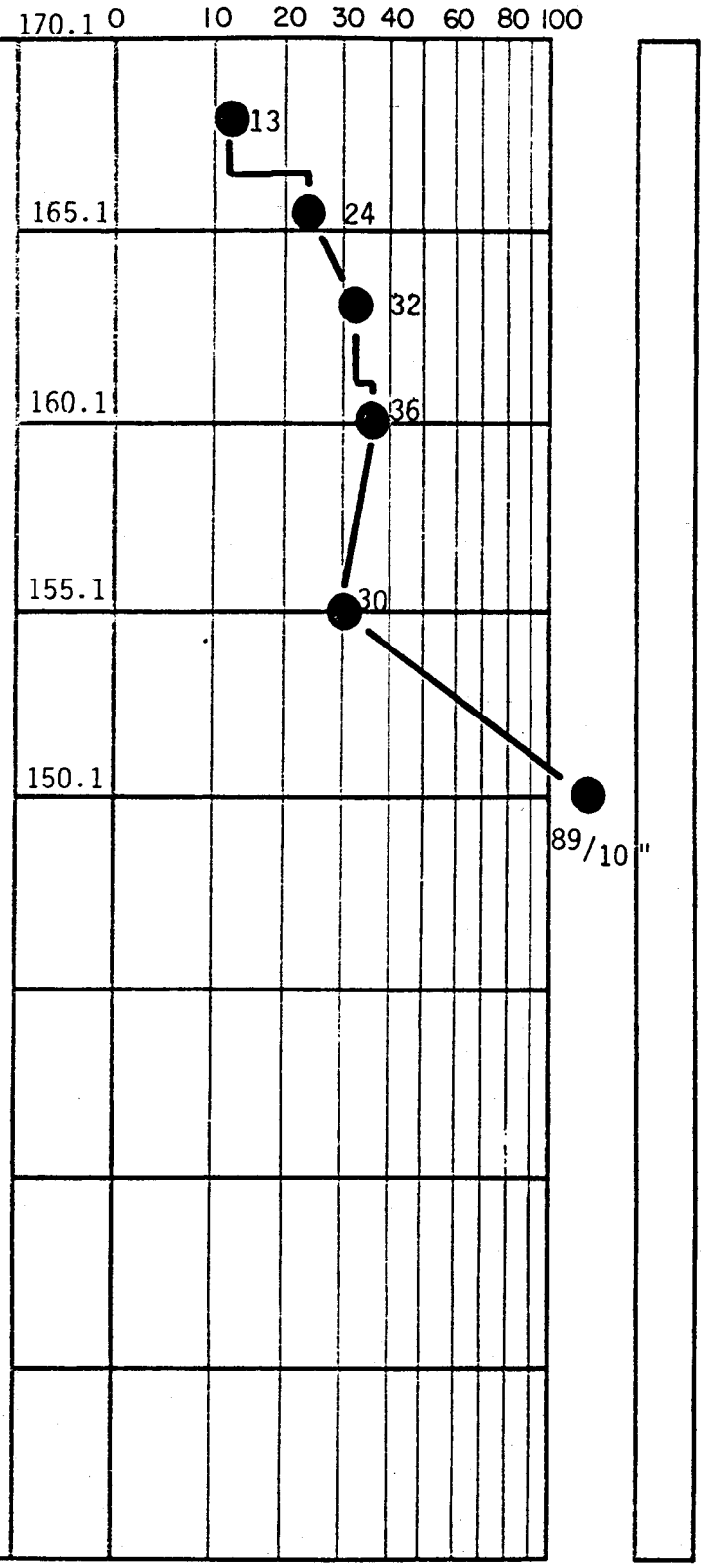
UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
◀ LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. S-5
DATE DRILLED 9-27-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.
0.0	Firm Tan Slightly Silty Fine to Medium SAND (SM)	170.1
3.5	Very Firm Tan to Orange Clayey Fine to Medium SAND (SC)	165.1
9.0	Dense Yellow Silty Fine SAND (SM)	160.1
		155.1
17.0	WEATHERED ROCK. When Disturbed, Appears as a Gray-Green Silty Fine SAND.	150.1
20.5	Boring Terminated at 20.5'. NOTE: No Water Observed in Borehole at Termination of Drilling and 4 Hours Later. Attempted to Take Undisturbed Samole at 14.0'. No Recovery.	



