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LABORATORY, INC.

Construction Materials Testing

Geotechnical Engineering Services

Geotechnical Investigation Report

4-023 (016) 078, PCN 19206
4-923 (019) 087, PCN 19376
ND State Highway 23
Major Rehabilitation
US Highway 83 to Mountrail County
MTL Project No M2115106

Midwest Testing
LABORATORY, INC.
A Terracon COMPANY

August 19, 2011

Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

Attn: Richard Gunderson
Vice-President
P: [701] 237 5065
F: [701] 237 5101
E: drgunderwon@houstoneng.com

Re: Geotechnical Investigation Report
4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Major Rehabilitation
US 83 to Mountrail County
Midwest Testing/Terracon Project No M2115106

Dear Mr. Gunderson:

The attached report presents the results of the geotechnical investigation we conducted for the referenced project. Three copies of our report are provided for your use. This work was conducted in general accordance with our Subconsultant Services Agreement signed by us on June 3, 2011, and signed by your office on June 6, 2011.

Approximately 50 percent of the soil samples obtained will be held at our office for two months and will then be discarded unless we are notified to hold them for a longer period of time.

The evaluations contained in this report have considered the normal contingencies; however, should any questions arise pertaining to the soil conditions during preparation of the working drawings or unexpected conditions develop during construction, please contact us.

Sincerely,

MIDWEST TESTING LABORATORY, INC.

Steven S. Smith, P.E.

Chad A. Cowley, P.E.

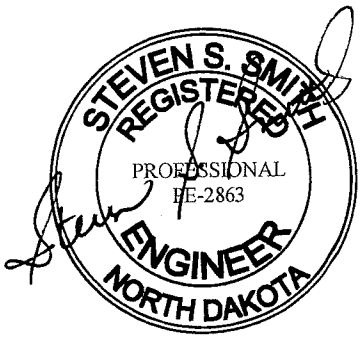
SSS/cb

Geotechnical Investigation Report

North Dakota State Highway 23
Major Rehabilitation
US 83 to Mountrail County

Prepared for
Houston Engineers, Inc

August 19, 2011



Date Aug 19, 2011

MTL Project Number M2115106

Midwest Testing Laboratory, Inc.
P.O. Box 2084
Bismarck, ND 58502-2084
701-258-2833

Contents

Appendix

1.0 Introduction

The proposed project will consist of rehabilitating an existing state highway in Ward County, North Dakota. This report presents the results of the field investigation along with our evaluation of the test results and recommendations concerning the geotechnical aspects of the proposed construction.

1.1 Scope of Work

Our scope of work for this project is limited to the following items:

1. Perform 20 soil test borings to a depth of six feet to obtain information regarding the soil and groundwater conditions along the highway route.

2. Perform four soil test borings to a depth of six feet to obtain information to assist in calibrating the ground penetration radar (GPR) data collection.

3. Perform laboratory testing to assist in classifying the soils. Laboratory testing includes determining moisture content, dry density, Atterberg limits and percent passing the #200 sieve. Additionally, moisture-density relationships and California Bearing Ratios (CBR) were determined.

4. Analyze the soil conditions encountered at the site and provide recommendations regarding the geotechnical aspects of the proposed construction.

2.0 Soil Borings and Laboratory Testing

The field work consisted of completing 24 test borings and evaluating groundwater conditions existent at the time of our investigation. A geotechnical laboratory analysis was performed on representative soil samples. More specific information regarding the field work and laboratory testing is discussed below.

2.1 Field Exploration

Standard penetration test borings were performed on July 12, and 13, 2011. The borings were advanced using a truck-mounted drill rig at the locations discussed with you and as noted on the attached boring logs.

2.1.1 Site Conditions

The project is approximately 27 miles in length, running from the intersection of North Dakota State Highway 23 and US Highway 83, west to the Mountrail County line. Topography through the project can be described as rolling, hilly, and undulating terrain. The existing highway is a rural section featuring asphalt driving lanes and aggregate shoulders.

2.1.2 Soil Conditions

Variable soil conditions were encountered within our borings. Asphalt thicknesses ranged from nine to twelve inches, averaging approximately ten and one-half inches in thickness. The underlying base varied in thickness from two to five inches with an average of approximately four inches. Subgrade soils present beneath the asphalt pavement and aggregate base consisted primarily of medium plasticity clays. Clayey sands, silty sands, and fat clays were also encountered to a lesser extent. All soils were of various shades of brown and gray, but generally brown to grayish brown in color. Variable consistencies were noted within the cohesive soils. Consistencies of the clays ranged from soft to hard, but were typically in the medium stiff to stiff range. The sands encountered were generally in a medium dense condition with some isolated loose to very loose areas present. The soils identified along the project route fall primarily within the AASHTO A-6, A-2-4, and A-7-6 Soil Group Classifications.

The preceding discussion is intended as a general and brief review of the soil conditions encountered. For a more complete description, we refer you to the attached boring logs.

2.1.3 Groundwater

Groundwater was encountered only within one boring advanced for the project. A summary of the times and levels of recording is included on the attached boring logs. Groundwater was identified at a depth of five and one-half feet within a waterbearing sand strata in test boring four.

Groundwater was not observed in the remaining borings while drilling or for the short duration that the borings were allowed to remain open. However, this does not necessarily mean these borings terminated above groundwater or that the water level discussed above represents a stable groundwater level. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for groundwater levels to develop and stabilize in bore holes in these materials. Long term

observations in piezometers sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the roadway may be higher or lower than the levels indicated in the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

2.2 Laboratory Testing

Several samples of the soils encountered were selected for laboratory analysis. The testing program consisted of the determination of the soil's index properties including moisture content, dry density, Atterberg limits, and percent passing the #200 sieve. Additionally, moisture-density relationships were determined utilizing AASHTO:T180. Supporting characteristics were evaluated utilizing California Bearing Ratio test methods. All test results are included on the attached boring logs opposite the samples on which they were performed and on the attached Tests of Soils reports.

3.0 Analysis and Recommendations

The following recommendations are based upon the design features described below. Should actual features vary from those listed, we ask that we be informed so that if required, the appropriate changes in our recommendations can be made.

3.1 Project Information

As previously stated, the project consists of a major rehabilitation of North Dakota State Highway 23. The existing highway pavement is structurally and functionally deficient and in need of rehabilitation. The highway needs to be widened, improved, and resurfaced so that load restrictions are no longer necessary. Right turn lanes and passing lanes will also be studied as a part of this project. Safety improvements through the project corridor will also be reviewed. Improvements to horizontal and vertical alignments, guardrail, access, turn lanes, and passing lanes will all be studied in conjunction with this rehabilitation.

3.2 Discussion

We understand some realignment and grade changes may occur in conjunction with the rehabilitation. Clearing and grubbing from excavation and embankment areas and removal of structures, obstructions, surfacing and miscellaneous items should be performed in accordance with North Dakota Department of Transportation (NDDOT) specifications. Salvaging, stockpiling, and spreading of topsoil shall be performed in accordance with the appropriate DOT specifications.

3.2.1 Compaction Control

Compaction control Type (A) (NDDOT Standard Specification 203.02G) is recommended for all embankment and cut areas. We recommend the maximum dry density and optimum moisture content be determined in accordance with state specifications. Embankment and cut areas designed to be excavated and recompacted should be compacted to 90 percent of the maximum density as determined by the modified proctor. Moisture contents at the time of compaction should not be less than optimum moisture content and no more than five percentage points above the optimum moisture as determined by this same method.

3.2.2 Subcut Areas

As previously discussed, subgrade soils available for supporting the pavement construction consist primarily of medium to high plasticity clays. These soils can be characterized as having a high to very high degree of frost susceptibility. The freeze-thaw cycles experienced in North Dakota's climate region can cause these soils to heave as they freeze with an associated strength loss during the thaw period.

Additionally, the clay soils identified throughout the project possess a volume change characteristic. The volume change is generally in the form of soil swell. Lean clays and fat clays are characterized as having a medium to high degree of expansion potential.

Frost action and/or soil swell occurring beneath the pavement structure can result in a loss of riding quality and serviceability, thus greatly affecting pavement performance. To reduce the effect of the saturated soils, frost action and soil swell, we recommend three feet of the existing subgrade soils be subcut and replaced with an aggregate in those areas identified in the following table.

REFERENCE POINT	LENGTH (ft)	BORINGS
82.4	300	18, 19 & 20
84.2	200	16 & 17
85.6	60	15
86.4	100	14
87.0	300	11, 12 & 13
88.9	20	10
95.2	20	9
96.8 TO 96.9	525	4, 5, 6, 7 & 8
97.2	50	3
99.5	50	2
101.3	100	1

The aggregate should meet the NDDOT's current specification for Class 3 aggregate. We further recommend that consideration be given to installing a reinforcement fabric meeting the requirements of the DOT's specification for R-1 Reinforcement Fabric. Fabric should be placed at the bottom of the subcut excavation. The fabric should be placed in a manner meeting the requirements of the NDDOT specifications. A 20:1 transition shall be constructed prior to entering and exiting subcut excavations. Construction equipment should not be allowed to travel on the soft subgrade.

With subgrade soils improved in the manner as described above and provided that adequate drainage of the pavement section is provided, it would be our opinion that a CBR of five would available for design of the pavement section.

4.0 Field Investigation Procedures

Twenty-four soil test borings were performed along the project route on July 12, and 13, 2011. The borings were advanced at locations as directed and as noted on the attached borings. The northings and eastings shown on each log are based on the US State Plane Coordinate System, NAD 1983. Surface elevations at our test boring locations, as provided by your office, are referenced to NAVD 1988. Please note each boring was advanced nine feet from centerline. East bound and west bound directions are shown on the boring logs.

4.1 Soil Sampling

The borings were advanced with 3¼ inch hollow stem auger, with split barrel samples obtained in accordance with ASTM D1586. Using this procedure, a two-inch O.D. split barrel sampler is driven by a 140-pound weight falling 30 inches. The number of blows required to drive the sampler twelve inches after a six inch initial set is the standard penetration resistance and will be referred to as N value, an index related to the consistency of cohesive soils and the relative density of cohesionless soils.

An automatic SPT hammer was used to advance the split barrel sampler in the borings performed for this site. A greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the standard penetration blow count (N) values. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

4.2 Soil Classifications

As the borings were advanced in the field and samples obtained, they were visually and manually classified in accordance with ASTM D2488. Representative portions of all samples were returned to the laboratory for review of the field classifications. Selected samples were submitted to a program of laboratory tests to aid in determining the characteristics of the soil. Logs of the borings, laboratory test results and charts illustrating the soil classification procedures and descriptive terminology are attached.

5.0 General Comments

MTL/Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. MTL/Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the limited data obtained from the boring performed at the indicated location and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or preventation of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use for our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

Midwest Testing
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A Terracon COMPANY

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Bismarck, ND 58502-2084
Phone (701) 258-2833 Fax (701) 258-2857

JOB NO.: M2115106 LOG OR TEST BORING NO.: 1 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2132.0**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
1	SANDY LEAN CLAY-grayish brown, stiff to medium stiff, trace of gravel, moist (CL)	1	SS	10	16	112	34/13	
		2	SS	7				
		3	SS	7				
6	END OF BORING **Northing 358,290.4; Easting 1,751,585.7** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	8:20	HSA 4½'	None
7-12-11	8:20	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 8:20
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 2 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2112.2**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
13"	FILL-LEAN CLAY WITH SAND-grayish brown, stiff (CL)	1	SS	11	14			
2	SANDY LEAN CLAY-grayish brown, stiff, trace of gravel (CL)	2	SS	9				
		3	SS	12				
6	END OF BORING **Northing 358,369.6; Easting 1,742,741.9** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	9:10	HSA 4½'	None
7-12-11	9:10	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 9:10
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 3 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2106.5**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
9"	AGGREGATE BASE							
13"	FILL-SANDY LEAN CLAY-grayish brown, stiff to soft, moist (CL)	1	SS	11	15			
		2	SS	4	21			
4½	SANDY LEAN CLAY-dark brownish gray, soft, original topsoil in upper 6" (CL)	3	SS	5				
6	END OF BORING **Northing 358,473.2; Easting 1,730,343.8** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	10:10	HSA 4½'	None
7-12-11	10:10	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 10:10

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 4 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2119.4**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
15"	FILL-SANDY LEAN CLAY- brown, very stiff, trace of gravel (CL)	1	SS	18				
2	LEAN CLAY WITH SAND-grayish brown mottled, medium stiff to soft (CL)	2	SS	7	24		29/17	
		3	SS	4				
6	END OF BORING **Northing 358,507.8; Easting 1,728,448.0** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	12:35	HSA 4½'	None
7-12-11	12:35	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 12:35

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 5 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2119.0**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
14"	FILL-LEAN CLAY WITH SAND-brown, stiff, trace of gravel (CL)	1	SS	14				
2	LEAN CLAY-grayish brown mottled, medium stiff, moist (CL)	2	SS	8	23			
4	FAT CLAY-grayish brown, stiff (CH)	3	SS	10				
6	END OF BORING **Northing 358,490.4; Easting 1,728,567.8** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	11:00	HSA 4½'	None
7-12-11	11:00	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 11:00

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 6 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2118.9**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
14"	FILL-FAT CLAY-gray, stiff, moist (CH)	1	SS	10	23	102		
2	SANDY LEAN CLAY-brown, stiff, trace of gravel, moist (CL)	2	SS	11				
		3	SS	11				
6	END OF BORING **Northing 358,506.0; Easting 1,728,683.5** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	12:10	HSA 4½'	None
7-12-11	12:10	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 12:10

