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CONSULTANTS

- Geotechnical
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This document was originally issued and sealed by Robert N Temme, P.E., Registration number PE-4006, on December 19, 2014 and the original documents are stored at 1745 Samco Road, Rapid City, SD 57702.

**REPORT OF GEOTECHNICAL
EXPLORATION AND REVIEW**

**PROPOSED KILLDEER BYPASS
LINEAR SOIL SURVEY
KILLDEER, NORTH DAKOTA**

**AET # 37-01518
NDDOT #5-022(110)104
PCN # 20027**

Date:

December 19, 2014

Prepared for:

HDR Engineering, Inc.
1611 East Century Avenue, Suite 302
Bismarck, North Dakota 58503-0780





CONSULTANTS
· ENVIRONMENTAL
· GEOTECHNICAL
· MATERIALS
· FORENSICS

December 19, 2014

HDR Engineering, Inc.
1611 East Century Avenue, Suite 302
Bismarck, North Dakota 58503-0780

Attn: Rick Stopplemoor, P.E.

RE: Geotechnical Exploration and Review
Proposed Killdeer Bypass
Linear Soil Survey
Killdeer, North Dakota
Report No. 37-01518

Dear Rick:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the linear soil survey along the proposed alignment from ND Highway 22 to ND Highway 200 west of Killdeer, North Dakota. These services were performed referencing our scope of services and fee estimate dated March 3, 2014. We are submitting one hardcopy of the report to you and an additional electronic copy.

We appreciate the opportunity to be of service to you on this project. If you have any questions, please call our office at 605-388-0029.

Sincerely,
American Engineering Testing, Inc.

A handwritten signature in blue ink that reads 'Kristen R. Yates'.

Kristen R. Yates, P.E.
Geotechnical Project Manager
Office: (605) 388-0029
kyates@amengtest.com

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SIGNATURE PAGE

Prepared for:

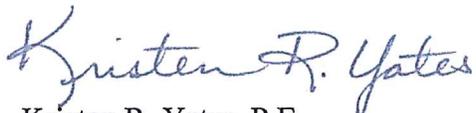
HDR Engineering, Inc.
1611 East Century Avenue, Suite 302
Bismarck, North Dakota 58503-0780

Attn: Rick Stopplemoor, P.E.

Prepared by:

American Engineering Testing, Inc.
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Authored by:


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Robert Temme, P.E.
Vice President Western Region

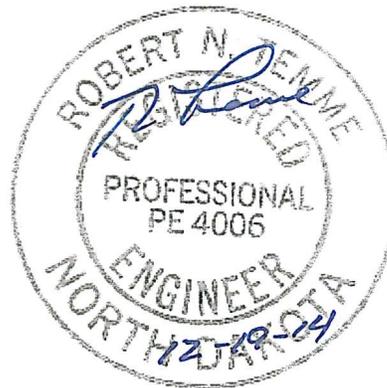


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1.0 INTRODUCTION

Based on the information provided, we understand the project is to include a new bypass road to route traffic to the west side of Killdeer, North Dakota. The new road bypass alignment will run for approximately 2 miles along Highway 200 from Killdeer to the west, along the section line between Highway 200 and Highway 22 and approximately 1 mile along Highway 22. The project location is shown on the Site Location Map in Appendix A.

The purpose of the geotechnical exploration and review is to provide a linear soil survey along the route with recommendations for design and construction of the new road alignment. To assist in planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct subsurface exploration work at the site including soil laboratory testing and geotechnical engineering review for the project. This report presents the results of the above services, and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's services were performed according to our scope of services and fee estimate dated March 3, 2014. The authorized scope consists of the following:

- Field Review
 - Conducted an onsite review to evaluate potential geotechnical issues
- Field Exploration
 - Advanced one (1) boring approximately every 1,000 feet along the alignment for standard penetration testing (SPT) and sample collection. Borings range in depth from 10 feet to 45 feet below grade.
 - Collected standard penetration test samples at 1-foot intervals for moisture contents borings beginning at subgrade elevation, and every 2.5 feet thereafter.
 - Observed the water levels at the time of drilling, if encountered
- The subsurface conditions were logged at each location and groundwater levels measured at each boring location following drilling and at the completion of the field services. The borings were advanced using a 3.25 inch inner diameter hollow stem auger. Disturbed split spoon soil samples were collected from the borings in accordance with ASTM D1586.
- Performed laboratory testing referencing ASTM and AASHTO procedures as appropriate to classify the soils and estimate index, strength, and consolidation properties of the soils. Laboratory testing included moisture content, Atterberg Limits, grain size analysis, and modified proctor.

- Prepared a final report including a summary of site conditions and field data, a summary of findings (AASHTO Classifications), and recommendations for other construction considerations.

These services are intended for geotechnical purposes. The scope is not intended to explore for the presence or extent of environmental contamination.

3.0 PROJECT INFORMATION

We understand the North Dakota Department of Transportation (NDDOT) is planning and designing a west side bypass route for trucks and other vehicular traffic around the town of Killdeer, North Dakota. The bypass alignment will extend along ND Highway 200 from ND Highway 22 west approximately 2 miles to 106th Avenue. At this point the bypass will extend north for a distance of approximately 4.5 miles along the section line before turning eastward and connecting back with ND Highway 22. The alignment is shown on the attached Site Vicinity Map and the Boring Location Map in Appendix A.

We understand the alignment of the proposed bypass will generally follow the current grade along the Highway 200 and Highway 22 alignment. Along the north-south section line alignment we anticipate required cuts and fills of 5 feet or less to reach the desired alignment elevations. We also understand new box culvert structures will be used along the north-south section line at Stations 134+05, 244+41, 289+31 and 294+95. These box culvert structures will be twin units measuring 12'x8', 9'x7', 12'x4' and 12'x4', respectively. The roadway elevations at these points will be 2 to 4 feet above the top of the culverts.

The North Dakota DOT has given new pavement design options for the alignment of the bypass road. These options consist of 7-inches of asphalt over 21-inches of Class 5 aggregate base, 7.5-inches of concrete over 12-inches of Class 5 aggregate base placed on 8-inches of a cement treated subgrade, 7.5-inches of asphalt over 14-inches of Class 5 aggregate base with a geo-grid placed 8-inches up in the aggregate base, and 9-inches of Portland Cement concrete over 8-inches of Class 5 aggregate base.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Review

AET reviewed the proposed alignment after it was staked by HDR Engineering. Parts of the alignment were inaccessible with a truck mounted rig due to soft soil conditions and high groundwater. An ATV rig was used to access and drill these locations.

4.2 Field Exploration Program

The subsurface exploration program conducted for the project consisted of forty-one (41) SPT borings for the linear soil survey and culvert crossings. The borings were drilled between September 30 and October 21, 2014. These locations are shown on the attached Boring Location Map. The borings were spaced at approximate 1,000 foot intervals along the proposed alignment. Elevations of the bore holes were estimated using the Plan & Profile sheets provided by HDR Engineering.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

4.2 Laboratory Testing

The laboratory test program included natural moisture content, Atterberg Limits, grain size analysis, and modified proctor. The moisture content test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed. The grain size analysis and modified proctor test results are indicated on separate sheets within Appendix A. The Atterberg Limits results are included on the respective modified proctor test results page for each bulk sample.