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

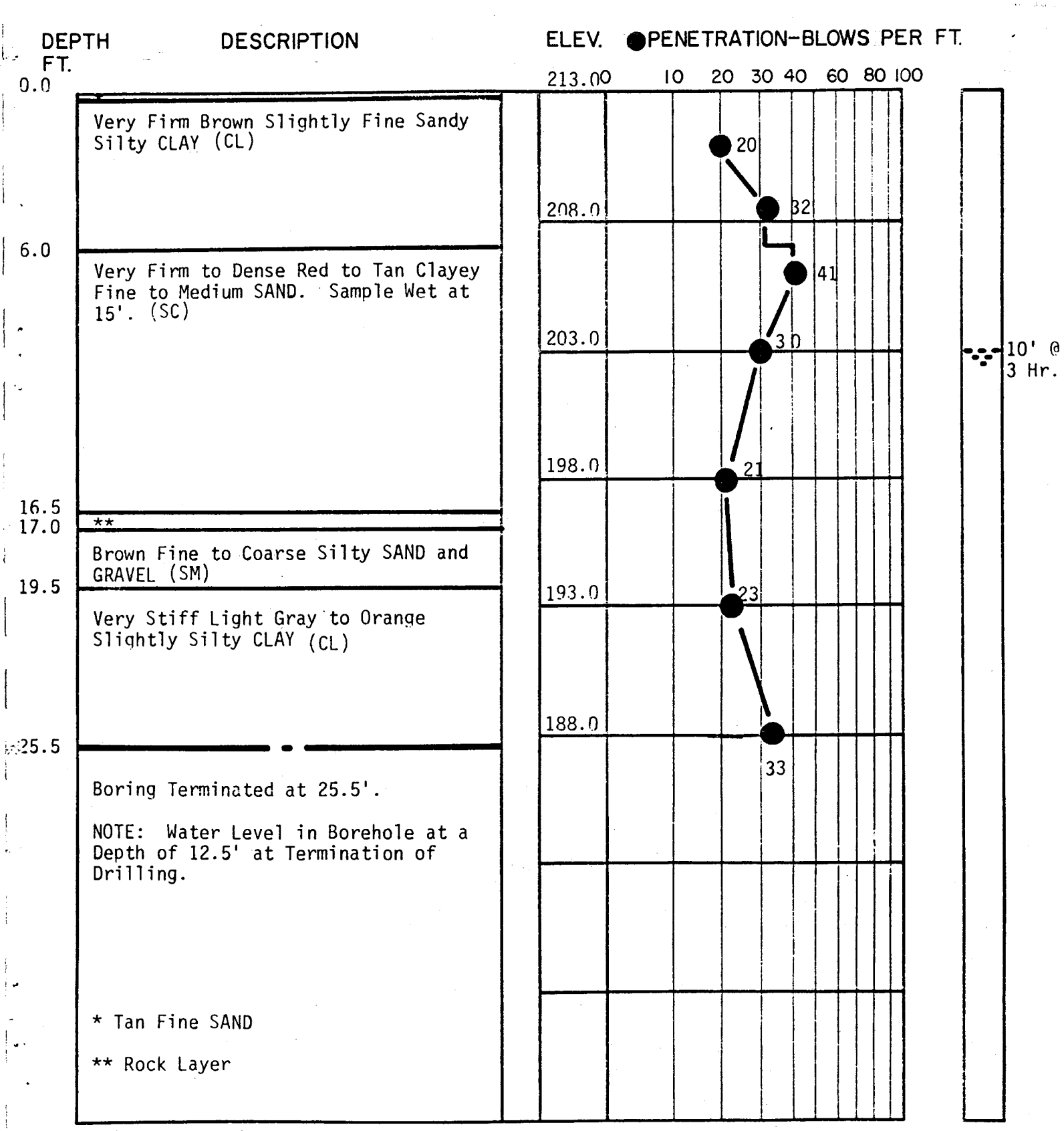
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. S-6
DATE DRILLED 9-27-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. T-1
DATE DRILLED 9-22-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION–BLOWS PER FT. (10 20 30 40 60 80 100)
0.0		219.70	
0.9	Tan Fine SAND (SP)		
	Firm Brown Silty Fine to Medium SAND (SM)		15
3.0	Firm to Dense Red to Brown Slightly Silty to Clayey Fine to Medium SAND with a Trace of Gravel. Sample Wet at 25'. (SC-SM)	214.7	31
			45
		209.7	29
		204.7	24
		199.7	20
		194.7	17
25.5	Boring Terminated at 25.5'.		
	NOTE: Borehole Caved with No Water Visable to a Depth of 22.5' at Boring Termination. Depth of Cave-In After 24 Hours was 22.0'.		
	Bag Sample Collected From Auger Cuttings From 0' to 10.0'		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

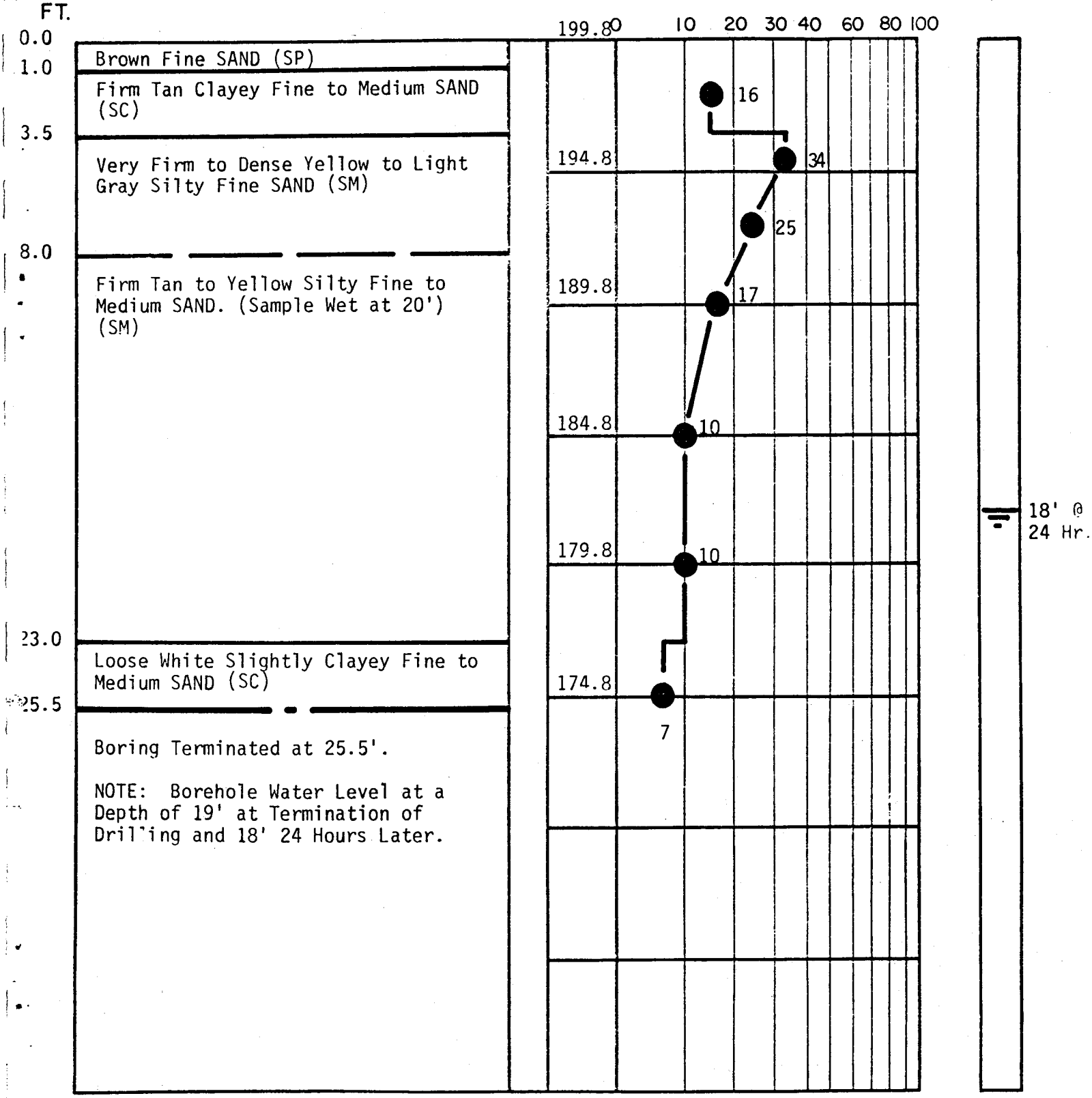
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE–24 HR.
WATER TABLE–1 HR.