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 7 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2118.4**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
9"	AGGREGATE BASE							
11"	FILL-LEAN CLAY WITH SAND-brown, stiff, moist (CL)	1	SS	10	22			
2	LEAN CLAY-brown, stiff, trace of gravel (CL)	2	SS	10				
		3	SS	10				
6	END OF BORING **Northing 358,488.5; Easting 1,728,789.6** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	11:25	HSA 4½'	None
7-12-11	11:25	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 11:50
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 8 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2117.4**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
13"	FILL-LEAN CLAY WITH SAND-brown, stiff, trace of gravel (CL)	1	SS	11	12			
		2	SS	10				
4½	FILL-CLAYEY SAND-brown, fine to coarse-grained, medium dense (SC)	3	SS	10				
6	END OF BORING **Northing 358,503.3; Easting 1,728,960.5** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	11:50	HSA 4½'	None
7-12-11	11:50	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 11:50
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 9 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2053.7**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE	1	SS	18	13			
15"	FILL-LEAN CLAY WITH SAND-brown, very stiff (CL)							
2	FILL-SILTY SAND-brown, fine to coarse-grained, loose to medium dense, moist (SM)	2	SS	6				
		3	SS	11				
6	END OF BORING **Northing 359,786.9; Easting 1,721,054.0** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	14:20	HSA 4½'	None
7-12-11	14:20	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 14:20

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 10 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2119.9**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE	1	SS	9	16		36/15	
15"	FILL-SANDY LEAN CLAY-brown, stiff, trace of gravel, sand inclusions (CL)	2	SS	14				
		3	SS	15				
6	END OF BORING **Northing 358,950.2; Easting 1,688,483.0** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	15:25	HSA 4½'	None
7-12-11	15:25	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 15:25

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 11 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2114.3**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-LEAN CLAY WITH SAND-brown, very stiff (CL)	1	SS	11	18			
2	LEAN CLAY WITH SAND-grayish brown, medium stiff, trace of gravel (CL)	2	SS	7				
		3	SS	9				
6	END OF BORING **Northing 359,081.1; Easting 1,677,699.4** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	17:25	HSA 4½'	None
7-12-11	17:25	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 17:25
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 12 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2116.1**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
14"	FILL-SANDY LEAN CLAY-brown, medium stiff to soft (CL)	1	SS	5	18			
		2	SS	3				
4	LEAN CLAY WITH SAND-grayish brown, soft, moist (CL)	3	SS	3	25			
6	END OF BORING **Northing 359,096.0; Easting 1,677,824.2** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	16:55	HSA 4½'	None
7-12-11	17:00	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 16:55
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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Bismarck, ND 58502-2084
Phone (701) 258-2833 Fax (701) 258-2857

JOB NO.: M2115106 LOG OR TEST BORING NO.: 13 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2119.1**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
14"	FILL-SANDY LEAN CLAY-brown, stiff to medium stiff, trace of gravel (CL)	1	SS	9	20			
		2	SS	8				
		3	SS	8				
6	END OF BORING **Northing 359,078.0; Easting 1,677,992.8** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	16:35	HSA 4½'	None
7-12-11	16:35	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 16:35

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 14 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2079.7**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-SANDY LEAN CLAY-grayish brown, hard, trace of gravel (CL)	1	SS	56				
2	FILL-SILTY SAND WITH GRAVEL-brown, fine to coarse-grained, medium dense (SM)	2	SS	24				P200 19%
4	SAND-light brown, fine to medium-grained, trace of gravel, medium dense, waterbearing @ 5½' (SP)	3	SS	11				
6	END OF BORING **Northing 359,105.9; Easting 1,675,811.3** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	8:10	HSA 4½'	5½'
7-12-11	8:10	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 8:10

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 15 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	SURFACE ELEVATION: **2051.5**							
	ASPHALT							
10"	AGGREGATE BASE							
14"	FILL-SANDY LEAN CLAY-brown, very stiff to stiff, trace of gravel (CL)	1	SS	27	12	116		
		2	SS	11				
		3	SS	11				
6	END OF BORING							
	Northing 359,147.4; Easting 1,672,521.1							
	EB Lane							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	9:10	HSA 4½'	None
7-13-11	9:15	3'	None

BORING DATA
STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 9:10
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 16 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	SURFACE ELEVATION: **2057.3**							
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-FAT CLAY WITH SAND-dark brown, stiff, topsoil inclusions (CH)	1	SS	15	25		49/19	
2½	SANDY LEAN CLAY-dark brown to light gray, medium stiff, moist, original topsoil in the upper 6" (CL)	2	SS	5				
5	SILTY SAND-brown, fine to medium-grained, medium dense (SM)	3	SS	13				
6	END OF BORING							
	Northing 359,253.2; Easting, 1,666,626.0							
	WB Lane							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	9:50	HSA 4½'	None
7-13-11	9:55	3'	None

BORING DATA
STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 9:50
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 17 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2057.3**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							
15"	FILL-SANDY LEAN CLAY-brown, very stiff, trace of gravel (CL)	1	SS	24				
2	FILL-SAND WITH SILT & GRAVEL-brown, fine to coarse-grained, loose, clay inclusions (SP-SM)	2	SS	6				
		3	SS	6				
6	END OF BORING **Northing 359,239.0; Easting 1,666,544.0** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	10:05	HSA 4½'	None
7-13-11	10:10	3'	None

BORING DATA
STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 10:05
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 18 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2084.9**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
10"	AGGREGATE BASE							P200 33%
13"	SILTY SAND-dark brown to brown, fine to medium-grained, medium dense (SM)	1	SS	24				
2	CLAYEY SAND-light brown, fine to medium-grained, loose, moist (SC)	2	SS	6				
3½	LEAN CLAY WITH SAND-grayish brown, medium stiff to stiff, trace of gravel, moist (CL)	3	SS	10				
6	END OF BORING **Northing 359,323.5; Easting 1,654,988.7** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	10:50	HSA 4½'	None
7-13-11	10:55	3'	None

BORING DATA
STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 10:50
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: 19 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2084.7**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
16"	FILL-CLAYEY SAND-brown, fine to coarse-grained, medium dense (SC)	1	SS	15				
2	LEAN CLAY WITH SAND-grayish brown, stiff to medium stiff, moist (CL)	2	SS	9	18			
		3	SS	5				
6	END OF BORING **Northing 359,345.0; Easting 1,65,893.2** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	11:05	HSA 4½'	None
7-13-11	11:10	3'	None

BORING DATA

STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 11:05

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: 20 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2084.5**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS: MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-SANDY LEAN CLAY-brown, very stiff (CL)	1	SS	22				
2	FILL-SILTY SAND-brown, fine to medium-grained, loose (SM)	2	SS	5				
5		3	SS	2				
6	CLAYEY SAND-brown, fine to medium-grained, very loose, waterbearing (SC)							
	END OF BORING **Northing 359,334.7; Easting 1,654,796.8** **EB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	11:25	HSA 4½'	None
7-13-11	11:30	3'	None

BORING DATA

STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 11:25

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: GPR1 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2076.4**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
14"	FILL-SANDY LEAN CLAY-grayish brown, stiff, trace of gravel, topsoil inclusions (CL)	1	SS	13	16	114		
		2	SS	15				
		3	SS	14				
6	END OF BORING **Northing 359,745.8; Easting 1,632,893.1** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	12:30	HSA 4½'	None
7-13-11	12:35	3'	None

BORING DATA
STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 12:30
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: GPR2 VERTICAL SCALE: 1"=3'
PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2105.2**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
12"	AGGREGATE BASE							
16"	FILL-LEAN CLAY WITH SAND-brownish gray, stiff to soft to medium stiff, trace of gravel, moist (CL)	1	SS	15	16			
		2	SS	4	25			
		3	SS	5				
6	END OF BORING **Northing 359,006.5; Easting 1,685,356.5** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	15:45	HSA 4½'	None
7-12-11	15:50	3'	None

BORING DATA
STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 15:45
METHOD USED: 3¼" HSA 0-4½'
CREW CHIEF: M. Roberts

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JOB NO.: M2115106 LOG OR TEST BORING NO.: GPR3 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2090.6**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-LEAN CLAY WITH SAND-brownish gray, stiff, trace of gravel (CL)	1	SS	13	6			
2½	FILL-SANDY LEAN CLAY-brownish gray, stiff, topsoil inclusions (CL)	2	SS	12				
4½	SANDY LEAN CLAY-dark brown to brown, stiff, trace of gravel, original topsoil in upper 8" (CL)	3	SS	10				
6	END OF BORING **Northing 358,572.7; Easting 1,723,545.4** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-12-11	13:50	HSA 4½'	None
7-12-11	13:55	3'	None

BORING DATA

STARTED 7-12-11 **COMPLETED:** 7-12-11 @ 13:50

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

JOB NO.: M2115106 LOG OR TEST BORING NO.: GPR4 VERTICAL SCALE: 1"=3'

PROJECT: North Dakota State Highway 23 Rehabilitation, Ward County, North Dakota

DEPTH IN FEET	SOIL DESCRIPTION SURFACE ELEVATION: **2150.8**	SAMPLE NO.	SAMPLE TYPE	N	LABORATORY TESTS MOISTURE	DENSITY	LL/PL	Qu
	ASPHALT							
11"	AGGREGATE BASE							
15"	FILL-LEAN CLAY WITH SAND-brown, stiff, trace of gravel (CL)	1	SS	9	16			
2	FILL-SANDY LEAN CLAY-brown, stiff, trace of gravel (CL)	2	SS	14	21			
		3	SS	13				
6	END OF BORING **Northing 358,124.5; Easting 1,773,860.3** **WB Lane**							

WATER LEVEL DATA

DATE	TIME	CAVE IN DEPTH	WATER LEVEL
7-13-11	7:10	HSA 4½'	None
7-13-11	7:15	3'	None

BORING DATA

STARTED 7-13-11 **COMPLETED:** 7-13-11 @ 7:10

METHOD USED: 3¼" HSA 0-4½'

CREW CHIEF: M. Roberts

MIDWEST TESTING LABORATORY

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Telephone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: TESTS OF SOILS

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

SAMPLE NUMBER:	1	2
LOCATION:	Test boring 1, depth 1-5'	Test boring 2, depth 11"-5'
CLASSIFICATION:	SANDY LEAN CLAY (CL)	SANDY LEAN CLAY (CL)
COLOR:	Grayish brown	Grayish brown
PARTICLE DISTRIBUTION:		
Gravel (%)	5	6
Sand (%)	34	37
Fines (%)	61	57
ATTERBERG LIMITS:		
Liquid Limit	34	33
Plastic Limit	12	13
Plasticity Index	22	20
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	9.8	12.6
Maximum Density (pcf)	129.7	125.4
CALIFORNIA BEARING RATIO (CBR):		Not Tested
Specimen Density (pcf)	116.7	
Percent Compaction (%)	90.0	
Remolded Moisture Content (%)	9.8	
Surcharge Load (lbs)	10.0	
Percent Swell – 96 hours	2.8	
CBR @ 0.1" Penetration	5.7	
Final Moisture Content (%)	14.0	
Final Moisture, Top 1" (%)	15.1	

MIDWEST TESTING LABORATORY

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Phone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

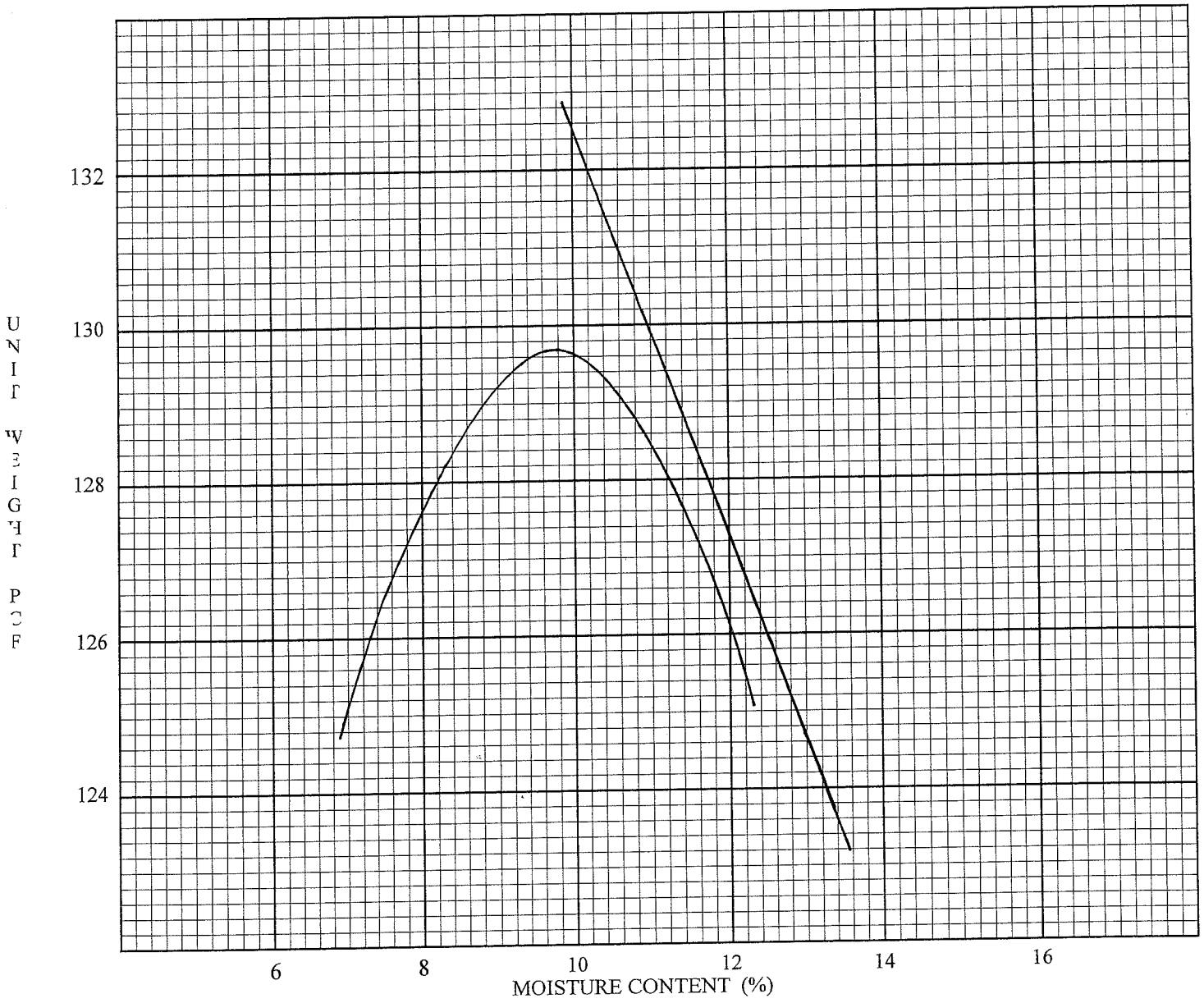
SAMPLE NUMBER: 1 (Test boring 1, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 129.7 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 9.8%