5.0 SITE CONDITIONS

5.1 Surface Observations

The alignment of the new bypass along ND Highway 200 and ND Highway 22 generally follows the existing roadway alignment. The north-south alignment of the bypass, along the section line, crosses open agricultural land to the west of Killdeer, North Dakota. The elevations of the existing topography along the alignment along Highway 200 ranges from approximately 2270 feet to 2335 feet; along the north-south section line from approximately 2260 feet to 2355 feet and along Highway 22 from approximately 2262 feet to 2280 feet.

5.2 Geology & Subsurface Conditions

The predominant geologic unit at the surface is the Sentinel Butte Formation. The Sentinel Butte Formation is known to consist of gray-brown silt, sand, clay, and sandstone with numerous and extensive lignite beds. The formation was deposited by rivers, lakes, and swamps during the Paleocene Epoch, and can be 600 feet thick in places. The bedrock in this unit is not typically well cemented. The lenses and layers that are well cemented include sandstones, claystones, and mudstones found sporadically within the unit.

The soil boring logs for this project site indicate either overlying fill or alluvium soils that are consistent with those of the Sentinel Butte Formation. In general, the soil borings that were advanced along the existing roadway alignments, either within the roadway or adjacent to it, consisted of fill material associated with the roadway subbase over natural soils consistent with those of the Sentinel Butte Formation.

Borings that were advanced along the north-south portion of alignment through the open fields typically encountered a varying amount of topsoil over either alluvial soils or Sentinel Butte soils. The alluvial soils have been classified as mixed to coarse alluvium which consists of loose to dense silty sand and sandy with silt, loose to medium dense clayey sand, medium dense to dense sandy silt, and loose silt with sand. Where encountered below the alluvium, the Sentinel Butte Formational soils extended to the terminal depths of the borings.

The Sentinel Butte Formation consisted of layers of gray, firm to hard lean clay, with layers of silty to clayey sand, varying amounts of silt and sand within the clay layers, and fat clay with very dense lignite layers.

5.3 Groundwater

Groundwater levels were checked in the borings at various times during drilling operations and upon completion of drilling and prior to backfilling at the end of the project. Groundwater was not observed in any of the twenty (20) test holes, drilled to 10 feet in depth, along Highways 200 and 22. Groundwater was encountered and measured in 11 of the 21 borings drilled along the north-south section line. Groundwater depths in these borings ranged from about 2.7 to 17.5 feet below ground surface.

The depth or lack of subsurface water noted at the boring locations should not be taken as an accurate representation of the actual subsurface water levels. A long period of time can be required for groundwater levels to stabilize in the soils present at the site; the period of time needed for groundwater stabilization in the boreholes is generally not available during a typical subsurface exploration program, without the installation of piezometers, which was not part of our scope of services for this project. Groundwater levels should be expected to fluctuate seasonally and yearly.

5.4 Soil Classification

For the linear soil survey a total of forty-one (41) SPT borings were drilled. Based on the boring locations and depths, AET collected 20 bulk samples. Laboratory testing on bulk samples included moisture content, Atterberg limits, gradation, and modified proctor. A moisture content profile at 1-foot intervals was developed starting two (2) feet below the proposed grade at the proposed roadway borings where bulk samples were obtained. These samples provided information for classifying the soil layers present beneath the project site.

Summary tables were prepared from the data obtained from the soil borings and are presented as follows. The Linear Laboratory Analysis is included in Appendix A.

Table 1. Summary of In-Place and Optimum Moisture Contents

AASHTO Class	Qty	In-Place Moisture Range (%)	In-Place Moisture Average (%)	T-180 Optimum Moisture Average (%)	Difference of Optimum vs. In-Place Moisture (%)
A-2-4	84	3 - 28	12.1	11.7	0.4
A-4	7	15 - 28	22.4	12.1	10.3
A-6	163	6 - 39	20.4	13.2	7.2
A-7-6	37	21 - 37	27.6	15.4	12.2

Table 2. Summary of In-Place vs. Optimum Moisture Contents

AASHTO Class	Qty	Below Optimum (%)	Optimum to Moderate (0-6% over opt.)	Moderate to High (6% - 10% over opt.)	High (10% - 16% over opt.)	Very High (> 16% over opt.)
A-2-4	4	50	30	8	7	1
A-4	5	0	29	14	57	0
A-6	7	12	34	21	26	4
A-7-6	4	0	8	22	54	16

Table 3. Summary of Atterberg Limits

AASHTO Class	Liquid Limit Range (%)	Liquid Limit Average (%)	Plastic Limit Range (%)	Plastic Limit Average (%)	Plasticity Index Range (%)	Plasticity Index Average (%)	Swell Potential*
A-2-4	17 - 28	24	17 - 18	18	0 - 10	6	Low
A-4	27 - 29	28	16 - 20	18	8 - 13	10	Low
A-6	28 - 40	36	16 - 20	18	10 - 23	18	Low
A-7-6	41 - 90	59	18 - 26	22	20 - 72	29	Marginal

*Swell potential is based on the average PI for the AASHTO class soils tested. Low: PI<25, Marginal: 25≤PI≤35, High: >35

Table 4. Group Index

AASHTO Class	Average Fines (%)	Liquid Limit Average (%)	Plasticity Index Average (%)	Group Index	Subgrade Rating
A-2-4	30	24	6	0	Good
A-4	43	28	10	1	Good
A-6	66	36	18	10	Fair
A-7-6	88	59	29	30	Poor

6.0 RECOMMENDATIONS

6.1 Subgrade Preparation

We anticipate varying depths of cuts and fills will be required to obtain the final subgrade elevations along the alignment, however, we assume the cuts and fill will be generally less than 5 feet. We recommend 12-inches of subgrade preparation for this project. Subgrade preparation should comply with NDDOT Specific 230.02 Type A in cut areas and in fill areas where less than 18 inches of fill will be placed. In fill areas with greater than 18-inches of fill, subgrade preparation should consist of topsoil stripping. If unstable soils are present below the topsoil, scarification and drying or over-excavation and replacement of the unsuitable soils could be considered. Compaction control should be in accordance with AASHTO T-180 and Specification 203.02G Type A.

6.2 Subcutting & Unsuitable Materials

Subcutting along the alignments is not anticipated. High plasticity fat clays, lignite or unsuitable fills were not observed in the borings in the upper 3 feet below anticipated subgrade elevation. If encountered during construction, we recommend high plasticity fat clays and/or any lignite layers be removed to 3 feet below final subgrade elevation.

6.3 Culvert Structures

As indicated new twin concrete culverts are to be placed at four (4) locations along the north-south section line alignment. At Station 134+05 (B-18), twin 12-foot x 8-foot culverts will be

used. At Station 244+41 (B-29) twin 9-foot x 7-foot culverts will be placed. At Stations 289+31 (B-34) and Station 294+95 (B-35) twin 12-foot x 4-foot culverts are to be placed.

We have assumed the top of road subgrade at these points will be 1 to 2 feet higher in elevation than the twin concrete box culvert structures.

Based on our borings drilled near these locations we anticipate the site soils will need to be over-excavated a minimum of two (2) feet below the footprint of these structures as well as two (2) feet on either side. Temporary dewatering of the excavations and/or temporary rerouting of the channels should be anticipated for each location.

To obtain subgrade stability, a clean granular backfill will need to be placed and compacted within the over-excavation and below the new culvert structures. We recommend the base of the over-excavation be observed by the geotechnical engineer prior to the placement of the granular backfill. Use of a S1 or S2 geo-grid or geo-fabric may be required at each or select locations to provide for a suitable subgrade on which to place the granular backfill.