TEST BORING RECORD

BORING NO. T-2
DATE DRILLED 9-20-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

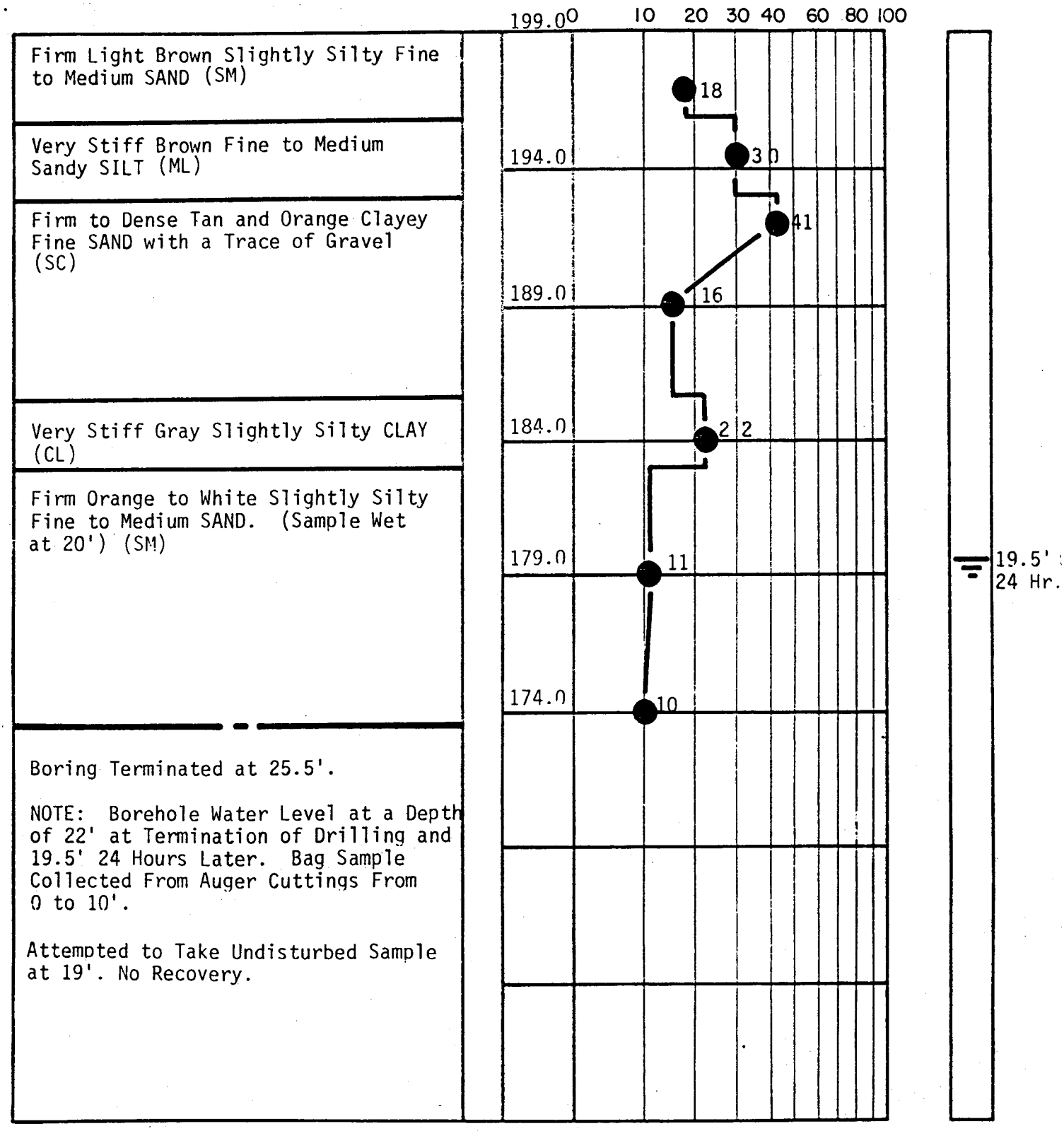
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. T-3
DATE DRILLED 9-20-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