MIDWEST TESTING LABORATORY

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Phone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
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1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

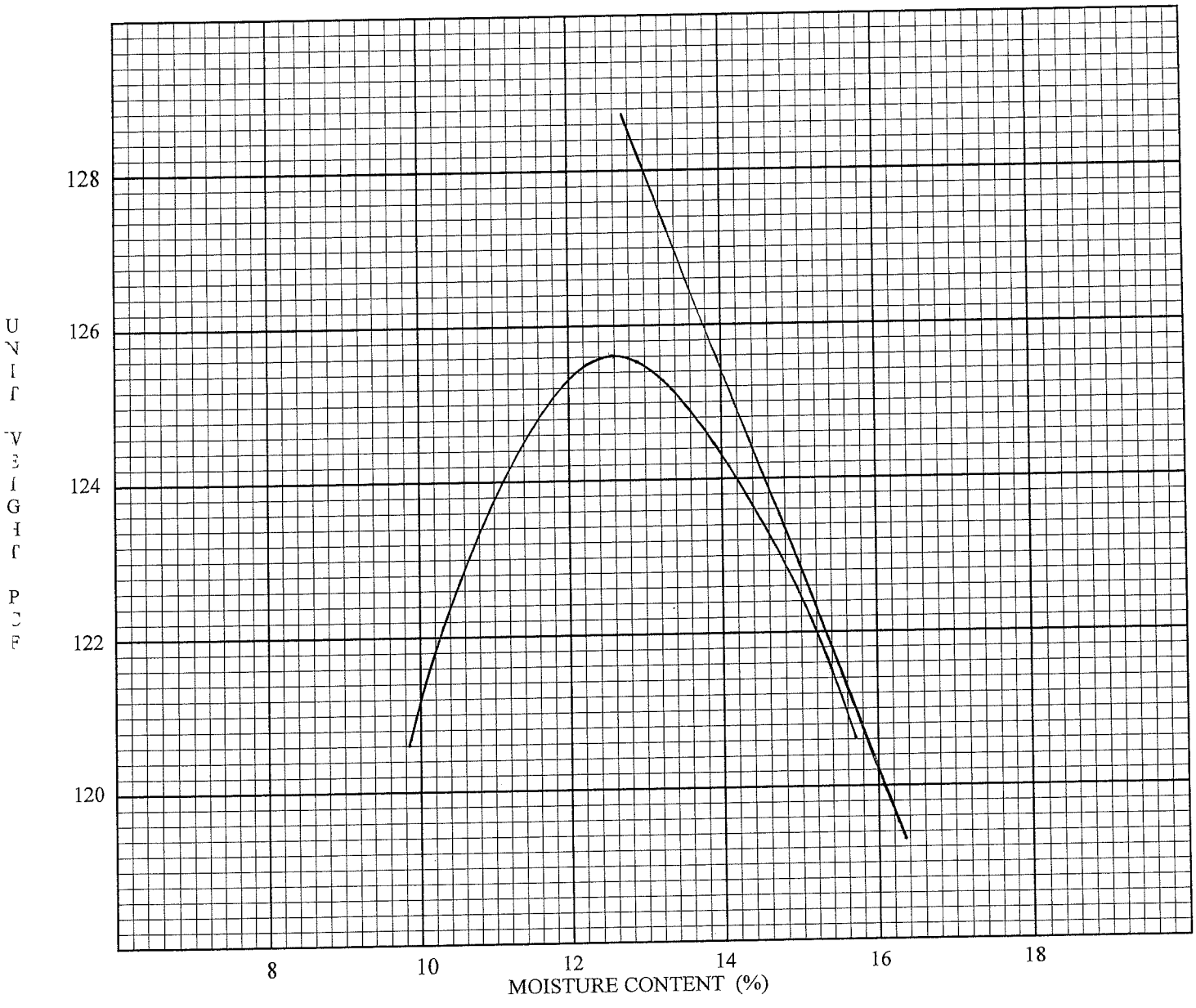
SAMPLE NUMBER: 2 (Test boring 2, depth 11"-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 125.4 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 12.6%



MIDWEST TESTING LABORATORY

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Telephone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: TESTS OF SOILS

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
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COPIES:

PROJECT NO: M2115106

SAMPLE NUMBER:	3	4
LOCATION:	Test boring 3, depth 1-5'	Test boring 4, depth 1-5'
CLASSIFICATION:	CLAYEY SAND (SC)	SANDY LEAN CLAY (CL)
COLOR:	Grayish brown	Grayish brown
PARTICLE DISTRIBUTION:		
Gravel (%)	11	10
Sand (%)	44	27
Fines (%)	45	63
ATTERBERG LIMITS:		
Liquid Limit	38	29
Plastic Limit	17	16
Plasticity Index	21	13
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	10.9	9.5
Maximum Density (pcf)	124.2	129.1
CALIFORNIA BEARING RATIO (CBR):	Not Tested	
Specimen Density (pcf)		116.2
Percent Compaction (%)		90.0
Remolded Moisture Content (%)		9.5
Surcharge Load (lbs)		10.0
Percent Swell – 96 hours		1.1
CBR @ 0.1" Penetration		17
Final Moisture Content (%)		13.7
Final Moisture, Top 1" (%)		14.8

MIDWEST TESTING LABORATORY

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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
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1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

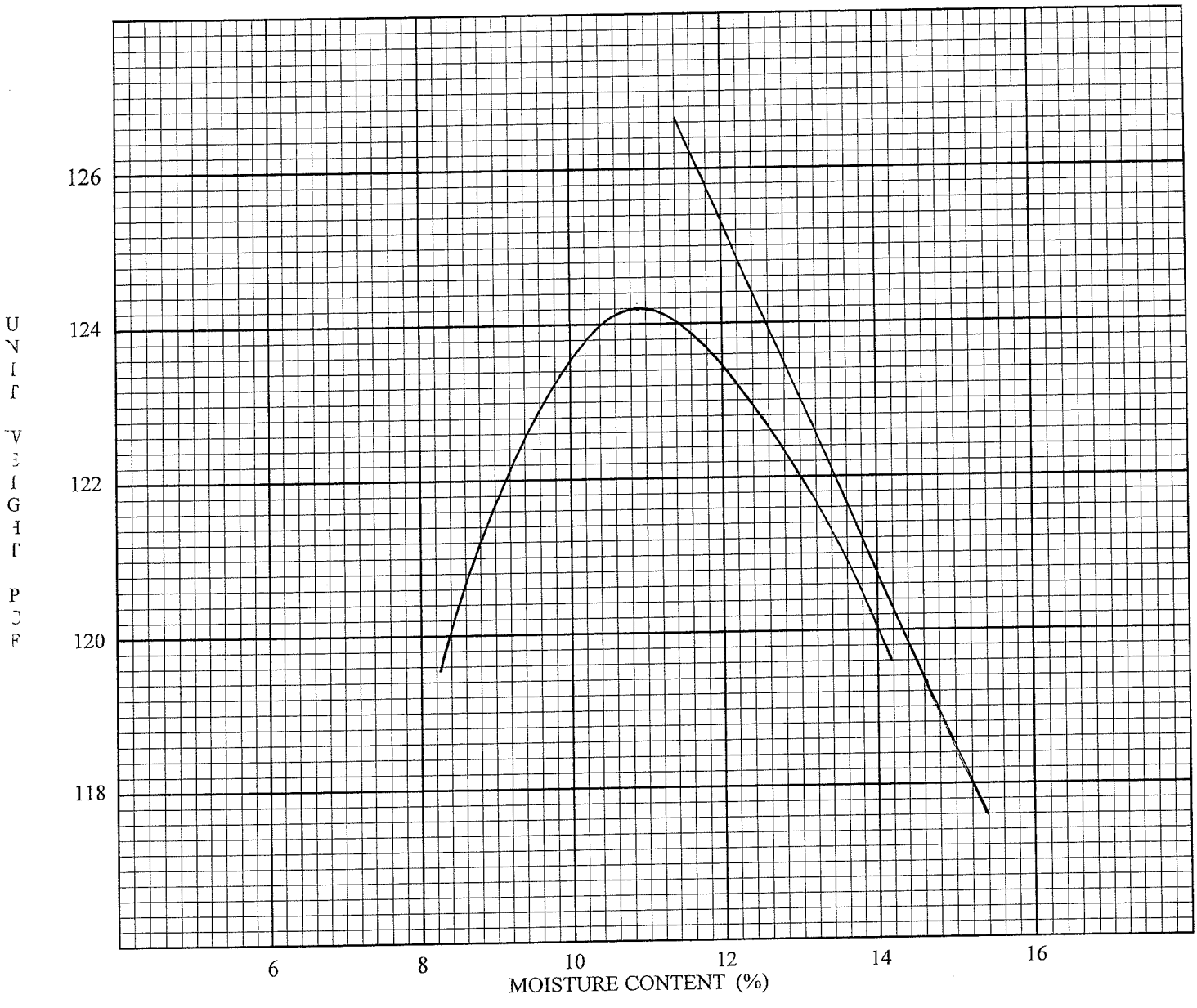
SAMPLE NUMBER: 3 (Test boring 3, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 124.2 pcf

SOIL TYPE: CLAYEY SAND-grayish brown (SC)

OPTIMUM MOISTURE: 10.9%



MIDWEST TESTING LABORATORY

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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
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COPIES:

PROJECT NO: M2115106

SAMPLE NUMBER: 4 (Test boring 4, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 129.1 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 9.5%

MIDWEST TESTING LABORATORY

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Telephone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: TESTS OF SOILS

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

SAMPLE NUMBER:	5	6
LOCATION:	Test boring 6, depth 1-5'	Test boring 8, depth 1-5'
CLASSIFICATION:	SANDY LEAN CLAY (CL)	SANDY LEAN CLAY (CL)
COLOR:	Grayish brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	6	8
Sand (%)	33	33
Fines (%)	61	59
ATTERBERG LIMITS:		
Liquid Limit	43	34
Plastic Limit	17	15
Plasticity Index	26	19
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	11.5	10.7
Maximum Density (pcf)	123.4	126.2
CALIFORNIA BEARING RATIO (CBR):	Not Tested	Not Tested
Specimen Density (pcf)		
Percent Compaction (%)		
Remolded Moisture Content (%)		
Surcharge Load (lbs)		
Percent Swell – 96 hours		
CBR @ 0.1" Penetration		
Final Moisture Content (%)		
Final Moisture, Top 1" (%)		

MIDWEST TESTING LABORATORY

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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
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Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