We recommend the granular backfill material meet the requirements for either a CL 3 or CL 5 aggregate. The granular backfill should be placed near optimum moisture and to at least 95% of the maximum modified Proctor dry density.

7.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use".

Appendix A

AET Project No. 37-01518

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Classification System
Site Vicinity Map
Boring Location Map
Subsurface Boring Logs (41)
Gradation Curves (20)
Modified Proctor Test Results (20)
Linear Laboratory Analysis

Appendix A
Geotechnical Field Exploration and Testing
Report No. 37-01518

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling seven (7) standard penetration test borings. The locations of the borings appear on the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as “DS” or “SU” on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Thin Walled Tube Sampling

Sample types described as “TW” on the boring logs are thin walled samples which were obtained by hydraulically pushing a thin-walled Shelby tube into the material to be sampled.

A.2.4 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of “topsoil” layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

Visual-manual judgment of the AASHTO Soil Group is also noted as a part of the soil description. A chart presenting details of the AASHTO Soil Classification System is also attached.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under “Water Level Measurements” on the logs:

- ◆ Date and Time of measurement
- ◆ Sampled Depth: lowest depth of soil sampling at the time of measurement
- ◆ Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- ◆ Cave-in Depth: depth at which measuring tape stops in the borehole
- ◆ Water Level: depth in the borehole where free water is encountered

Appendix A
Geotechnical Field Exploration and Testing
Report No. 37-01518

- ♦ **Drilling Fluid Level:** same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days. For this project we will retain representative samples of the soils from the borings for a period of 90 days after submittal our final geotechnical report.

UNIFIED SOIL CLASSIFICATION SYSTEM

ASTM Designations: D 2487, D2488

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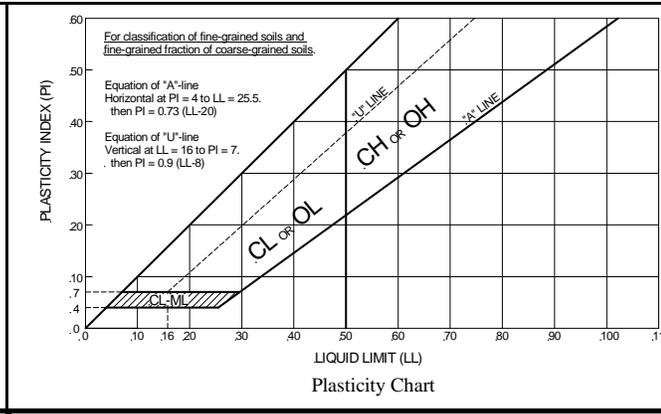
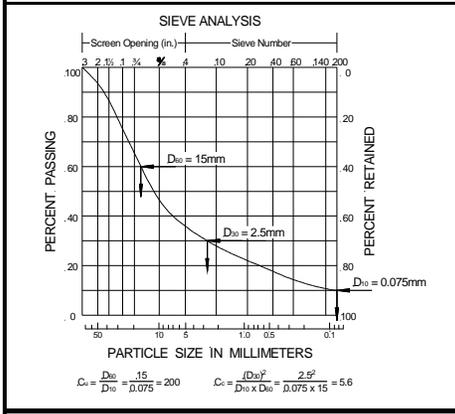
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A			Soil Classification		
			Group Symbol	Group Name ^B	
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 < Cc < 3^E$	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 ^D	$Cu \geq 6$ and $1 < Cc < 3^E$	SW	Well-graded sand ^I
			$Cu < 6$ and $1 > Cc > 3^E$	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 (see Plasticity Chart below)	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 < 0.75	OL	Organic clay ^{K,L,M,N}	
		Liquid limit - not dried		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 < 0.75	OH	Organic clay ^{K,L,M,P}		
	Liquid limit - not dried		Organic silt ^{K,L,M,Q}		
Highly organic soil	Primarily organic matter, dark in color, and organic in odor		PT	Peat ^R	

Notes

- ^ABased on the material passing the 3-in (75-mm) sieve.
^BIf field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
^CGravels with 5 to 12% fines require dual symbols:
 GW-GM well-graded gravel with silt
 GW-GC well-graded gravel with clay
 GP-GM poorly graded gravel with silt
 GP-GC poorly graded gravel with clay
^DSands 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

$$^E C_u = D_{60} / D_{10}, \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

- ^FIf soil contains $\geq 15\%$ sand, add "with sand" to group name.
^GIf fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
^HIf fines are organic, add "with organic fines" to group name.
^IIf soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
^JIf Atterberg limits plot is hatched area, soils is a CL-ML silty clay.
^KIf soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
^LIf soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
^MIf soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.
^N $PI \geq 4$ and plots on or above "A" line.
^O $PI < 4$ or plots below "A" line.
^PPI plots on or above "A" line.
^QPI plots below "A" line.
^RFiber Content description shown below.



ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size	Gravel Percentages	Consistency of Plastic Soils	Relative Density of Non-Plastic Soils																																														
<table border="0" style="width: 100%;"> <tr> <th>Term</th> <th>Particle Size</th> </tr> <tr> <td>Boulders</td> <td>Over 12"</td> </tr> <tr> <td>Cobbles</td> <td>3" to 12"</td> </tr> <tr> <td>Gravel</td> <td>#4 sieve to 3"</td> </tr> <tr> <td>Sand</td> <td>#200 to #4 sieve</td> </tr> <tr> <td>Fines (silt & clay)</td> <td>Pass #200 sieve</td> </tr> </table>	Term	Particle Size	Boulders	Over 12"	Cobbles	3" to 12"	Gravel	#4 sieve to 3"	Sand	#200 to #4 sieve	Fines (silt & clay)	Pass #200 sieve	<table border="0" style="width: 100%;"> <tr> <th>Term</th> <th>Percent</th> </tr> <tr> <td>A Little Gravel</td> <td>3% - 14%</td> </tr> <tr> <td>With Gravel</td> <td>15% - 29%</td> </tr> <tr> <td>Gravelly</td> <td>30% - 50%</td> </tr> </table>	Term	Percent	A Little Gravel	3% - 14%	With Gravel	15% - 29%	Gravelly	30% - 50%	<table border="0" style="width: 100%;"> <tr> <th>Term</th> <th>N-Value, BPF</th> </tr> <tr> <td>Very Soft</td> <td>less than 2</td> </tr> <tr> <td>Soft</td> <td>2 - 4</td> </tr> <tr> <td>Firm</td> <td>5 - 8</td> </tr> <tr> <td>Stiff</td> <td>9 - 15</td> </tr> <tr> <td>Very Stiff</td> <td>16 - 30</td> </tr> <tr> <td>Hard</td> <td>Greater than 30</td> </tr> </table>	Term	N-Value, BPF	Very Soft	less than 2	Soft	2 - 4	Firm	5 - 8	Stiff	9 - 15	Very Stiff	16 - 30	Hard	Greater than 30	<table border="0" style="width: 100%;"> <tr> <th>Term</th> <th>N-Value, BPF</th> </tr> <tr> <td>Very Loose</td> <td>0 - 4</td> </tr> <tr> <td>Loose</td> <td>5 - 10</td> </tr> <tr> <td>Medium Dense</td> <td>11 - 30</td> </tr> <tr> <td>Dense</td> <td>31 - 50</td> </tr> <tr> <td>Very Dense</td> <td>Greater than 50</td> </tr> </table>	Term	N-Value, BPF	Very Loose	0 - 4	Loose	5 - 10	Medium Dense	11 - 30	Dense	31 - 50	Very Dense	Greater than 50
Term	Particle Size																																																
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<p>Moisture/Frost Condition (MC Column)</p> <p>D (Dry): Absence of moisture, dusty, dry to touch.</p> <p>M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").</p> <p>W (Wet/Waterbearing): Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.</p> <p>F (Frozen): Soil frozen</p>	<p>Layering Notes</p> <p>Laminations: Layers less than 1/2" thick of differing material or color.</p> <p>Lenses: Pockets or layers greater than 1/2" thick of differing material or color.</p>	<p>Fiber Content of Peat</p> <p>Fiber Content (Visual Estimate)</p> <p>Term</p> <p>Fibric Peat: Greater than 67%</p> <p>Hemic Peat: 33 - 67%</p> <p>Sapric Peat: Less than 33%</p>	<p>Organic/Roots Description (if no lab tests)</p> <p>Soils are described as <i>organic</i>, if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. <i>Slightly organic</i> used for borderline cases.</p> <p>With roots: Judged to have sufficient quantity of roots to influence the soil properties.</p> <p>Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.</p>																																														