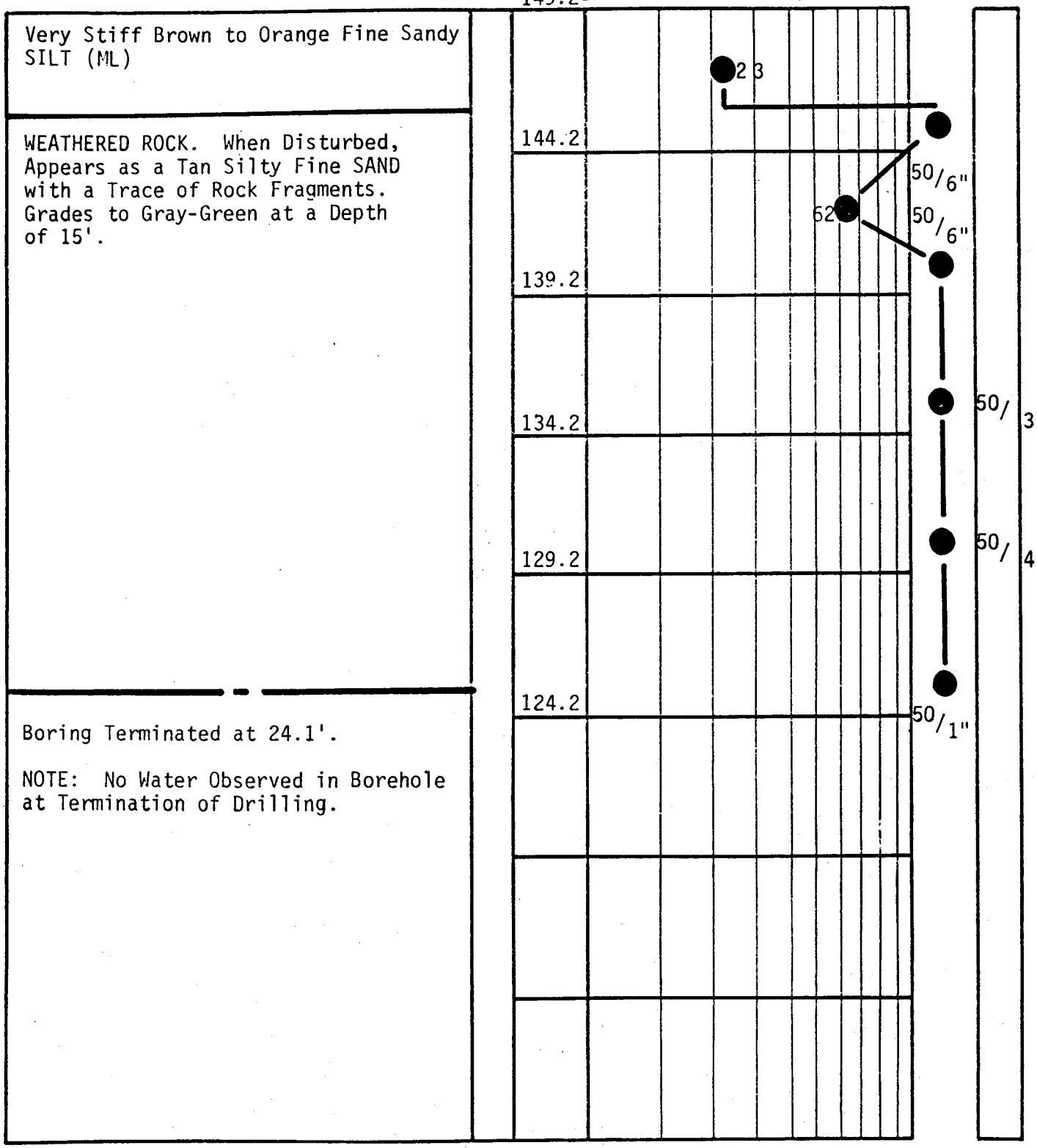
TEST BORING RECORD

BORING NO. T-4
DATE DRILLED 9-22-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.

SM-14

DEPTH FT.	DESCRIPTION	ELEV.	PENETRATION–BLOWS PER FT.
0.0	Very Stiff Brown to Orange Fine Sandy SILT (ML)	149.2	2 3
3.5	WEATHERED ROCK. When Disturbed, Appears as a Tan Silty Fine SAND with a Trace of Rock Fragments. Grades to Gray-Green at a Depth of 15'.	144.2	62 50/6" 50/6"
		139.2	
		134.2	50/3"
		129.2	50/4"
24.1	Boring Terminated at 24.1'. NOTE: No Water Observed in Borehole at Termination of Drilling.	124.2	50/1"



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

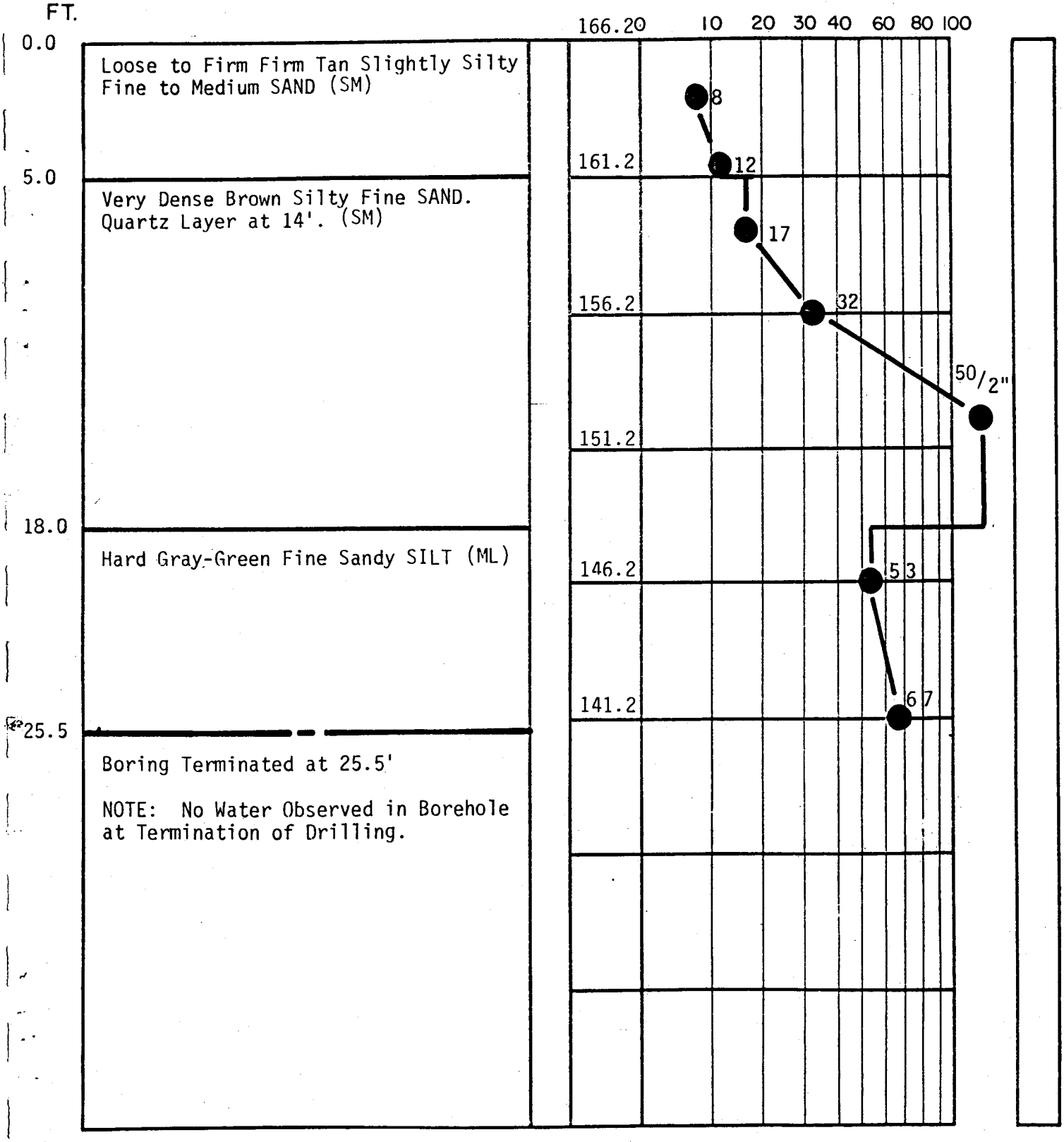
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE–24HR.
WATER TABLE–1HR.