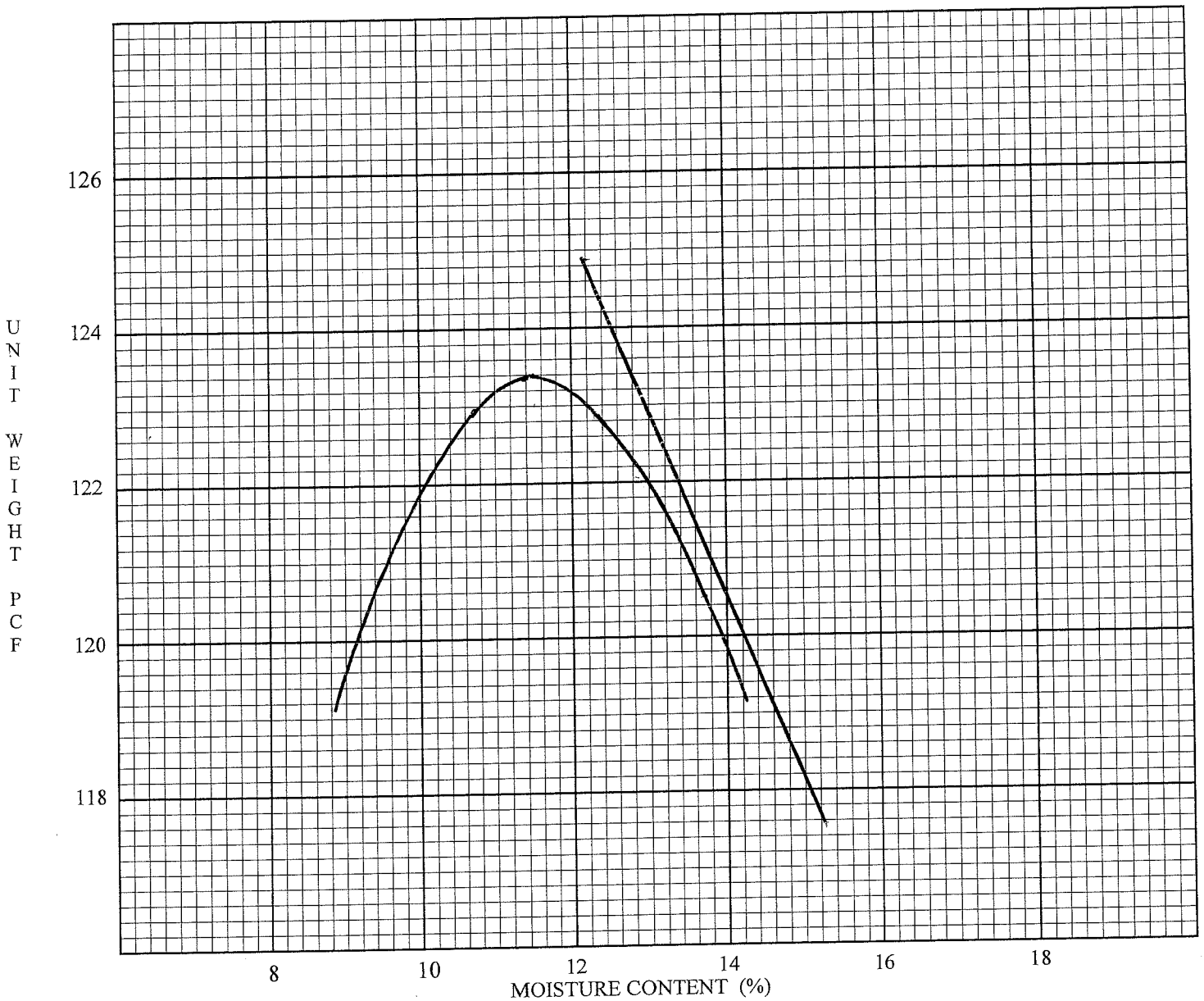
SAMPLE NUMBER: 5 (Test boring 6, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 123.4 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 11.5%



MIDWEST TESTING LABORATORY

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Phone (701) 258-2833 / Fax (701) 258-2857

REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

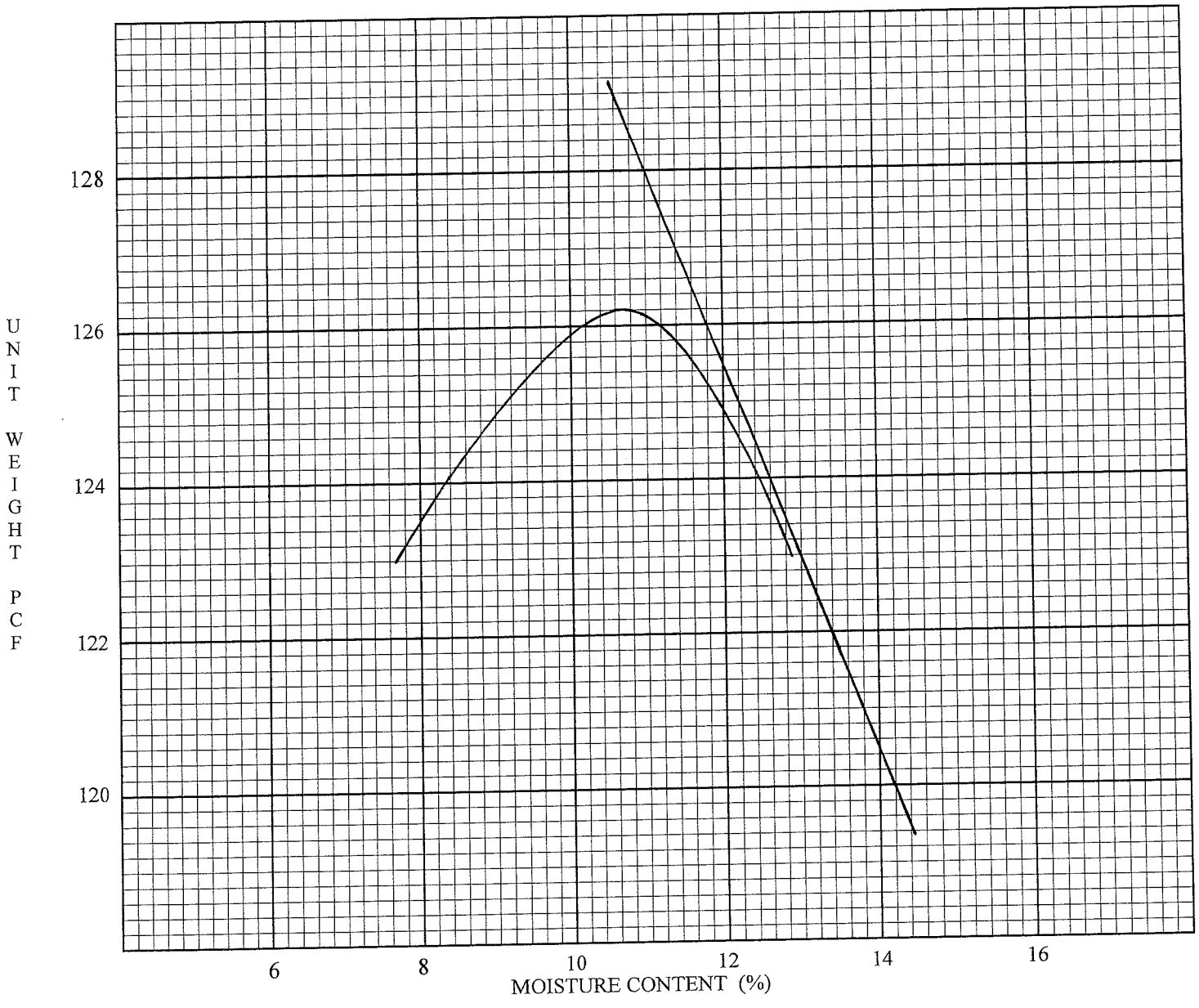
SAMPLE NUMBER: 6 (Test boring 8, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 126.2 pcf

SOIL TYPE: SANDY LEAN CLAY-brown (CL)

OPTIMUM MOISTURE: 10.7%



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REPORT OF: TESTS OF SOILS

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
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PROJECT NO: M2115106

SAMPLE NUMBER:	7	8
LOCATION:	Test boring 9, depth 1-5'	Test boring 10, depth 1-5'
CLASSIFICATION:	CLAYEY SAND WITH GRAVEL (SC)	SANDY LEAN CLAY (CL)
COLOR:	Brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	15	6
Sand (%)	40	34
Fines (%)	45	60
ATTERBERG LIMITS:		
Liquid Limit	29	41
Plastic Limit	15	17
Plasticity Index	14	24
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	10.7	11.1
Maximum Density (pcf)	126.2	122.0
CALIFORNIA BEARING RATIO (CBR):	Not Tested	Not Tested
Specimen Density (pcf)		
Percent Compaction (%)		
Remolded Moisture Content (%)		
Surcharge Load (lbs)		
Percent Swell – 96 hours		
CBR @ 0.1" Penetration		
Final Moisture Content (%)		
Final Moisture, Top 1" (%)		

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PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
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PROJECT NO: M2115106

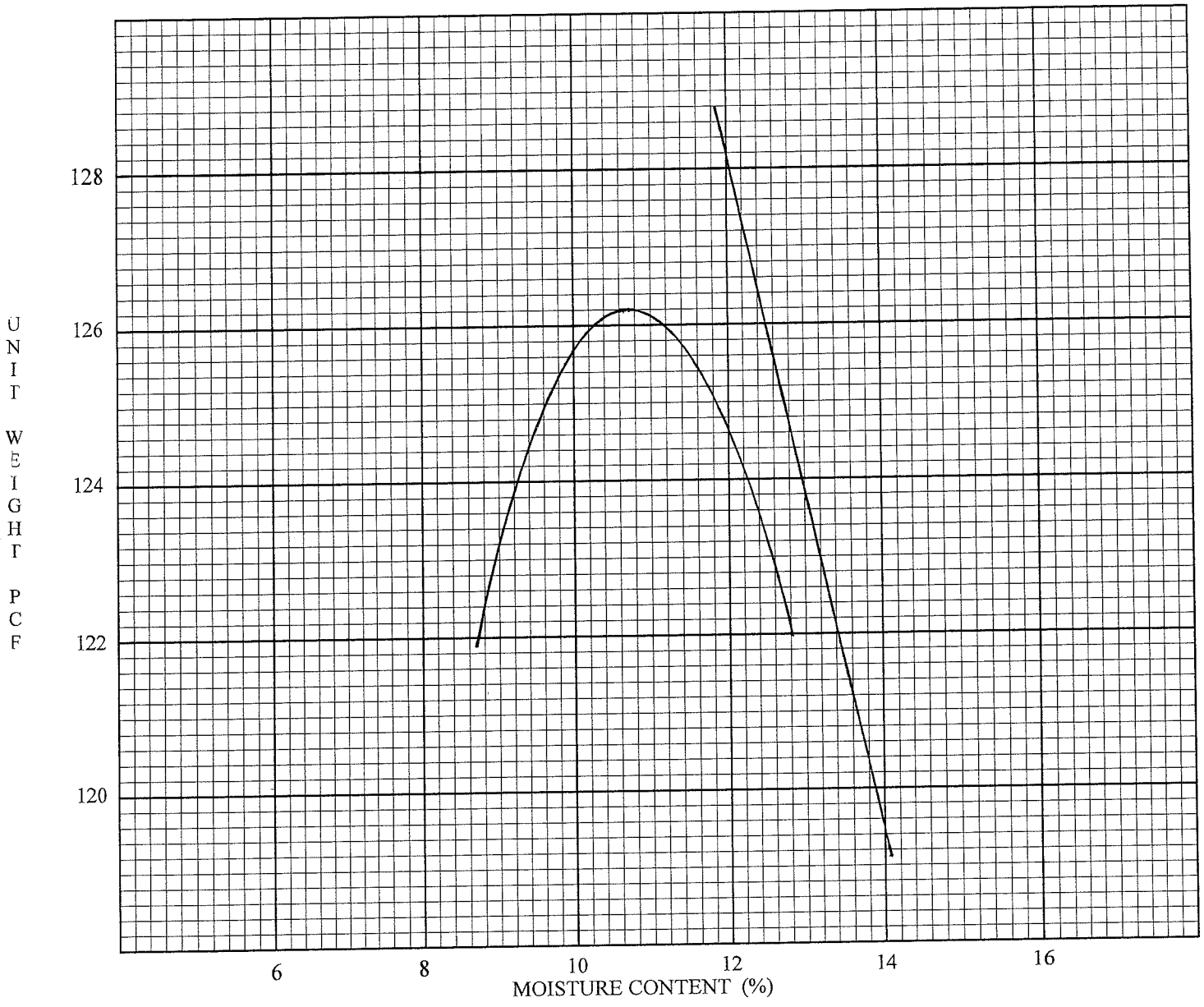
SAMPLE NUMBER: 7 (Test boring 9, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 126.2 pcf

SOIL TYPE: CLAYEY SAND WITH GRAVEL-brown (SC)

OPTIMUM MOISTURE: 10.7%



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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
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PROJECT NO: M2115106