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1d" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
<u>?</u> :	Water level directly measured in boring
<u>∅</u> :	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q _p :	Pocket Penetrometer strength, tsf (<u>approximate</u>)
q _c :	Static cone bearing pressure, tsf
q _u :	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designator in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, re-molded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

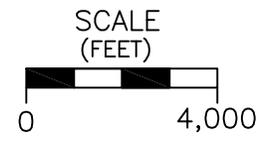
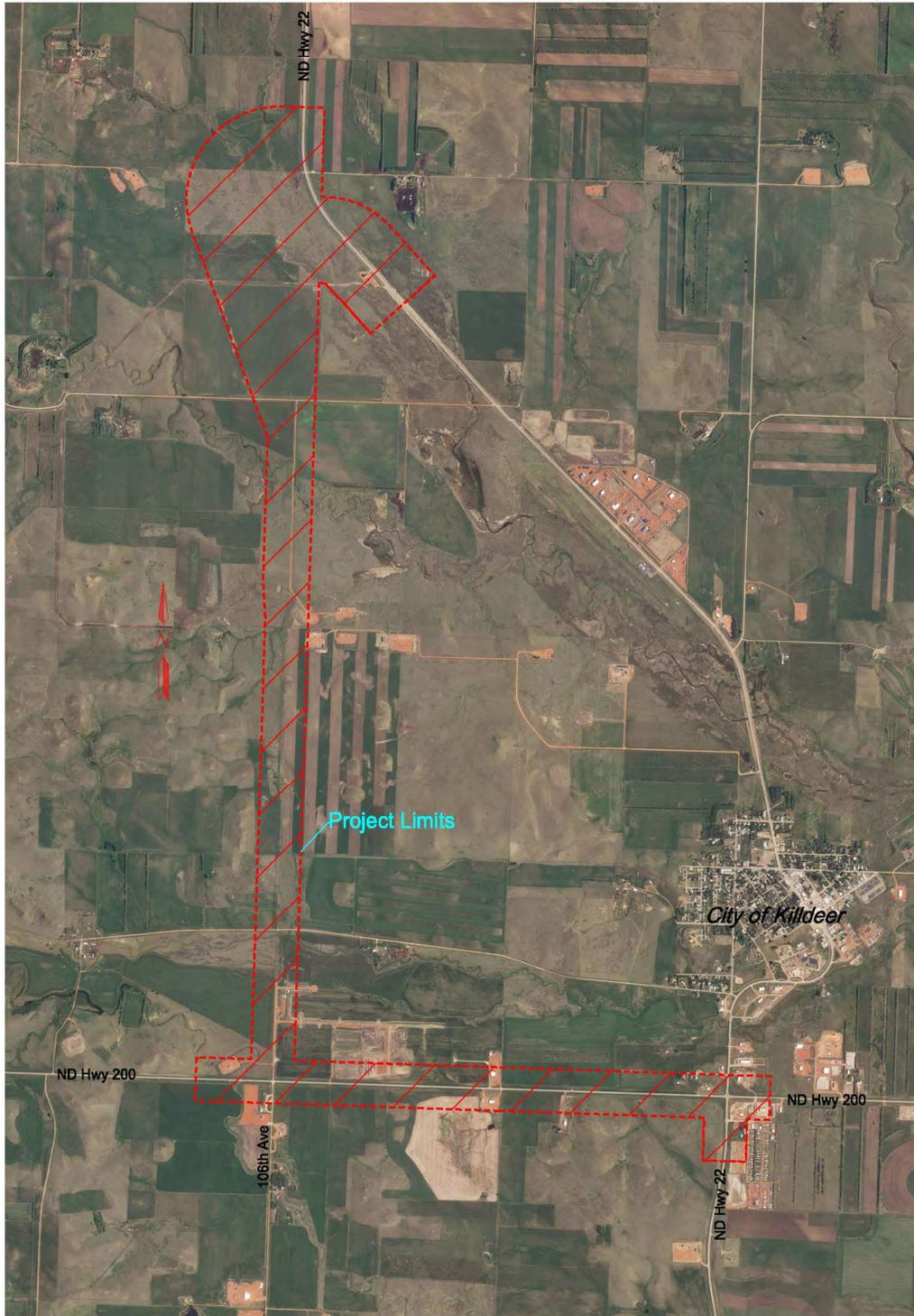
The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the REC column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM:D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").

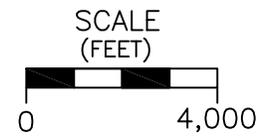
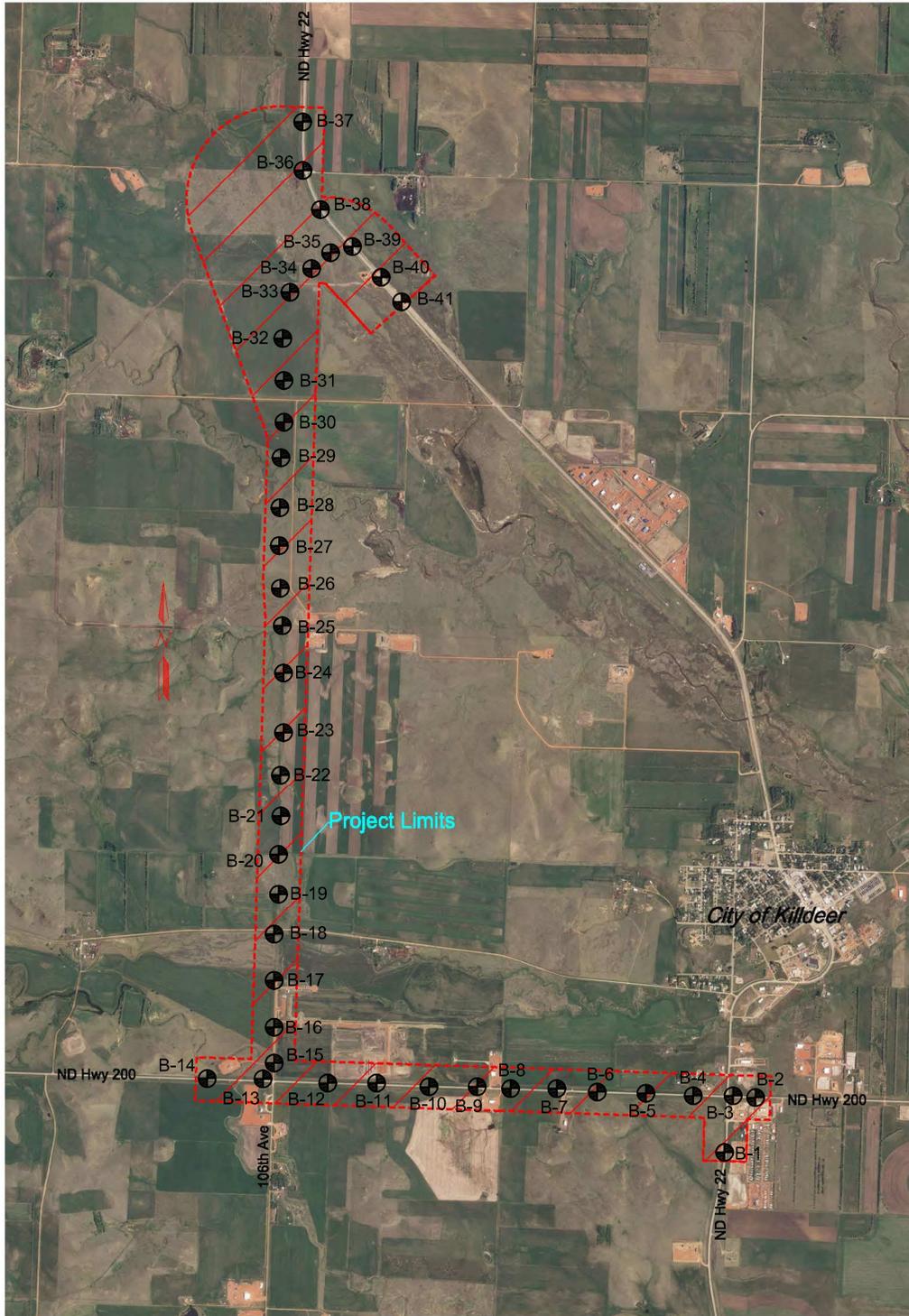
ROCK DESCRIPTION TERMINOLOGY