TEST BORING RECORD

BORING NO. T-5
DATE DRILLED 9-22-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

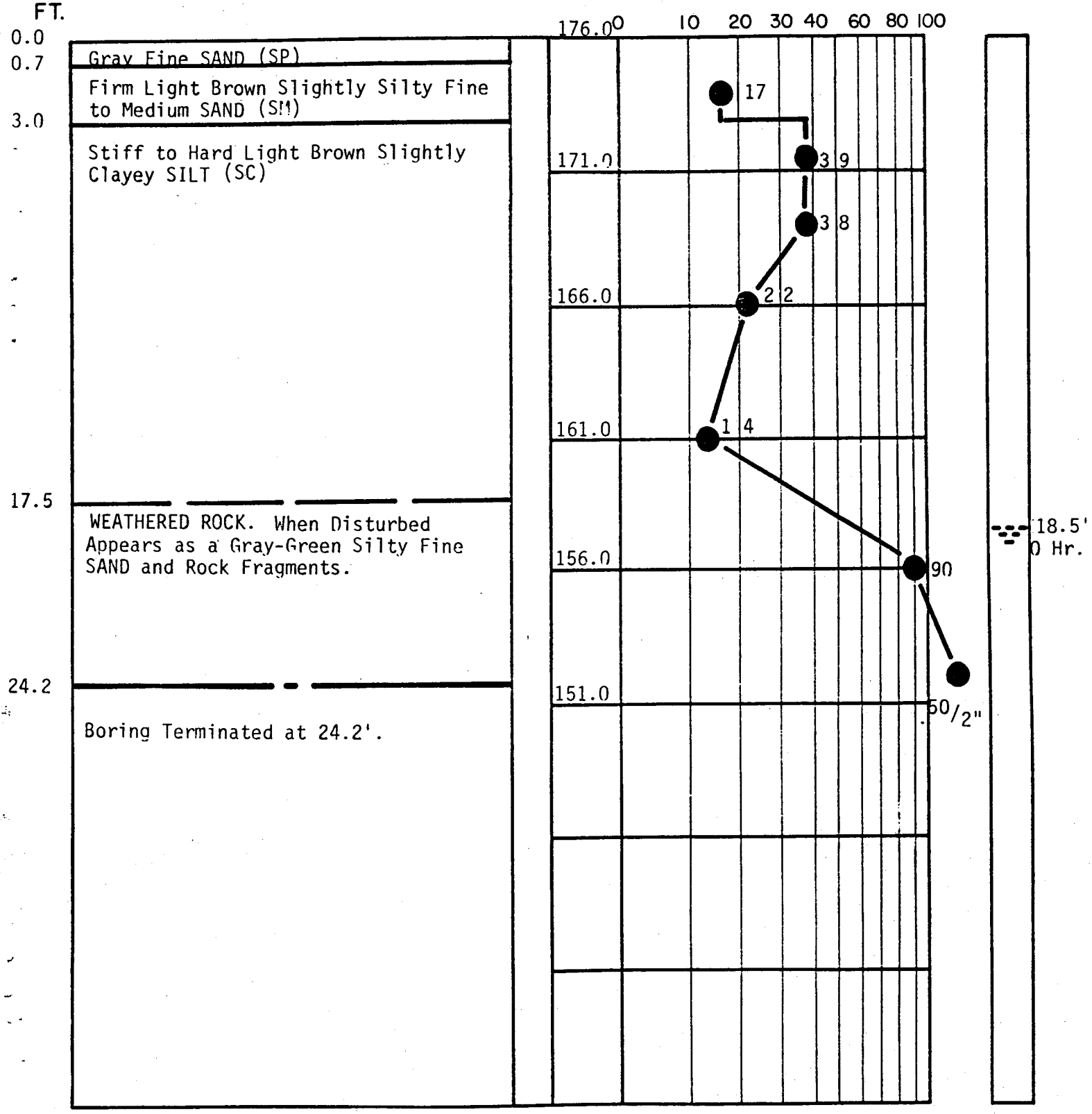
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. T-6
DATE DRILLED 9-22-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

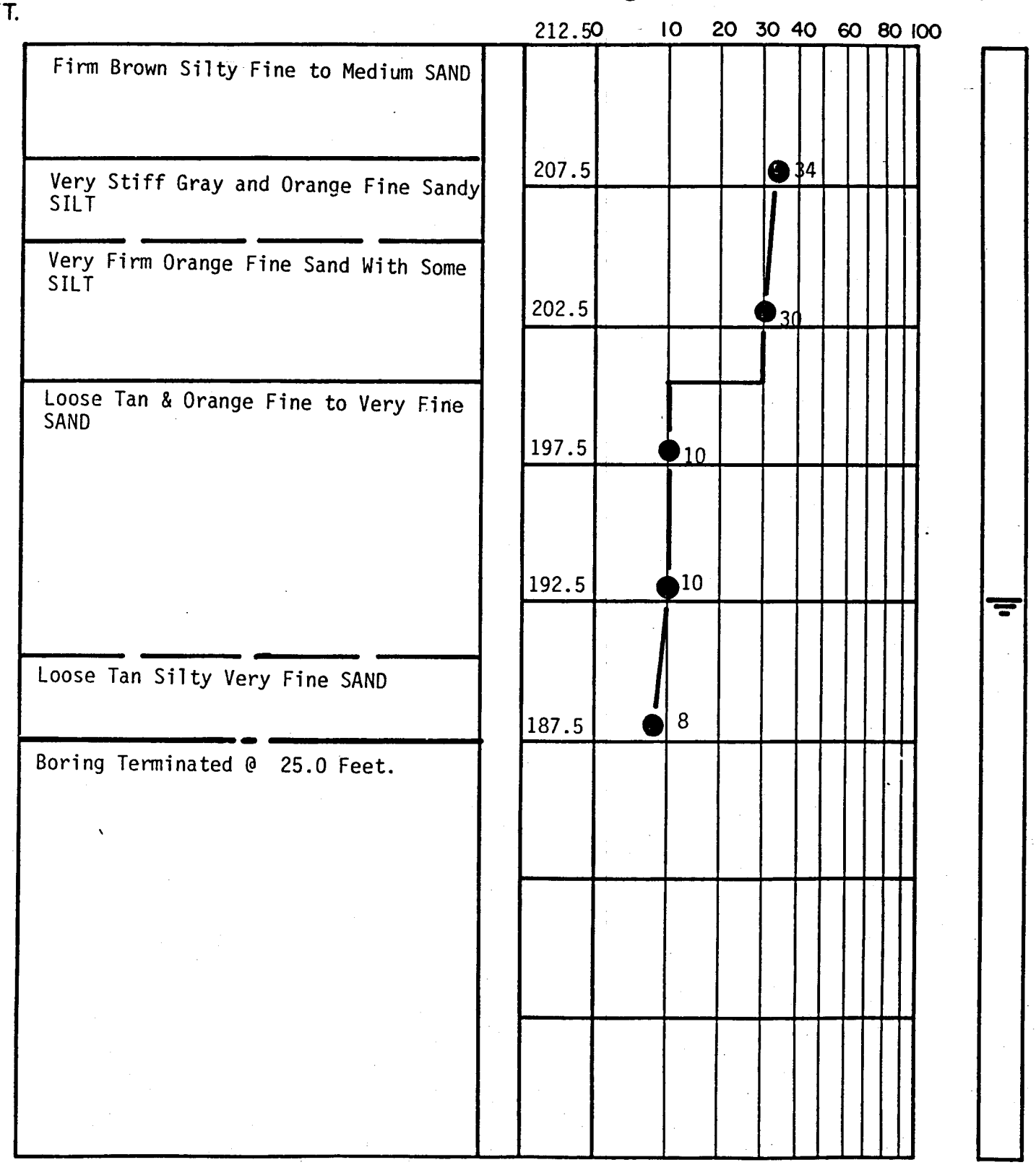
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. I-7
DATE DRILLED 9-23-82
JOB NO. 82-104-A