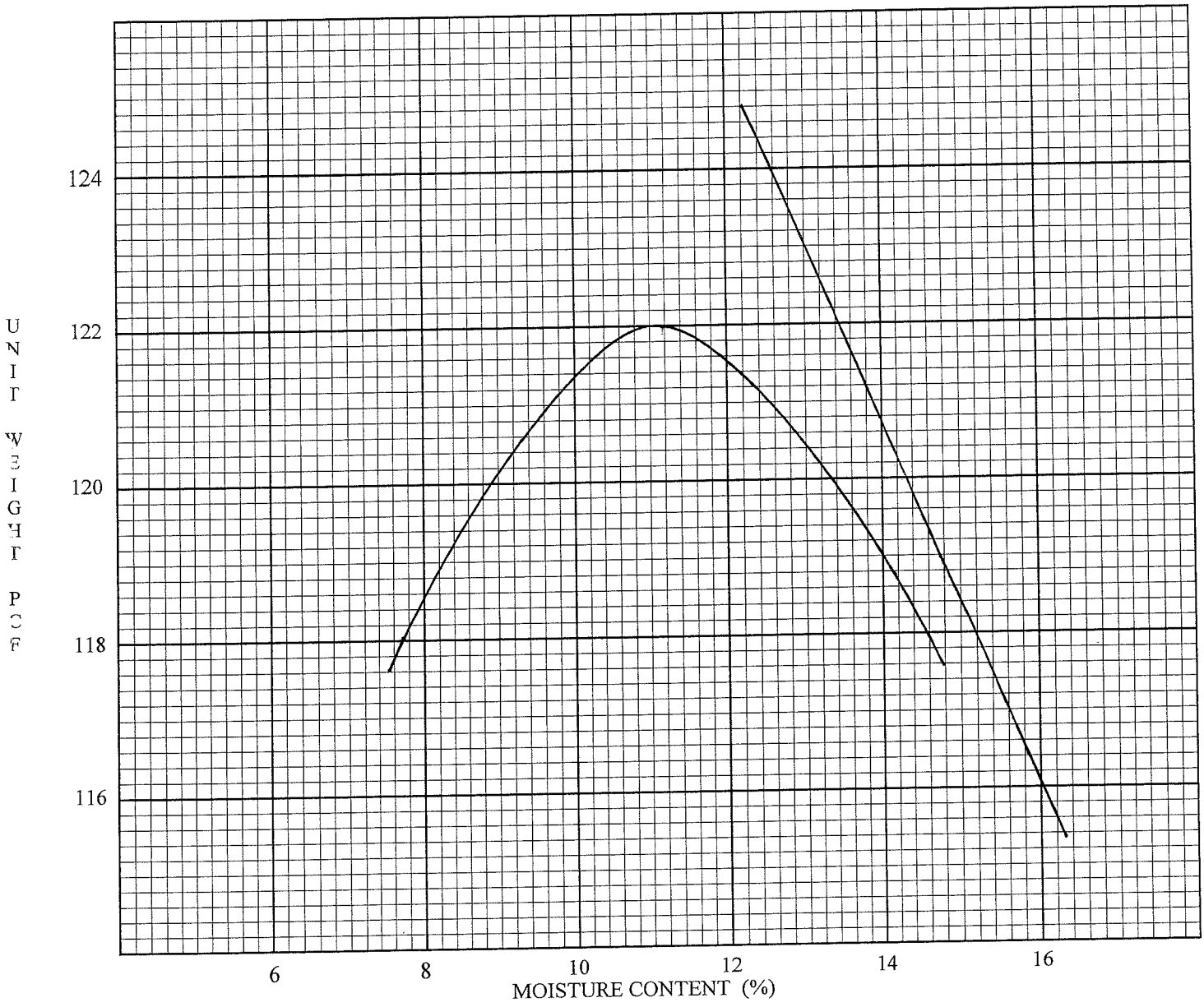
SAMPLE NUMBER: 8 (Test boring 10, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 122.0 pcf

SOIL TYPE: SANDY LEAN CLAY-brown (CL)

OPTIMUM MOISTURE: 11.1%



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REPORT OF: TESTS OF SOILS

PROJECT:	4-023 (016) 078, PCN 19206 4-023 (019) 087, PCN 19376 North Dakota State Highway 23 Ward County, North Dakota	DATE:	August 11, 2011
REPORTED TO:	Attn: Rick Gunderson Houston Engineering, Inc 1401 21st Avenue North Fargo, ND 58102-1814	COPIES:	
PROJECT NO:	M2115106		

SAMPLE NUMBER:	9	10
LOCATION:	Test boring 12, depth 1-5'	Test boring 13, depth 1-5'
CLASSIFICATION:	SANDY LEAN CLAY (CL)	SANDY LEAN CLAY (CL)
COLOR:	Brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	10	6
Sand (%)	38	34
Fines (%)	52	60
ATTERBERG LIMITS:		
Liquid Limit	38	36
Plastic Limit	17	16
Plasticity Index	21	20
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	11.3	10.6
Maximum Density (pcf)	123.0	123.6
CALIFORNIA BEARING RATIO (CBR):		
Specimen Density (pcf)	110.7	111.2
Percent Compaction (%)	90.0	90.0
Remolded Moisture Content (%)	13.6	10.6
Surcharge Load (lbs)	10.0	10.0
Percent Swell – 96 hours	3.4	5.6
CBR @ 0.1" Penetration	9.6	2.1
Final Moisture Content (%)	16.2	17.3
Final Moisture, Top 1" (%)	16.7	24.8

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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

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PROJECT NO: M2115106

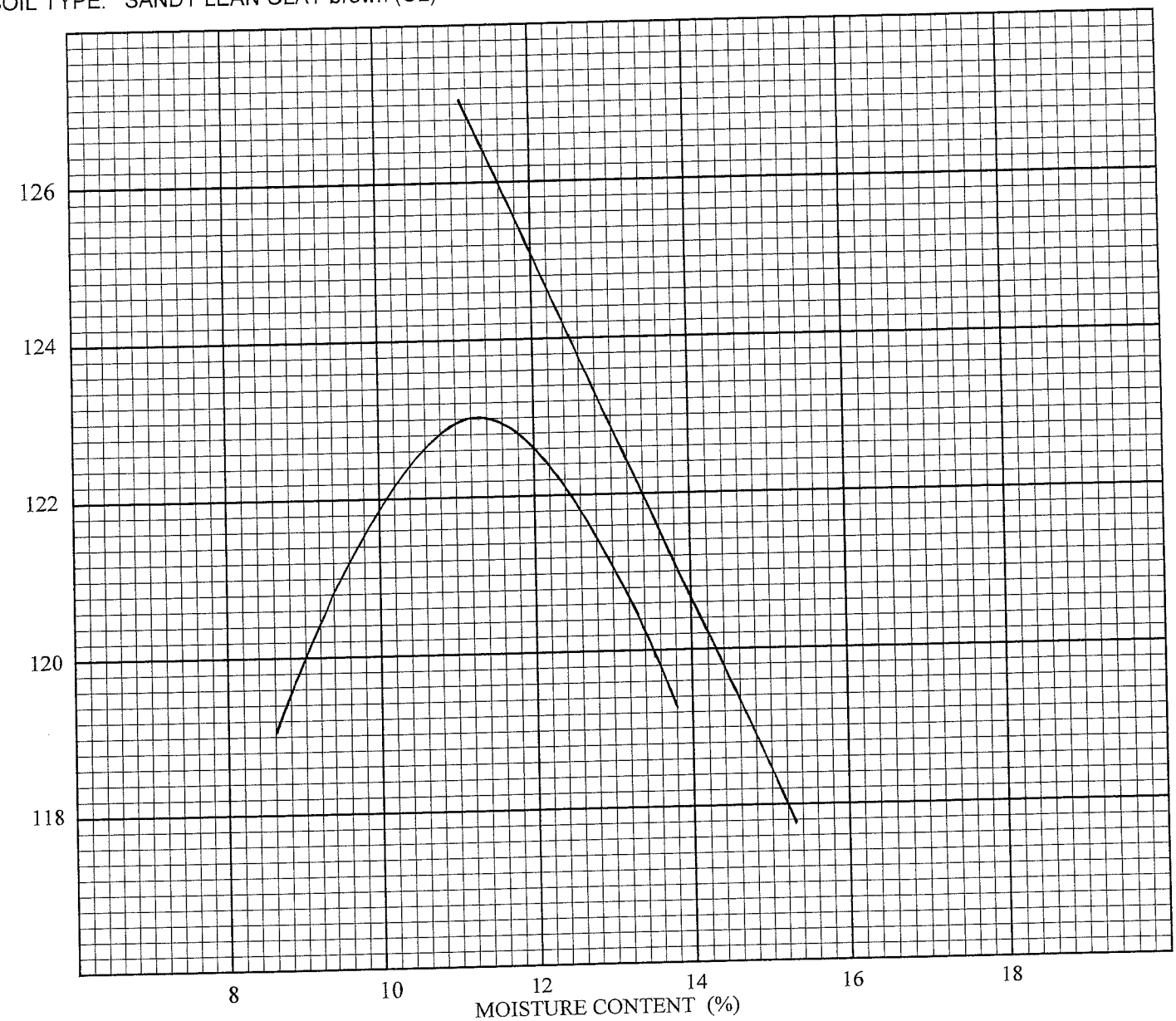
SAMPLE NUMBER: 9 (Test boring 12, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 123.0 pcf

SOIL TYPE: SANDY LEAN CLAY-brown (CL)

OPTIMUM MOISTURE: 11.3%



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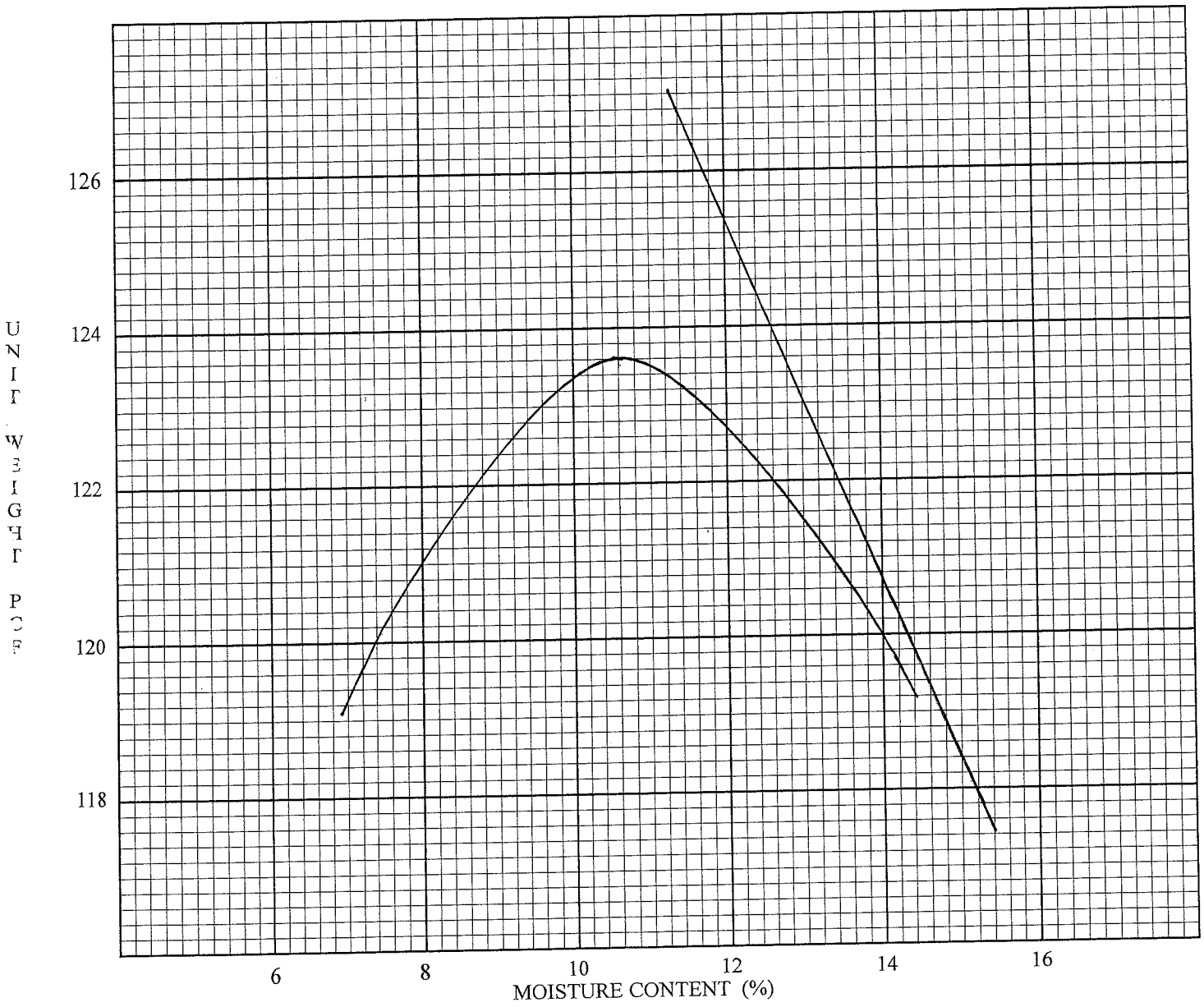
SAMPLE NUMBER: 10 (Test boring 13, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 123.6 pcf

SOIL TYPE: SANDY LEAN CLAY-brown (CL)

OPTIMUM MOISTURE: 10.6%



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REPORT OF: TESTS OF SOILS

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4-023 (019) 087, PCN 19376
North Dakota State Highway 23
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PROJECT NO: M2115106

SAMPLE NUMBER:	11	12
LOCATION:	Test boring 14, depth 1-5'	Test boring 15, depth 1-5'
CLASSIFICATION:	SILTY SAND WITH GRAVEL (SM)	SANDY LEAN CLAY (CL)
COLOR:	Brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	36	3
Sand (%)	50	40
Fines (%)	14	57
ATTERBERG LIMITS:		
Liquid Limit	NP	33
Plastic Limit	NP	15
Plasticity Index	NP	18
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "D"	Method "A"
Optimum Moisture (%)	6.0	9.8
Maximum Density (pcf)	140.0	127.2
CALIFORNIA BEARING RATIO (CBR):	Not Tested	Not Tested
Specimen Density (pcf)		
Percent Compaction (%)		
Remolded Moisture Content (%)		
Surcharge Load (lbs)		
Percent Swell – 96 hours		
CBR @ 0.1" Penetration		
Final Moisture Content (%)		
Final Moisture, Top 1" (%)		