<u>Rock Property</u>	<u>Descriptive Term</u>	<u>Visual or Physical Properties</u>
Weathering	Highly Weathered	Almost complete rock disintegration and decomposition. Soil-like texture with some small inclusions of hard rock.
	Very Weathered	Abundant fractures coated with oxides, carbonates, sulfates, mud, etc., thorough discoloration, rock disintegration, and mineral decomposition.
	Moderately Weathered	Some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition
	Slightly Weathered	A few stained fractures, slight discoloration, little to no effect on cementation, no mineral decomposition.
	Fresh	Unaffected by weathering agents, no appreciable change with depth.
Fracturing	Intensely Fractured	Less than 1" spacing
	Very Fractured	1" to 6" spacing
	Moderately Fractured	6" to 12" spacing
	Slightly Fractured	12" to 36" spacing
	Solid	36" spacing or greater
Stratification	Thinly Laminated	Less than 1/10"
	Laminated	1/10" to 2"
	Very Thinly Bedded	2" to 2"
	Thinly Bedded	2" to 2'
	Thickly Bedded	More than 2'
Hardness	Soft	Can be dug by hand and crushed by fingers.
	Moderately Hard	Friable, can be gouged deeply with knife and will crumble readily under light hammer blows.
	Hard	Knife scratch leaves dust trace, will withstand a few hammer blows before breaking.
	Very Hard	Scratched with knife with difficulty, difficult to break with hammer blows.
RQD*	Very Poor	0 - 25 (%)
	Poor	25 - 50 (%)
	Fair	50 - 75 (%)
	Good	75 - 90 (%)
	Excellent	90 - 100 (%)

**Rock Quality Designation: Percent of core run consisting of the summation of hard, sound and unfractured rock core segments 40 or greater in length.*



PROJECT: PROPOSED KILLDEER BYPASS DUNN COUNTY, NORTH DAKOTA		PROJECT NO. 37-01518
SUBJECT: SITE VICINITY MAP		DATE: OCTOBER 9, 2014
SCALE: 1 INCH = 4,000 FEET	DRAWN BY: KY	REVIEWED BY: RNT



**AMERICAN
ENGINEERING
TESTING, INC.**

PROJECT: PROPOSED KILLDEER BYPASS DUNN COUNTY, NORTH DAKOTA		PROJECT NO. 37-01518
SUBJECT: BORING LOCATION MAP		DATE: OCTOBER 9, 2014
SCALE: 1 INCH = 4,000 FEET	DRAWN BY: KY	REVIEWED BY: RNT



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-2 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2308.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , sandy lean clay with a little gravel and trace organics, brown (A-6)	FILL	7	M	SS	16	21				
2							17				
3	FILL , silty sand with trace organics, with lamination of clay, brown (A-2-4)	FILL	10	M	SS	22	8				
4							11				
5							8				
6							16				
7											
8			14	M	SS	18	12				
9											
10	SILTY SAND with trace organics, black, loose (SM, A-2-4)	COARSE ALLUVIUM	5	M	SS	14	27				
11											
Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/6/14	15:25	11.5	0.0	8.5	NA	None	
BORING COMPLETED: 10/6/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-3 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2308.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	FILL , silty sand with trace organics, dark brown to brown (A-2-4)	FILL	3	M	SS	16	14					
2	2" BITUMINOUS PAVEMENT FILL , silty sand with a little gravel, brown (A-2-4)						12					
3	SILTY SAND with trace organics, light brown with iron oxide stains, very loose (SM, A-2-4)	SENTINEL BUTTE FORMATION	2	M	SS	17	8					
4	SANDSTONE , gray (SP, A-1-a)						28					
5			50/5	M	SS	1						
6												
7	SILTY SAND , light brown with iron oxide stains, medium dense (SM, A-2-4)											
8			25	M	SS	18	10					
9												
10												
11			27	M	SS	18	8					
Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/6/14	13:45	11.5	0.0	8.5	NA	None	
BORING COMPLETED: 10/6/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-4 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2296.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS								
							WC	DEN	LL	PL	%-#200				
	12" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT													
1	FILL , silty sand with a little gravel, brown (A-2-4)	FILL	7	M	SS	17	22								
2	FILL , sandy lean clay, brown (A-6)						22								
3			6	M	SS	3	19								
4	CLAYEY SAND , brown, medium dense (SC, A-6)	MIXED ALLUVIUM					14								
5			15	M	SS	20	18								
6															
7	SILTY SAND , brown, loose (SM, A-2-4)	COARSE ALLUVIUM													
8			5	M	SS	18	8								
9															
10															
11			6	M	SS	18	6								
Bottom of Boring															

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	9:30	11.5	0.0	8.9	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-5 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2276.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS						
							WC	DEN	LL	PL	%-#200		
	12" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					8						
1	FILL , silty sand with a little gravel, brown (A-2-4)	FILL	7	M	SS	20	18						
2	FILL , clayey sand with laminations of lean clay, dark brown (A-6)						19						
3	FILL , silty sand, brown (A-2-4)		9	M	SS	18	14						
4	FILL , fat clay with trace lignite and lenses of silty sand (A-7-6)						37						
5			5	M	SS	20							
6													
7	FILL , lean clay, brown with iron oxide stains (A-6)												
8			8	M	SS	18	34						
9													
10													
11	SILTY SAND with trace organics, dark brown, medium dense (SM, A-2-4)	COARSE ALLUVIUM	11	M	SS	18	27						
	Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/7/14	10:15	11.5	0.0	9.0	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-6 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2278.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS						
							WC	DEN	LL	PL	%-#200		
	10" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					9						
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	5	M	SS	18							
2	FILL , fat clay with lenses of sandy lean clay, light brown (A-7-6)						31						
3	SILTY SAND , dark brown, loose to medium dense (SM, A-2-4)	COARSE ALLUVIUM	10	M	SS	20	16						
4							17						
5							16						
6							18						
7													
8													
9													
10													
11													
Bottom of Boring													