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

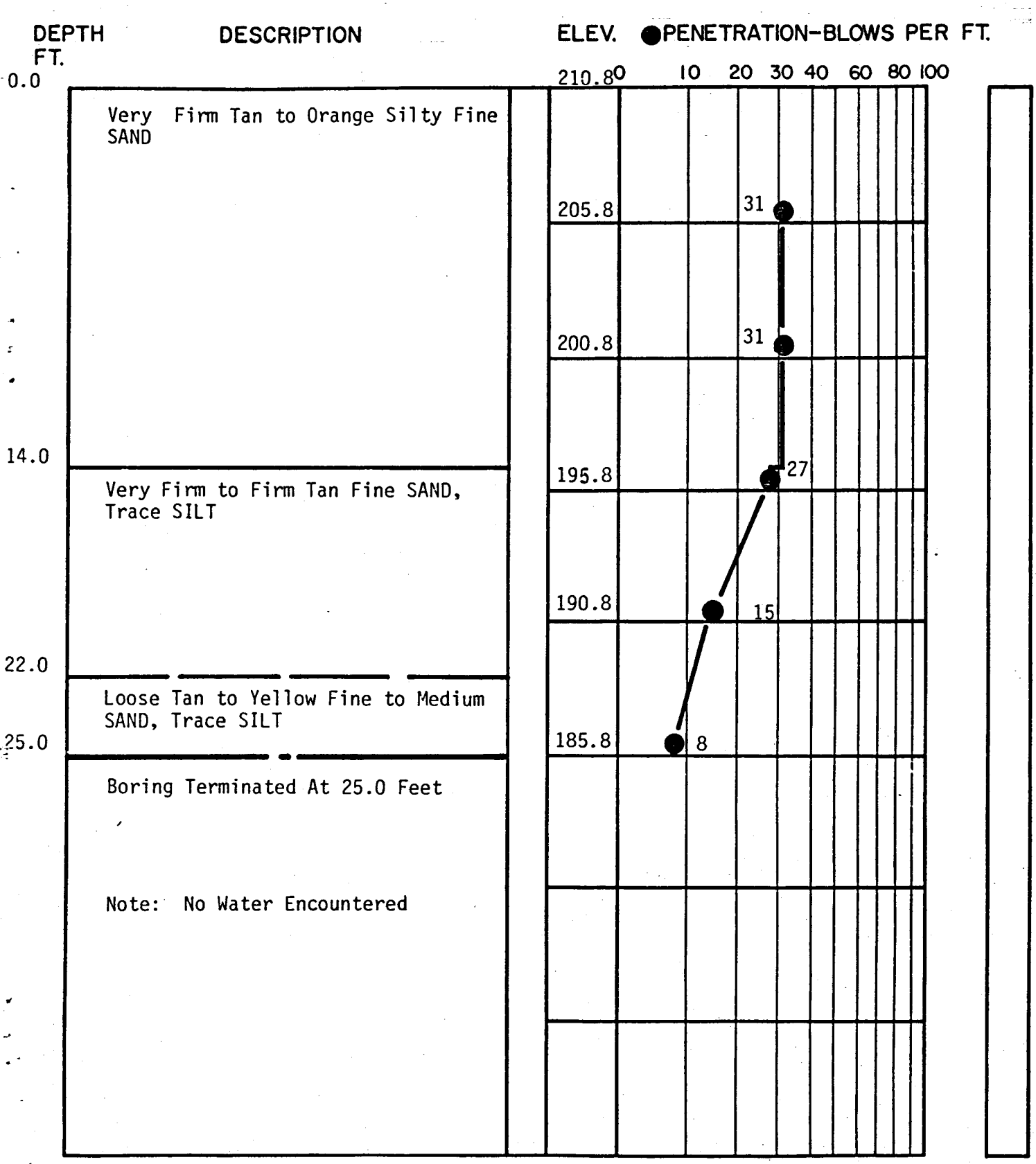
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE 24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. W-1
DATE DRILLED 6-9-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