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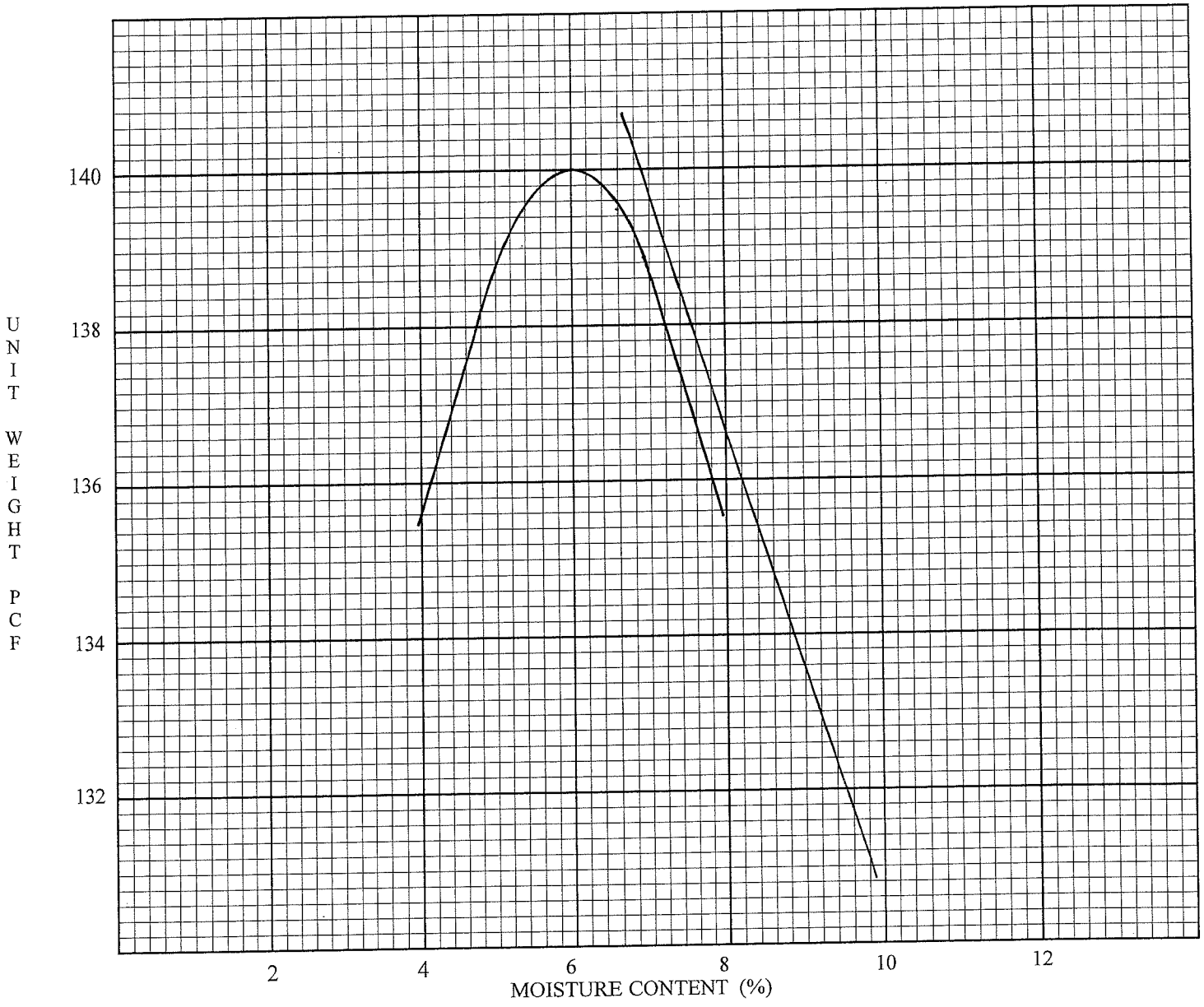
SAMPLE NUMBER: 11 (Test boring 14, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "D"

MAXIMUM DENSITY: 140.0 pcf

SOIL TYPE: SILTY SAND WITH GRAVEL-brown (SM)

OPTIMUM MOISTURE: 6.0%



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4-023 (019) 087, PCN 19376
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PROJECT NO: M2115106

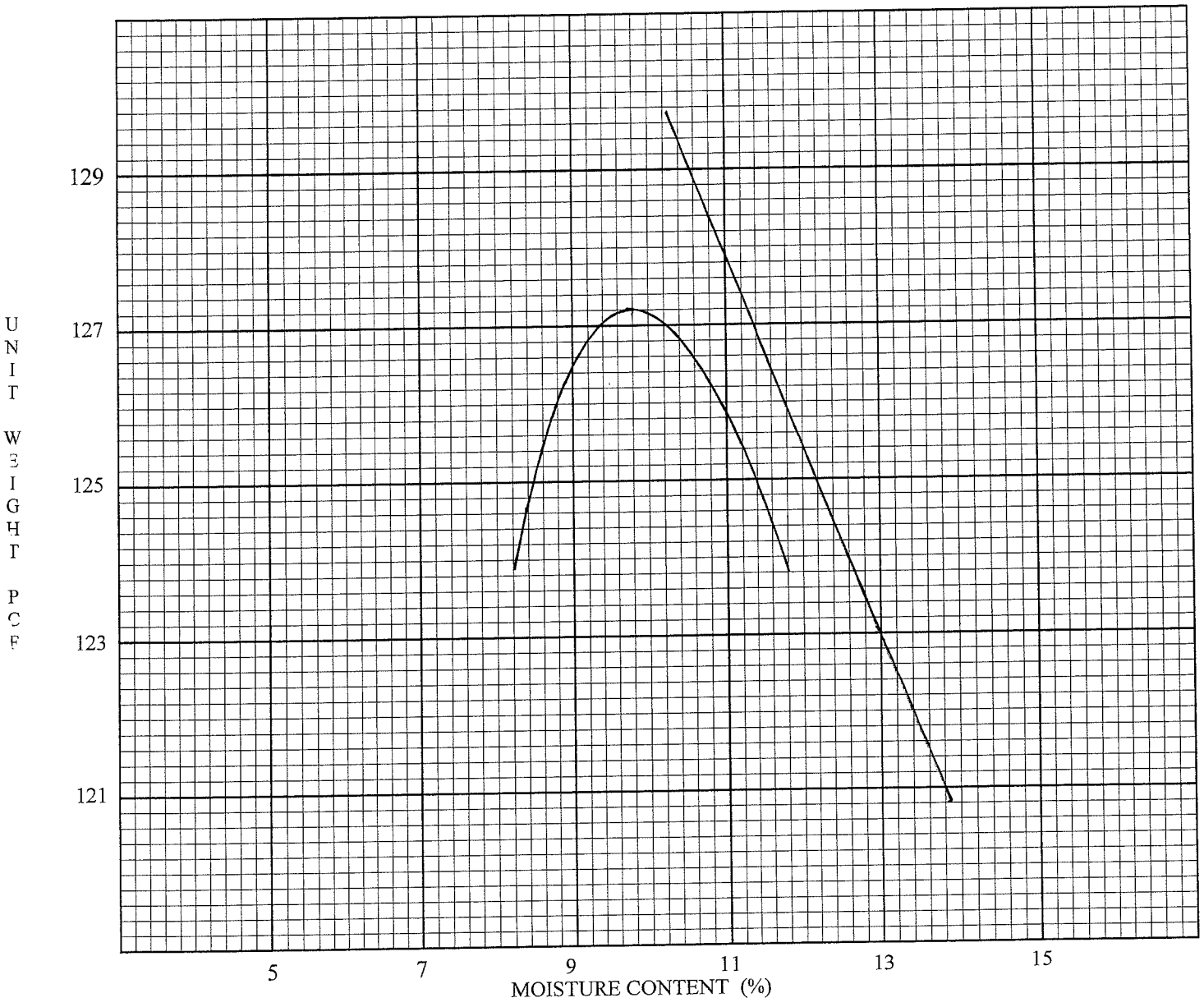
SAMPLE NUMBER: 12 (Test boring 15, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 127.2 pcf

SOIL TYPE: SANDY LEAN CLAY-brown (CL)

OPTIMUM MOISTURE: 9.8%



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REPORT OF: TESTS OF SOILS

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PROJECT NO: M2115106

SAMPLE NUMBER:	13	14
LOCATION:	Test boring 16, depth 1-5'	Test boring 17, depth 1-5'
CLASSIFICATION:	CLAYEY SAND (SC)	CLAYEY SAND WITH GRAVEL (SC)
COLOR:	Dark brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	0	21
Sand (%)	79	46
Fines (%)	21	33
ATTERBERG LIMITS:		
Liquid Limit	51	26
Plastic Limit	20	14
Plasticity Index	31	12
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	Method "C"
Optimum Moisture (%)	13.9	7.5
Maximum Density (pcf)	115.0	136.3
CALIFORNIA BEARING RATIO (CBR):	Not Tested	
Specimen Density (pcf)		122.7
Percent Compaction (%)		90.0
Remolded Moisture Content (%)		7.5
Surcharge Load (lbs)		10.0
Percent Swell – 72 hours		0.4
CBR @ 0.1" Penetration		8.7
Final Moisture Content (%)		9.7
Final Moisture, Top 1" (%)		9.8

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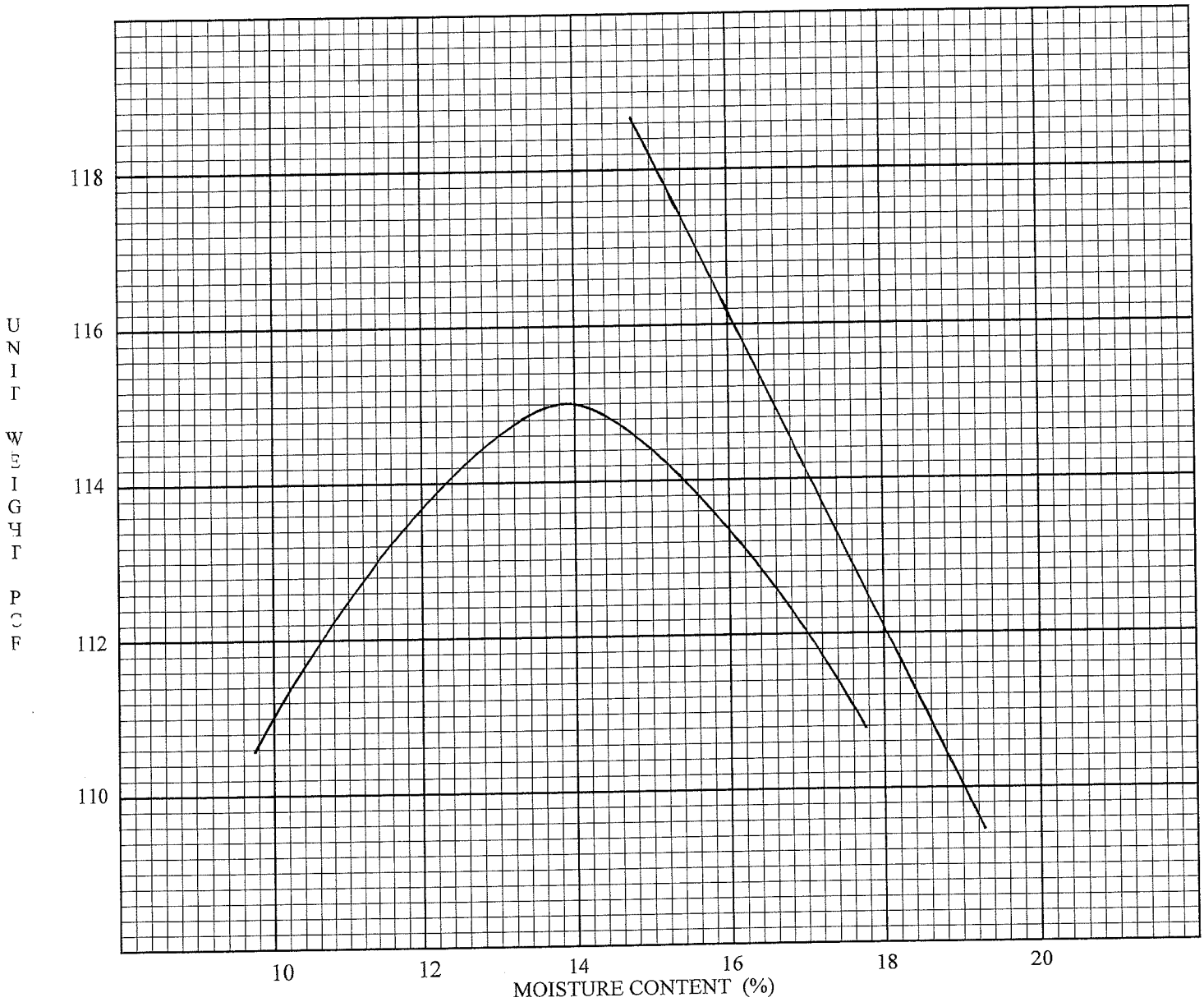
SAMPLE NUMBER: 13 (Test boring 16, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 115.0 pcf

SOIL TYPE: CLAYEY SAND-dark brown (SC)