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	11:00	11.5	0.0	9.0	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B- 7 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2276.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	9" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					8							
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	7	M	SS	20								
2	FILL , sandy lean clay, brown with iron oxide stains (A-6)		12											
3	FILL , clayey sand, brown (A-6)		20											
4			10	M	SS	20	13							
5			8	M	SS	20	17							
6														
7	FAT CLAY with trace lignite, light gray with iron oxide stains and white inclusions, firm (CH, A-7-6)	SENTINEL BUTTE FORMATION	6	M	SS	18	27							
8														
9														
10			8	M	SS	16	24							
11														
Bottom of Boring														

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/7/14	11:45	11.5	0.0	9.1	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B- 8 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2280.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS								
							WC	DEN	LL	PL	%-#200				
	12" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT													
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	7	M	SS	20	8								
2	FILL , sandy lean clay with a little gravel, brown with iron oxide stains (A-6)						22								
3															
4			6	M	SS	3	20								
5							24								
6			11	M	SS	20	18								
7															
8			12	M	SS	18	17								
9															
10	CLAYEY SAND with trace organics, brown with iron oxide stains, medium dense (SC, A-6)	MIXED ALLUVIUM													
11			13	M	SS	18	12								
Bottom of Boring															

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	12:30	11.5	0.0	9.3	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-9 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2297.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	12" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					9							
1	FILL , silty sand with a little gravel, brown (A-2-4)	FILL	9	M	SS	18	14							
2	FILL , sandy lean clay with a little gravel, brown with white inclusions (A-6)													
3							23							
4	CLAYEY SAND , with trace lignite, light brown with iron oxide stains, loose to medium dense (SC, A-6)	SENTINEL BUTTE FORMATION	8	M	SS	8	23							
5														
6			14	M	SS	22	25							
7														
8			18	M	SS	18	24							
9														
10														
11			15	M	SS	18	23							
Bottom of Boring														

AET_CORP_37-01518.GPJ AET+CPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	13:15	11.5	0.0	8.1	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-10 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2332.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS									
							WC	DEN	LL	PL	%-#200					
	12" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT														
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	11	M	SS	20	8									
2	FILL , clayey sand, brown with iron oxide stains (A-6)						14									
3	FILL , sandy lean clay, brown with iron oxide stains (A-6)						25									
4			8	M	SS	19	26									
5	FILL , fat clay with trace lignite and laminations of silty sand, light brown (A-7-6)		10	M	SS	20	21									
6																
7	SILTY SAND with laminations of lean clay, brown, medium dense (SM, A-2-4)	COARSE ALLUVIUM														
8			17	M	SS	18	12									
9																
10																
11			12	M	SS	18	13									
Bottom of Boring																

AET_CORP 37-01518.GPJ AET+CPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	14:00	11.5	0.0	8.9	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-11 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2326.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	11" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					7							
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	5	M	SS	18	28							
	FILL , fat clay with trace lignite, brown (A-7-6)													
2														
3	FILL , clayey sand, gray (A-6)						14							
4			8	M	SS	15	23							
5	LEAN CLAY with organics, black, soft (CL, A-6)	FORMER TOPSOIL	4	M	SS	1	15							
6														
7	FAT CLAY with trace organics, brown with white inclusions, firm (CH, A-7-6)	SENTINEL BUTTE FORMATION												
8			7	M	SS	17	26							
9														
10	LEAN CLAY with laminations of silt, brown with iron oxide stains, stiff (CL, A-6)													
11			9	M	SS	18	25							
	Bottom of Boring													

AET_CORP_37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	14:45	11.5	0.0	8.9	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-12 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2291.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	9" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT												
1	FILL , silty sand with trace lignite, light brown (A-2-4)	FILL	13	M	SS	20	12							
2	FILL , clayey sand, brown (A-6)						13							
3														
4			10	M	SS	20	14							
5	CLAYEY SAND , dark brown, loose to very loose (SC, A-6)	MIXED ALLUVIUM	5	M	SS	18	12							
6														
7														
8			3	M	SS	18	13							
9	SILTY SAND , brown, very loose (SM, A-2-4)	COARSE ALLUVIUM												
10														
11			4	M	SS	18	10							
	Bottom of Boring						5							

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	15:30	11.5	0.0	8.8	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-13 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2283.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	9" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT												
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	10	M	SS	20	7							
	FILL , silty sand with laminations of lean clay, brown (A-2-4)						13							
2														
3														
4														
5			17	M	SS	NR								
6														
7														
8	FILL , clayey sand, dark brown (A-6)													
9														
10	SILTY SAND , brown, very loose (SM, A-2-4)	COARSE ALLUVIUM												
11			1	M	SS	16	14							
Bottom of Boring														

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	16:15	11.5	0.0	8.8	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-14 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2282.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
	9" BITUMINOUS PAVEMENT	BITUMINOUS PAVEMENT					6							
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	5	M	SS	17								
	FILL , clayey sand, brown (A-6)						29							
2	FILL , sandy lean clay, brown (A-6)													
3							18							
			5	M	SS	20								
4	CLAYEY SAND with lenses of fat clay, gray with iron oxide stains, loose to medium dense (SC, A-6)	MIXED ALLUVIUM					27							
5							16							
			13	M	SS	20								
6							13							
7														
			7	M	SS	18	28							
8														
9	CLAYEY SAND , dark brown, loose to medium dense (SC, A-6)													
10														
11			11	M	SS	18								
Bottom of Boring														