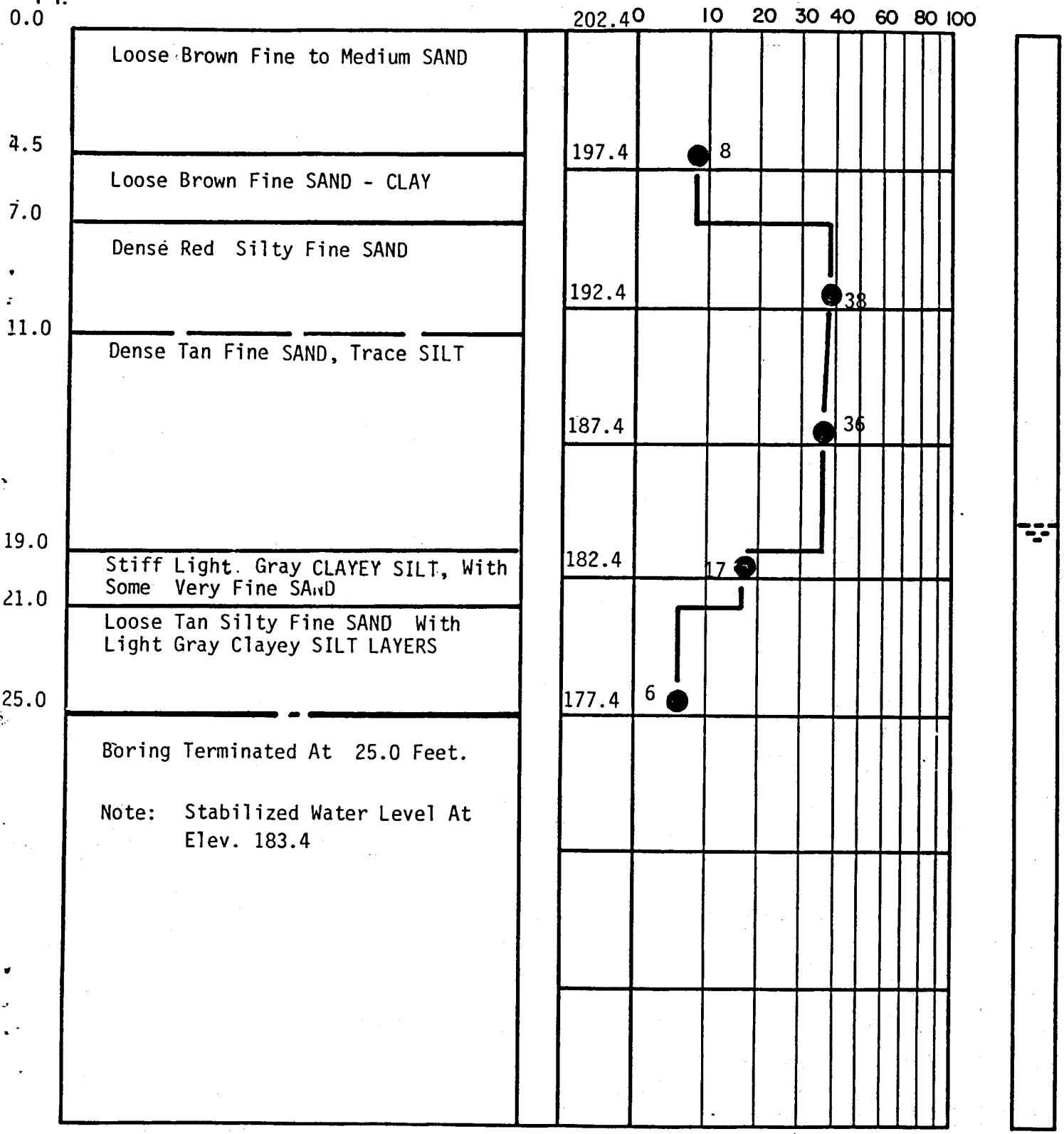
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE 24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. W-2
DATE DRILLED 6-9-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE 24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. W-3
DATE DRILLED 6-10-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.

DEPTH FT.	DESCRIPTION	ELEV.	●PENETRATION–BLOWS PER FT. 10 20 30 40 60 80 100
0.0		207.50	
2.0	Brown Silty Fine SAND		
	Very Stiff Reddish Brown Sandy Clayey SILT	202.5	23
		197.5	15
14.0		192.5	13
	Firm to Very Firm Red Silty Fine to Medium SAND	187.5	31
24.0			
25.0	Firm Tan to Yellow Fine SAND, Some *	182.5	14
	Boring Terminated @ 25.0		
	NOTE: No Water in Bolehole at Termination of Boring After 24 Hours.		
	* SILT		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

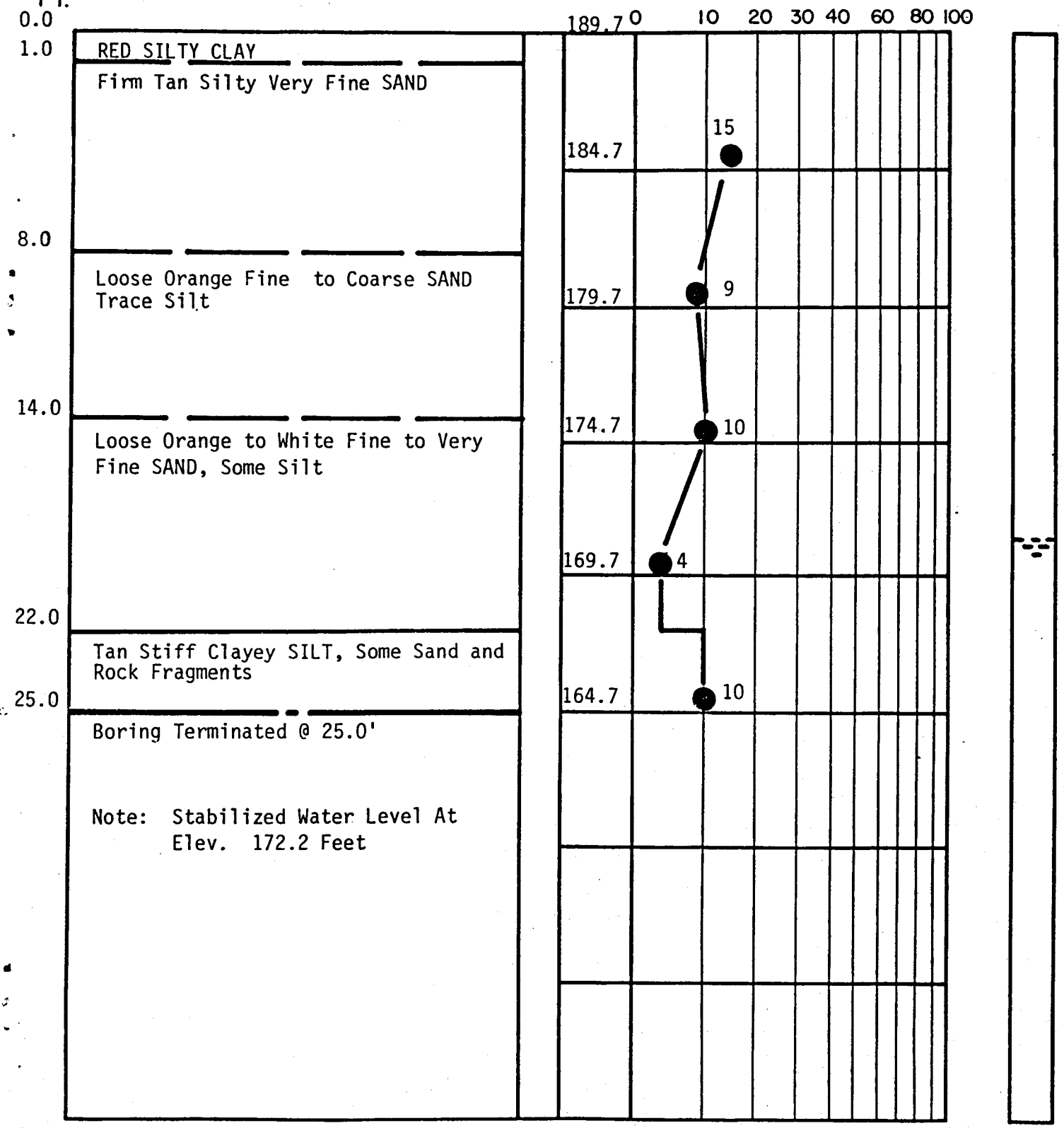
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
◀ LOSS OF DRILLING WATER
WATER TABLE–24HR.
WATER TABLE–1HR.