OPTIMUM MOISTURE: 13.9%



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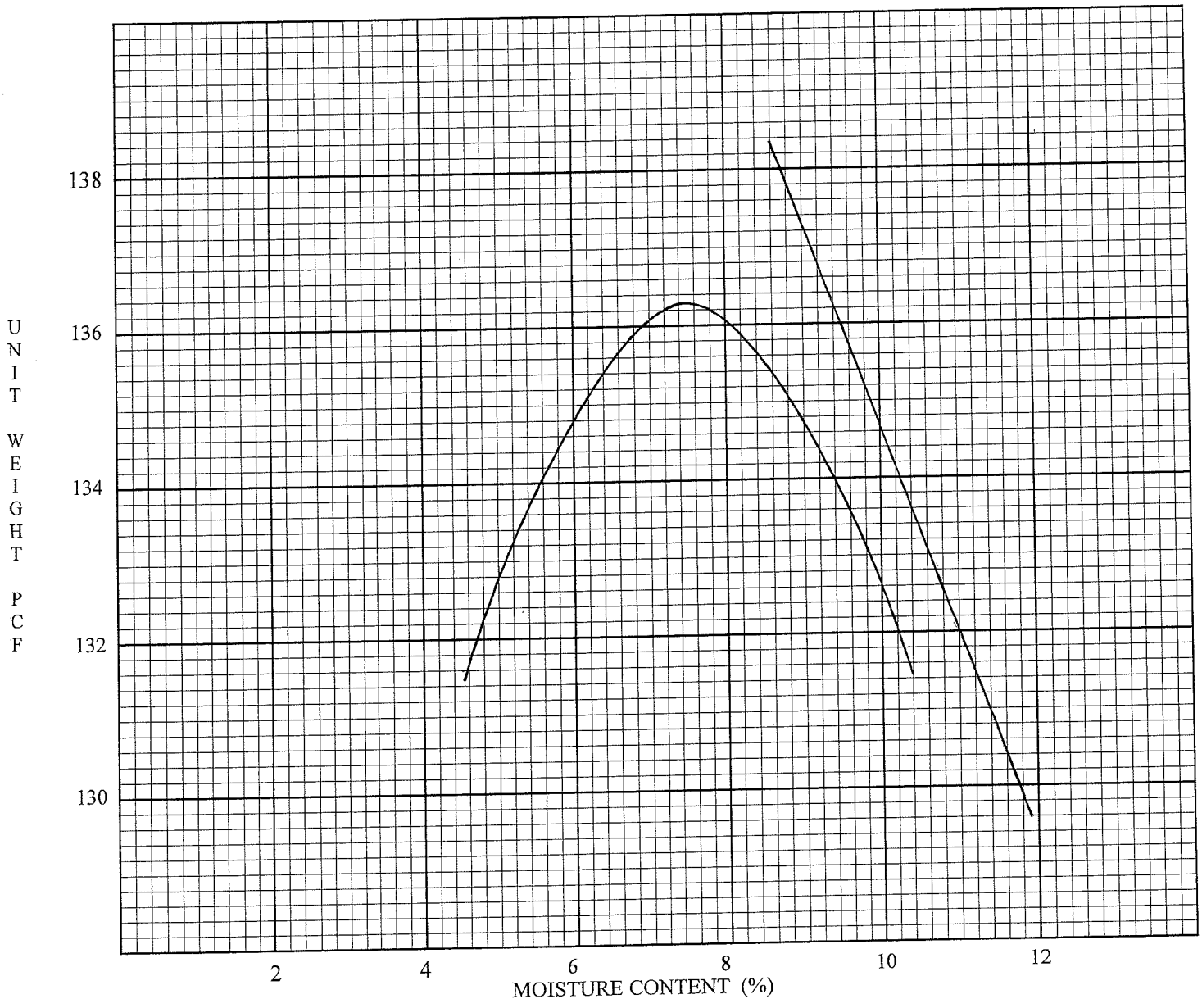
SAMPLE NUMBER: 14 (Test boring 17, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "C"

MAXIMUM DENSITY: 136.3 pcf

SOIL TYPE: CLAYEY SAND WITH GRAVEL-brown (SC)

OPTIMUM MOISTURE: 7.5%



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REPORT OF: TESTS OF SOILS

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SAMPLE NUMBER:	15	16
LOCATION:	Test boring 18, depth 1-5'	Test boring 20, depth 1-5'
CLASSIFICATION:	CLAYEY SAND (SC)	CLAYEY SAND (SC)
COLOR:	Grayish brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	4	3
Sand (%)	54	53
Fines (%)	42	44
ATTERBERG LIMITS:		
Liquid Limit	26	24
Plastic Limit	15	14
Plasticity Index	11	10
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	9.3	9.1
Maximum Density (pcf)	128.6	129.7
CALIFORNIA BEARING RATIO (CBR):		Not Tested
Specimen Density (pcf)	115.7	
Percent Compaction (%)	90.0	
Remolded Moisture Content (%)	9.3	
Surcharge Load (lbs)	10.0	
Percent Swell – 72 hours	0.8	
CBR @ 0.1" Penetration	13	
Final Moisture Content (%)	11.9	
Final Moisture, Top 1" (%)	13.5	

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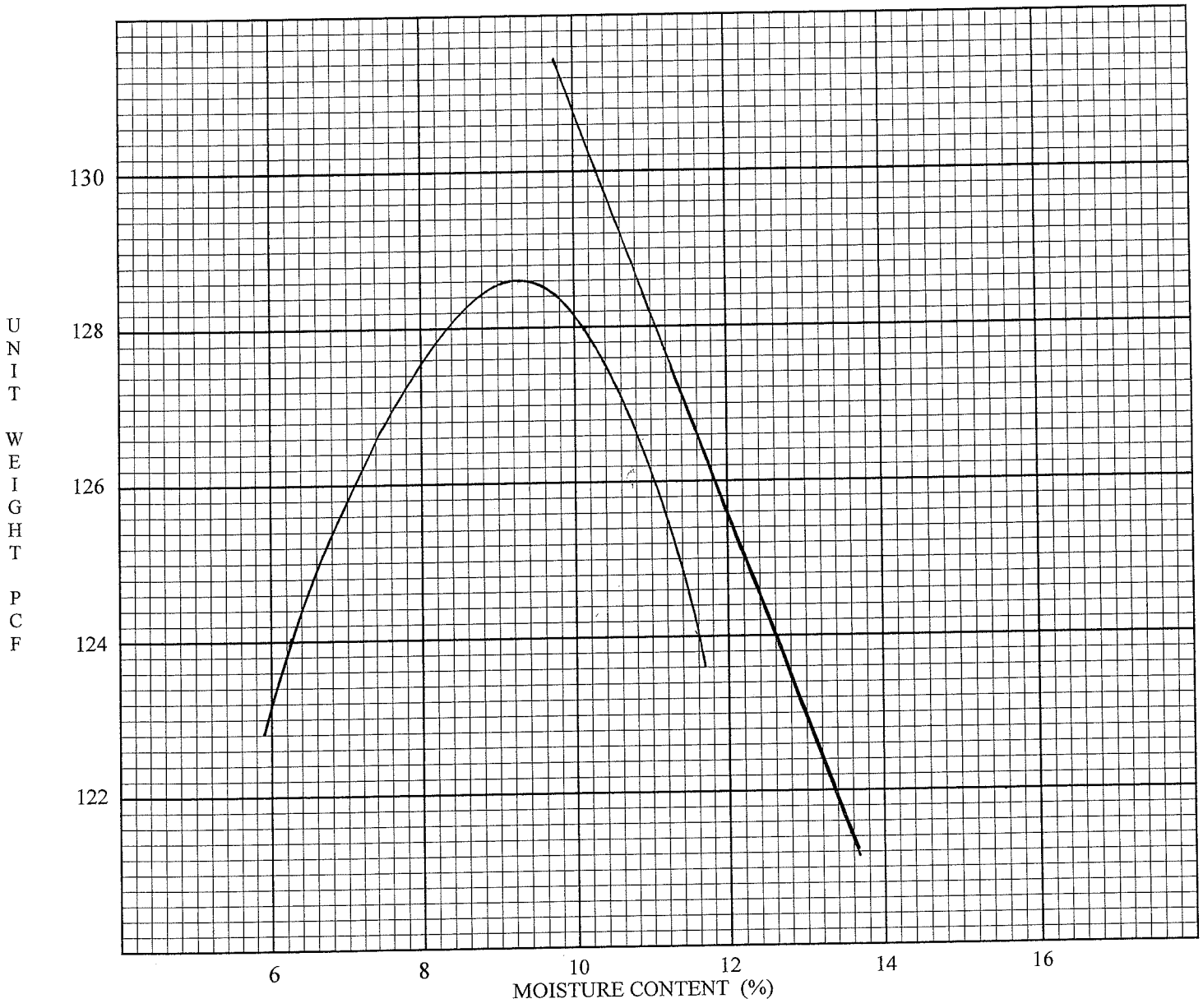
SAMPLE NUMBER: 15 (Test boring 18, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 128.6 pcf

SOIL TYPE: CLAYEY SAND-grayish brown (SC)

OPTIMUM MOISTURE: 9.3%



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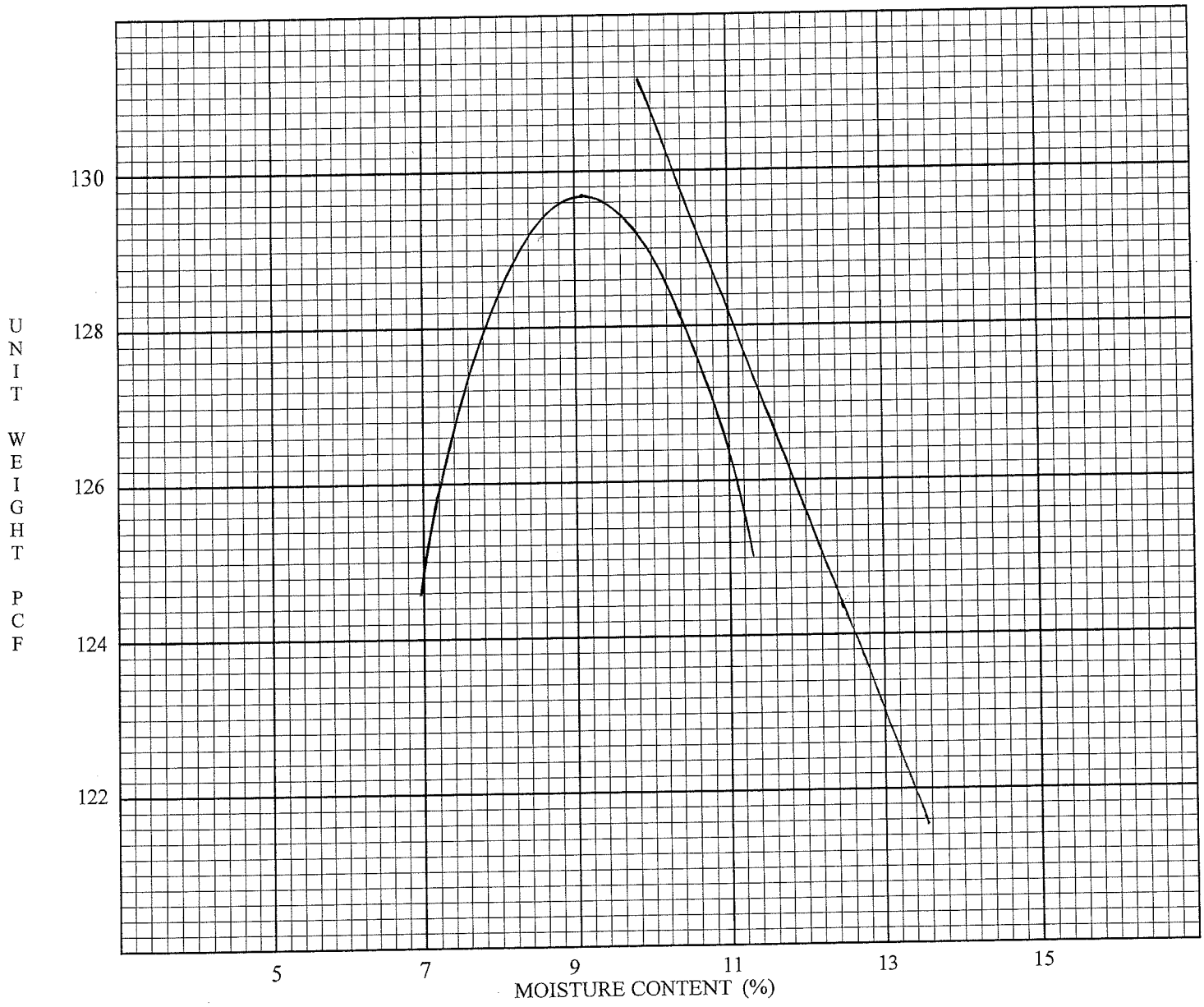
SAMPLE NUMBER: 16 (Test boring 20, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 129.7 pcf

SOIL TYPE: CLAYEY SAND-brown (SC)

OPTIMUM MOISTURE: 9.1%



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PROJECT NO: M2115106

SAMPLE NUMBER:	17	18
LOCATION:	GPR #1, depth 1-5'	GPR #4, depth 1-5'
CLASSIFICATION:	SANDY LEAN CLAY (CL)	SANDY LEAN CLAY (CL)
COLOR:	Grayish brown	Brown
PARTICLE DISTRIBUTION:		
Gravel (%)	2	2
Sand (%)	33	28
Fines (%)	65	70
ATTERBERG LIMITS:		
Liquid Limit	40	43
Plastic Limit	17	16
Plasticity Index	23	27
LABORATORY MOISTURE-DENSITY RELATIONS (see attached curve):		
Method	Modified Proctor, AASHTO:T180, Method "A"	
Optimum Moisture (%)	11.2	11.3
Maximum Density (pcf)	124.7	121.8
CALIFORNIA BEARING RATIO (CBR):	Not Tested	Not Tested
Specimen Density (pcf)		
Percent Compaction (%)		
Remolded Moisture Content (%)		
Surcharge Load (lbs)		
Percent Swell – 72 hours		
CBR @ 0.1" Penetration		
Final Moisture Content (%)		
Final Moisture, Top 1" (%)		