AET_CORP 37-01518.GPJ AET+CPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/7/14	17:00	11.5	0.0	9.0	NA	None	
BORING COMPLETED: 10/7/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-15 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2278.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	FILL , silty sand with scoria and trace organics, brown (A-2-4)	FILL MIXED ALLUVIUM	7	M	SS	22	10					
2	SILTY SAND with trace organics, dark brown, loose to very loose (SM, A-2-4)											
3	CLAYEY SAND with trace organics, brown, very loose (SC, A-6)		4	M	SS	22	13					
4												
5												
6	SILTY SAND with lenses and laminations of lean clay, brown, very loose (SM, A-2-4)		3	M	SS	18	16					
7												
8	SANDY SILT with lenses and laminations of sand, brown, loose (ML, A-4)		5	M	SS	18	25					
9												
10												
11	SILTY SAND with lenses and laminations of lean clay, brown, loose (SM, A-2-4)	SENTINEL BUTTE FORMATION	10	M	SS	18						
12												
13	CLAYEY SAND , brown, very loose (SC, A-6)		5	M	SS	17	20					
14												
15												
16			4	M	SS	18						
17												
18	Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-20'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		9/30/14	14:35	21.5	20.0	NA	NA	None	
BORING COMPLETED: 9/30/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-16 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2277.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	LEAN CLAY with organics, black (CL, A-6)	TOPSOIL	4	M	SS	15	25					
2												
3	LEAN CLAY with trace organics, dark brown, firm (CL, A-6)	FINE ALLUVIUM	6	M	SS	17	26	26				
4												
5	LEAN CLAY with trace organics, brown with white inclusions, firm (CL, A-6)		5	M	SS	17	26	29				
6												
7												
8												
9	LEAN CLAY with lenses and laminations of sand, brown, firm (CL, A-6)		5	M	SS	17						
10												
11			5	M	SS	17	29					
12												
13	SAND WITH SILT , fine grained, brown, loose (SP-SM, A-2-4)	COARSE ALLUVIUM	8	M	SS	18						
14	CLAYEY SAND , brown, loose (SC, A-6)	MIXED ALLUVIUM										
15	SAND with lenses and laminations of lean clay, brown, medium dense (SP, A-3)	COARSE ALLUVIUM	12	M	SS	18	14					
16												
17												
18												
19	FAT CLAY , gray, stiff (CH, A-7-6)	SENTINEL BUTTE FORMATION	9	M	SS	18						
20												
21	Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-20'	3.25" HSA	10/1/14	9:35	21.5	0.0	19.0	NA	None	
		10/6/14	NA	21.5	0.0	19.0	NA	None	
BORING COMPLETED: 10/1/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-17 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2274.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	SANDY LEAN CLAY with organics, dark brown (CL, A-6)	TOPSOIL MIXED ALLUVIUM	8	M	SS	16	19					
2							17					
3	CLAYEY SAND , brown, very loose (SC, A-6)		4	M	SS	18	12					
4							16					
5							17					
6	SILTY SAND , dark brown, very loose (SM, A-2-4)	COARSE ALLUVIUM	4	M	SS	18						
7												
8	FAT CLAY with lenses and laminations of silt, gray with white inclusions and iron oxide stains, stiff (CH, A-7-6)	SENTINEL BUTTE FORMATION	12	M	SS	16	21					
9												
10												
11												
12												
13	FAT CLAY with trace lignite and lenses and laminations of silt, gray with iron oxide stains, stiff (CH, A-7-6)		10	M	SS	18	33					
14												
15												
16			10	M	SS	18						
17												
18	LEAN CLAY with laminations of fat clay, brown with iron oxide stains, stiff (CL, A-6)		13	M	SS	18						
19												
20												
21												
Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-20'	3.25" HSA	10/1/14	11:15	21.5	0.0	18.2	NA	None	
		10/6/14	NA	21.5	0.0	11.9	NA	10.0	
BORING COMPLETED: 10/1/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-18 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2275.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with sand and organics, dark brown (CL, A-6)	TOPSOIL	15	M	SS	18	19				
2		SENTINEL BUTTE FORMATION					12				
3						3					
4						11					
5						15					
6	LEAN CLAY, brown, stiff (CL, A-6)		24	M	SS	18					
7											
8			11	M	SS	18	27				
9	CLAYEY SAND with a little gravel, brown, very loose to loose (SC, A-6)										
10			4	M	SS	18					
11											
12											
13			6	M	SS	2	18				
14											
15	SAND WITH SILT, fine grained, brown, loose (SP-SM, A-2-4)		8	W	SS	18					
16											
17											
18											
19											
20				9	W	SS	18				
21											
22											
23											
24											
25			7	W	SS	18					
26											
27											
28											
29											
30			8	W	SS	18					
31											
32											
33											
34											
35											
36			10	W	SS	18					
37											
38	CLAYEY SAND, brown, medium dense (SC, A-6)										
39											
40											
41	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-39½'	3.25" HSA	10/21/14	9:26	16.0	14.5	NA	NA	14.5	
		10/21/14	10:17	41.0	39.5	40.0	NA	17.0	
BORING COMPLETED: 10/21/14		10/21/14	10:29	41.0	0.0	14.0	NA	None	
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-19 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2287.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	CLAYEY SAND with organics, dark brown (SC, A-6)	TOPSOIL	5	M	SS	18	20				
2	CLAYEY SAND with trace organics, light brown with iron oxide stains, loose (SC, A-6)	SENTINEL BUTTE FORMATION					15				
3	SILTY SAND , gray with iron oxide stains, loose (SM, A-2-4)		8	M	SS	22	18				
4							13				
5				10	M	SS	22	22			
6											
7	FAT CLAY with trace lignite, gray with iron oxide stains, stiff (CH, A-7-6)										
8			9		SS	16	37				
9											
10	SANDY LEAN CLAY , light brown with iron oxide stains, stiff (CL, A-6)										
11			12	M	SS	18					
12											
13	FAT CLAY with trace lignite and laminations of silt, gray with iron oxide stains, stiff (CH, A-7-6)										
14			15	M	SS	18	28				
15											
16	CLAYEY SAND with trace lignite, gray with iron oxide stains, medium dense (SC, A-6)										
17			18	M	SS	18					
18											
19	SANDSTONE , gray (A-1-a)										
	Bottom of Boring; Auger Refusal		50/2	M	SS	1					

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19'	3.25" HSA	10/1/14	16:12	19.5	0.0	17.2	NA	None	
		10/6/14	NA	19.5	0.0	11.0	NA	8.5	
BORING COMPLETED: 10/1/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-20 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2296.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
1	CLAYEY SAND with organics, black (SC, A-6)	TOPSOIL					22							
2	SANDY LEAN CLAY with trace organics, brown with white inclusions, firm (CL, A-6)	MIXED ALLUVIUM	7	M	SS	17	18							
3							18							
4	CLAYEY SAND , brown, loose (SC, A-6)		6	M	SS	20	17							
5	LEAN CLAY with trace organics, brown with white inclusions, firm (CL, A-6)	SENTINEL BUTTE FORMATION	6	M	SS	20	19							
6														
7	FAT CLAY with trace lignite, gray with iron oxide stains, stiff (CH, A-7-6)													
8			10	M	SS	16	22							
9														
10														
11			8	M	SS	17								
12														
13	SILTY SAND , with trace lignite and lenses and laminations of lean clay, gray with iron oxide stains, medium dense (SM, A-2-4)		15	M	SS	18	22							
14														
15														
16	CLAYEY SAND , gray with iron oxide stains, medium dense (SC, A-6)		19	M	SS	18								
17														
18														
19														
20														
21			19	M	SS	18								
Bottom of Boring														

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-20'	3.25" HSA	10/1/14	17:50	21.5	0.0	19.0	NA	None	
		10/6/14	NA	21.5	0.0	10.0	NA	9.0	
BORING COMPLETED: 10/1/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-21 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2312.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	SANDY LEAN CLAY with organics, dark brown (CL, A-6)	TOPSOIL	5	M	SS	18	20					
2	LEAN CLAY with trace organics, dark brown, firm (CL, A-6)	FINE ALLUVIUM					23					
3	LEAN CLAY with trace lignite and organics, gray with white inclusions, firm (CL, A-6)	SENTINEL BUTTE FORMATION	7	M	SS	18	24					
4	FAT CLAY with trace lignite, gray with iron oxide stains, stiff to soft (CH, A-7-6)						28					
5				12	M	SS	20	23				
6												
7												
8			3	M	SS	2	28					
9	LIGNITE											
10	FAT CLAY with trace lignite, gray, stiff (CH, A-7-6)		12	M	SS	18						
11												
12												
13			14	M	SS	18	29					
14												
15	FAT CLAY with trace lignite and laminations of silt, gray with iron oxide stains, stiff to hard (CH, A-7-6)		14	M	SS	18						
16												
17												
18												
19												
20												
21	LIGNITE		31	M	SS	18						
Bottom of Boring												