TEST BORING RECORD

BORING NO. W-5
DATE DRILLED 7-10-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

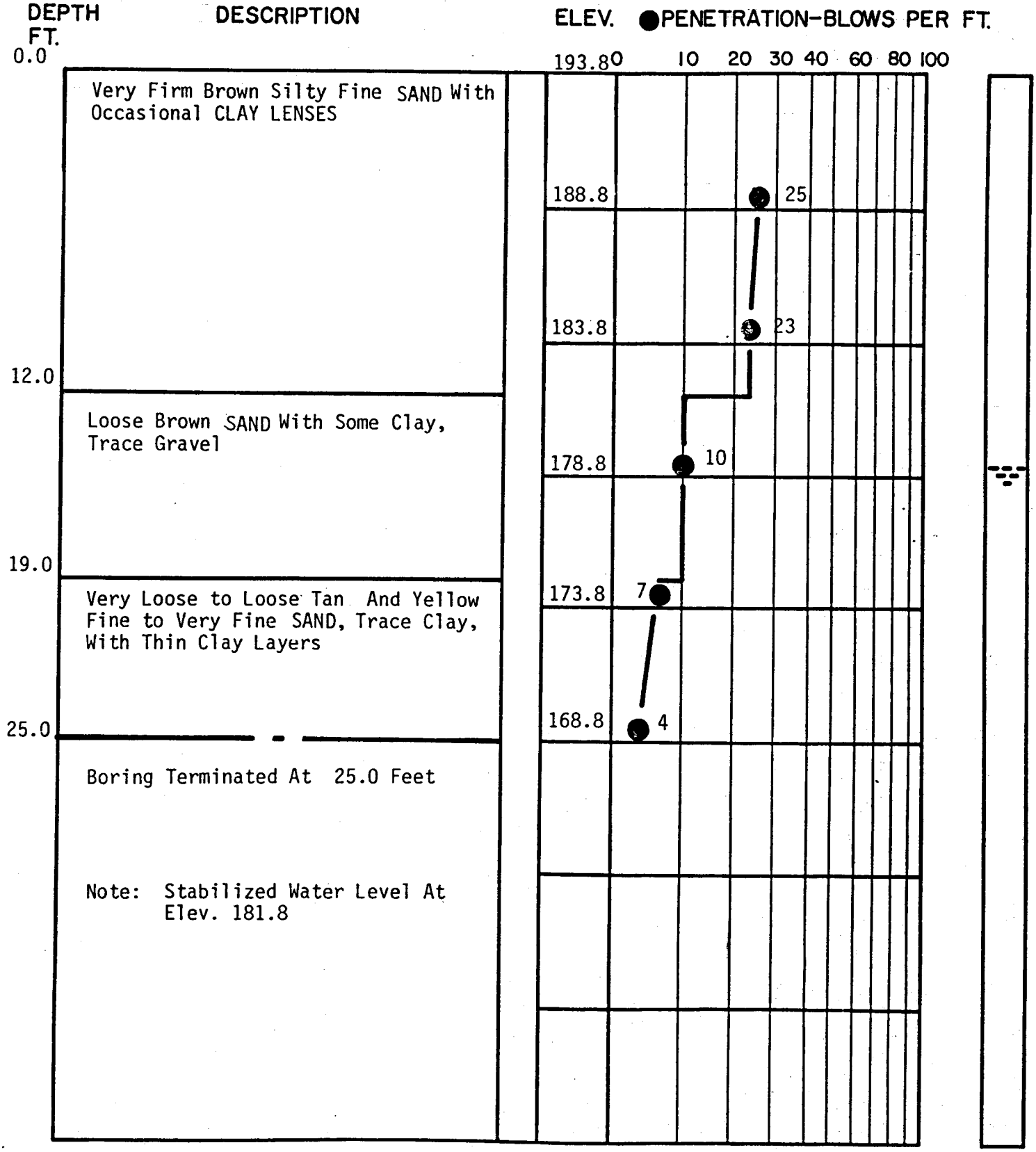
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50% ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24 HR.
WATER TABLE-1 HR.

TEST BORING RECORD

BORING NO. W-6
DATE DRILLED 7-10-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
LOSS OF DRILLING WATER
WATER TABLE-24HR.
WATER TABLE-1HR.

TEST BORING RECORD

BORING NO. W-4
DATE DRILLED 10-10-81
JOB NO. RS-1670

SOIL & MATERIAL ENGINEERS, INC.