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PROJECT NO: M2115106

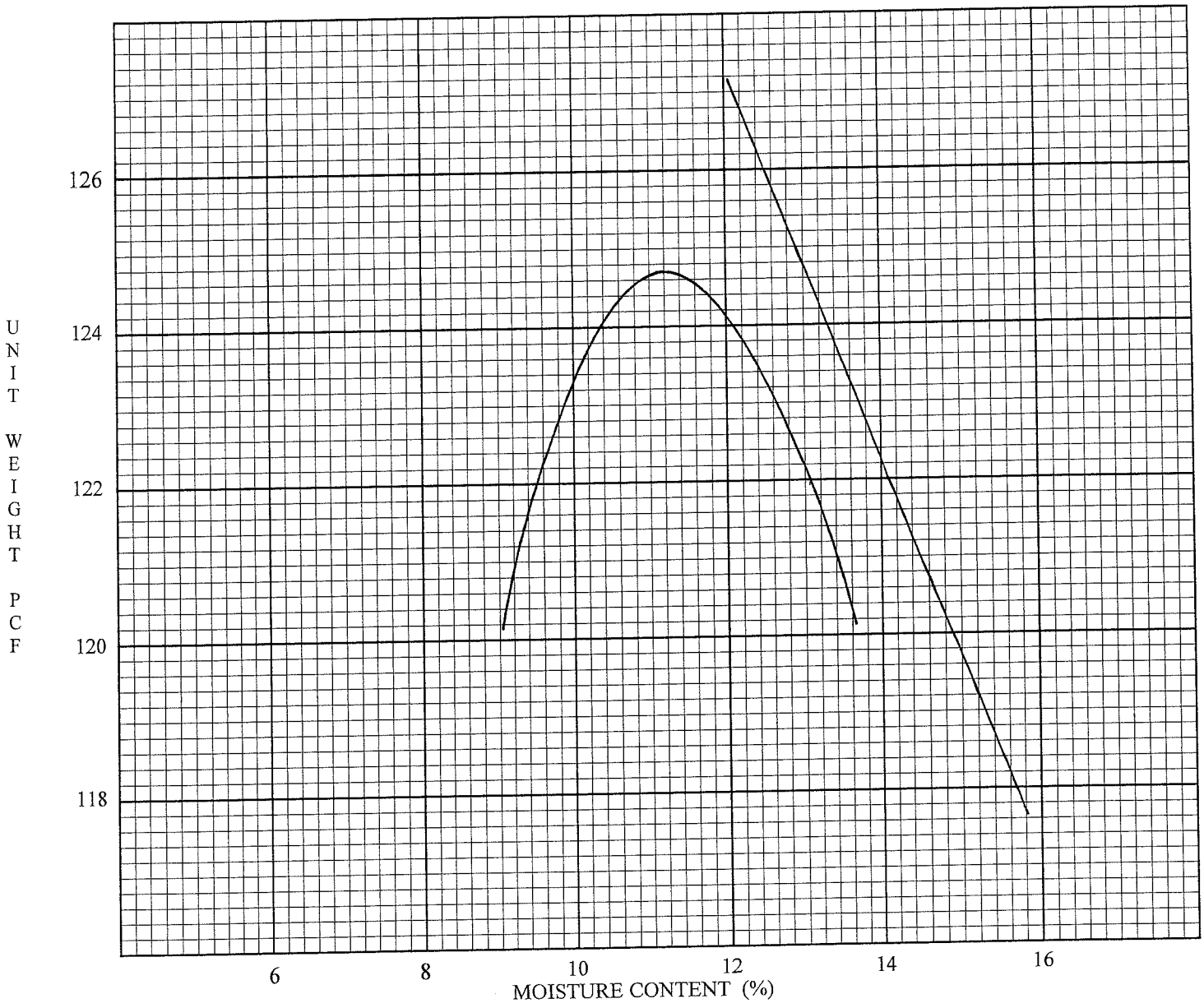
SAMPLE NUMBER: 17 (Test boring GPR #1, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 124.7 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 11.2%



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REPORT OF: MOISTURE-DENSITY RELATIONS OF SOIL

PROJECT: 4-023 (016) 078, PCN 19206
4-023 (019) 087, PCN 19376
North Dakota State Highway 23
Ward County, North Dakota

DATE: August 11, 2011

REPORTED TO: Attn: Rick Gunderson
Houston Engineering, Inc
1401 21st Avenue North
Fargo, ND 58102-1814

COPIES:

PROJECT NO: M2115106

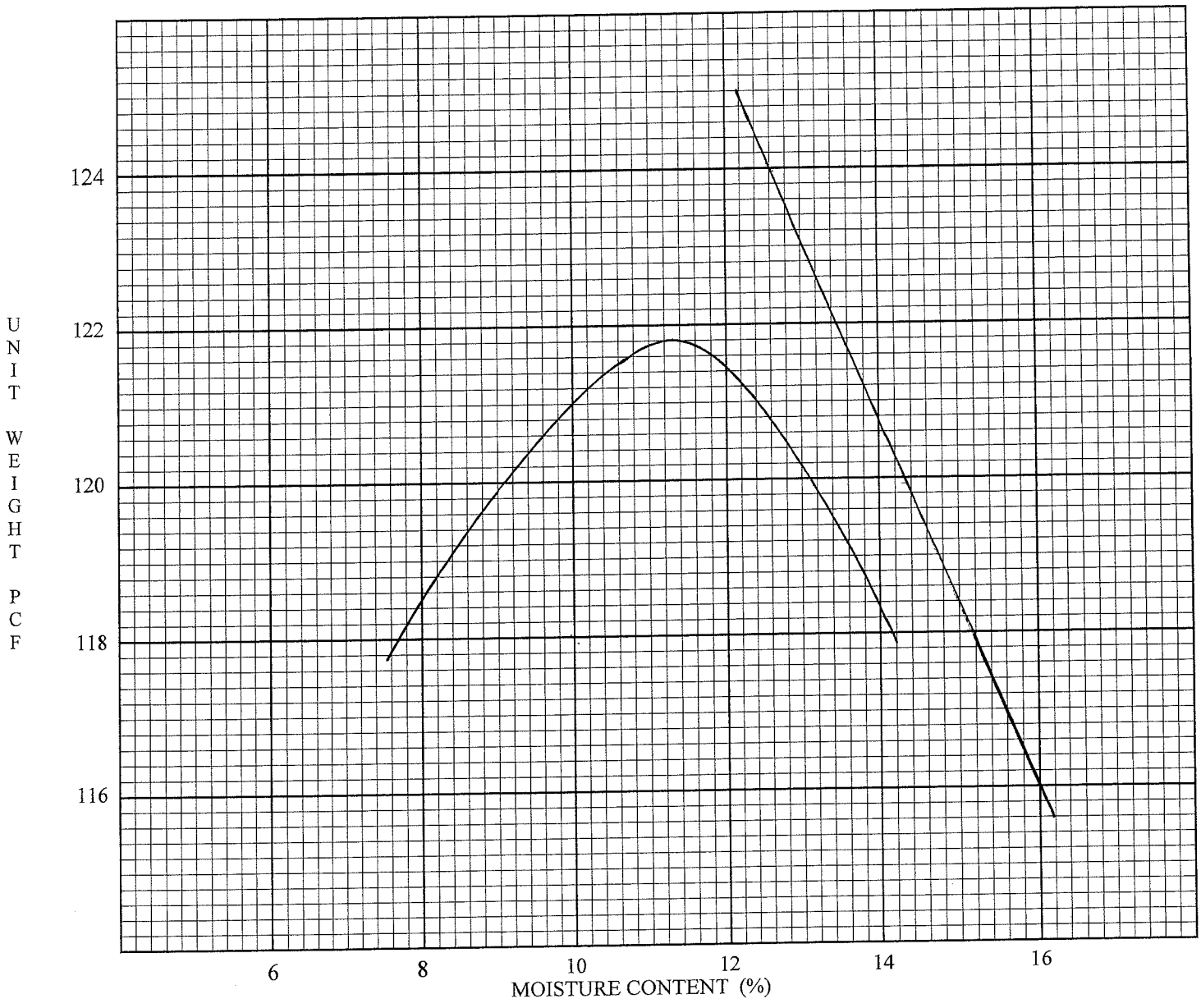
SAMPLE NUMBER: 18 (Test boring GPR #4, depth 1-5')

METHOD: Modified proctor, AASHTO:T180, Method "A"

MAXIMUM DENSITY: 121.8 pcf

SOIL TYPE: SANDY LEAN CLAY-grayish brown (CL)

OPTIMUM MOISTURE: 11.3%



DESCRIPTIVE TERMINOLOGY

RELATIVE DENSITY

Term	"N" Value
Very Loose	0-4
Loose	5 – 9
Medium Dense	10 – 30
Dense	31 – 50
Very Dense	Greater than 50

THICKNESS OF SOIL INTRUSIONS

Term	Range
Lense / Lamination	0 – 1/8"
Seam	1/8" – 1"
Layer	1" – 12"

CONSISTENCY OF COHESIVE SOILS

Term	"N" Value
Very soft	Less than 2
Soft	2 – 4
Medium stiff	5 – 8
Stiff	9 – 15
Very Stiff	16 – 30
Hard	Greater than 30

PARTICLES SIZES

Term	Range
Boulders	Over 12"
Cobbles	3"– 12"
Gravel	
Coarse	3/4" – 3"
Fine	#4 – 3/4"
Sand	
Coarse	#4 - #10
Medium	#10 - #40
Fine	#40 - #200
Silt	#200 – 0.005 mm
Clay	Less than 0.005 mm

Note: Sieve sizes shown are U.S. Standard

RELATIVE PROPORTIONS

Term	Range
Trace	0 – 5%
A Little	5 – 15%
With	15 – 50%

DRILLING & SAMPLING SYMBOLS

Symbol	Definition
FA	Flight Auger
SS	Split Spoon
TW	Thin-Walled Tube
HSA	Hollow Stem Auger
N	Penetration Resistance: blows required to drive a two-inch OD split spoon sampler one foot by means of a 140-pound hammer falling 30 inches

LABORATORY TEST SYMBOLS

Symbols	Definition
LL	Liquid Limit, %
PL	Plastic Limit, %
Q_u	Unconfined Compressive Strength, psf
Additional insertions in Q_u column	
G	Specific Gravity
SL	Shrinkage Limit, %
pH	Hydrogen Ion Content-Meter Method
O	Organic Content, % - Combustion Method
M.A.	Grain Size Analysis - Mechanical Method
Hyd.	Grain Size Analysis - Hydrometer Method
C	One-Dimensional Consolidation
Q_c	Triaxial Compression
K	Coefficient of Permeability

WATER LEVEL INFORMATION

Water levels shown on the boring logs are levels measured in the borings at the time and under the conditions noted. In sand, the indicated levels can be considered reliable. In clay soil, it is not possible to determine the ground water level within the normal scope of a test boring investigation, except where lenses or layers of more pervious water-bearing soils are present. Even then, a long period of time may be necessary to reach equilibrium. Therefore, the position of the water level noted on the boring logs for cohesive or mixed-texture soils may not indicate the true level of the ground water table.

SOIL STRATIFICATION BOUNDARIES

The soil stratification lines shown on the boring logs indicate the approximate boundary between different soil types. In the field, the transition between soil types may be gradual.

Classification of Soils For Engineering Purposes

ASTM:D 2487-98

	Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]			Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 Sieve	Gravels More than 50% coarse fraction retained on No. 4 Sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 Sieve	Clean Sands Less than 5% fines	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 Sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soils Fibric Peat > 67% Fiber	Primary organic matter, dark in color, and organic odor Hemic Peat 33%-67% Fibers			PT	Peat Sapric Peat < 33% Fibers

[A] Based on the material passing the 3-in. (75mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60} / D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines, are organic, add " with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥ 30% plus no. 200, predominantly sand, add "sandy" to group name.

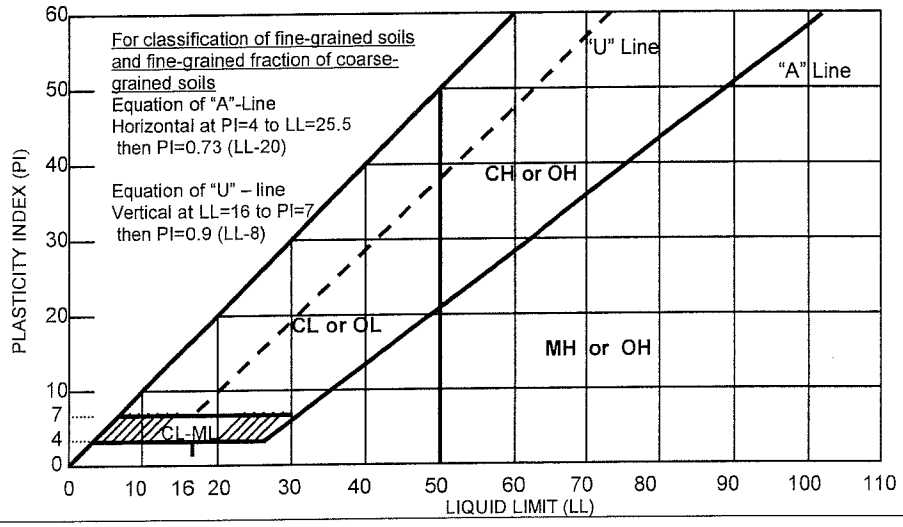
[M] If soil contains ≥ 30% plus no. 200, predominantly gravel, add "gravelly" to group name.

[N] PI≥ 4 and plots on or above "A"line.

[O] PI<4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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