AET_CORP 37-01518.GPJ AET+CPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-20'	3.25" HSA	10/2/14	10:05	21.5	0.0	18.6	NA	None	
		10/6/14	NA	21.5	0.0	18.0	NA	17.5	
BORING COMPLETED: 10/2/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-22 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2321.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	SANDY LEAN CLAY with organics, dark brown, firm (CL, A-6)	TOPSOIL					24					
2	SANDY LEAN CLAY with trace organics, brown, firm (CL, A-6)	MIXED ALLUVIUM	7	M	SS	15	20					
3	FAT CLAY with trace organics, light brown with iron oxide stains and white inclusions, firm (CH, A-7-6)	SENTINEL BUTTE FORMATION	6	M	SS	18	22					
4							24					
5	FAT CLAY with trace lignite, gray to brown with iron oxide stains, firm to very stiff (CH, A-7-6)		6	M	SS	20	33					
6												
7												
8			13	M	SS	18	27					
9												
10												
11												
12	SANDY LEAN CLAY with laminations of lignite, dark brown, very stiff to stiff (CL, A-6)		16	M	SS	18						
13												
14	FAT CLAY with trace lignite, dark gray, stiff to very stiff (CH, A-7-6)		9	M	SS	18						
15												
16												
17			19	M	SS	18						
18												
19												
20												
21												
Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19½'	3.25" HSA	10/8/14	16:45	21.5	0.0	18.5	NA	None	
BORING COMPLETED: 10/8/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-23 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2352.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS								
							WC	DEN	LL	PL	%-#200				
1	CLAYEY SAND with organics, dark brown, very loose (SC, A-6)	TOPSOIL													
2	CLAYEY SAND with trace organics, dark brown, very loose to loose (SC, A-6)	MIXED ALLUVIUM	4	M	SS	18									
3															
4			3	M	SS	20									
5															
6	SANDY LEAN CLAY , brown with iron oxide stains and white inclusions, firm (CL, A-6)		5	M	SS	18									
7															
8	SILT , gray with white inclusions, loose (ML, A-4)	FINE ALLUVIUM													
9			5	M	SS	18									
10	FAT CLAY with laminations of lignite, gray to brown, firm to very stiff (CH, A-7-6)	SENTINEL BUTTE FORMATION													
11			8	M	SS	19	32								
12							29								
13			17	M	SS	22	27								
14							27								
15			20	M	SS	20	21								
16															
17															
18															
19															
20															
21			27	M	SS	18	25								
Bottom of Boring															

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19½'	3.25" HSA	10/8/14	17:55	21.5	0.0	18.0	NA	None	
BORING COMPLETED: 10/8/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-24 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: 2315.0 MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with sand and trace lignite, dark gray with white inclusions, soft (CL, A-6)	TOPSOIL	4	M	SS	14	17				
2							20				
3	LEAN CLAY with laminations of silt, gray with iron oxide stains, soft to stiff (CL, A-6)	FINE ALLUVIUM	4	M	SS	18	19				
4							29				
5							25				
6	SILT with sand and laminations of lean clay, gray with iron oxide stains, medium dense (ML, A-4)	MIXED ALLUVIUM	15	M	SS	22					
7											
8							18	M	SS	17	22
9	SILTSTONE , gray (ML, A-4)	SENTINEL BUTTE FORMATION	50/2	M	SS	1					
10							FAT CLAY , gray, very stiff (CH, A-7-6)				
11											
12											
13											
14											
15	FAT CLAY with trace lignite and laminations of silt, gray with iron oxide stains, very stiff to hard (CH, A-7-6)		16	M	SS	17					
16											
17											
18											
19											
20											
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-20'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/8/14	18:45	21.0	0.0	18.2	NA	None	
BORING COMPLETED: 10/8/14									
DR: TB LG: CD Rig: 39									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-25 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2288.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	SILT with sand and organics, dark brown, loose (ML, A-4)	TOPSOIL	5	M	SS	6					
2	SANDY LEAN CLAY with trace lignite, gray with iron oxide stains, stiff (CL, A-6)	MIXED ALLUVIUM	14	M	SS	20	6				
3							10				
4							11				
5							24				
6							25				
7	SANDY SILT , gray with iron oxide stains, medium dense (ML, A-4)		14	M	SS	18					
8											
9	LEAN CLAY with trace lignite, gray with iron oxide stains, soft to very stiff (CL, A-6)	FINE ALLUVIUM	13	M	SS	18	23				
10											
11											
12											
13											
14	LIGNITE , black	SENTINEL BUTTE FORMATION	3	M	SS	13					
15											
16											
17	FAT CLAY , gray, very stiff (CH, A-7-6)		19	M	SS	20					
18											
19											
20											
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-20'	3.25" HSA	10/8/14	17:15	21.0	0.0	19.0	NA	19.5	
		10/8/14	18:46	21.0	0.0	18.3	NA	13.3	
BORING COMPLETED: 10/8/14									
DR: TB LG: CD Rig: 39									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-26 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2280.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with organics, dark brown (CL, A-6)	TOPSOIL	10	M	SS	18	19				
2							13				
3	LEAN CLAY with trace organics, brown with iron oxide stains, very stiff (CL, A-6)	SENTINEL BUTTE FORMATION	16	M	SS	18	13				
4							9				
5							15				
6	SILTY SAND , gray, medium dense (SM, A-2-4)		12	M	SS	18					
7											
8	FAT CLAY , gray, stiff (CH, A-7-6)		10	M	SS	18					
9											
10	LEAN CLAY with sand, brown, stiff to firm (CL, A-6)		14	M	SS	18	24				
11											
12											
13											
14	LIGNITE , black		6	M	SS	6					
15											
16											
17	FAT CLAY with trace lignite, gray, very stiff (CH, A-7-6)		16	M	SS	18	29				
18											
19											
20											
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-19½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/13/14	11:08	21.0	19.5	NA	NA	None	
BORING COMPLETED: 10/13/14									
DR: MH LG: JMM Rig: 30									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-27 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2279.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	SILTY SAND with organics, dark brown (SM, A-2-4)	TOPSOIL	9	M	SS	18	15				
2											
3	SANDY FAT CLAY , brown, firm (CH, A-7-6)	FINE ALLUVIUM	8	M	SS	18	20				
4											
5											
6	FAT CLAY , gray to brown, stiff (CH, A-7-6)		13	M	SS	18	27				
7											
8											
9											
10	SANDY LEAN CLAY , brown, stiff to very stiff (CL, A-6)	SENTINEL BUTTE FORMATION	15	M	SS	18	24				
11											
12											
13											
14											
15	CLAYEY SAND , gray, very stiff (SC, A-6)		22	M	SS	18	21				
16											
17	FAT CLAY , gray with iron oxide stains, very stiff (CH, A-7-6)		23	M	SS	18					
18											
19											
20											
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH: 0-19½'	DRILLING METHOD: 3.25" HSA	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/13/14	10:10	21.0	19.5	NA	NA	None	
BORING COMPLETED: 10/13/14									
DR: MH LG: JMM Rig: 30									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-28 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2272.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS							
							WC	DEN	LL	PL	%-#200			
1	SILT with sand and organics, dark brown, loose (ML, A-4)	TOPSOIL	7	M	SS	6	18							
2							15							
3	LEAN CLAY with sand and trace lignite, brown with gray mottling and iron oxide stains, very stiff to stiff (CL, A-6)	FINE ALLUVIUM	9	M	SS	8	15							
4							18							
5							16							
6														
7														
8	SANDY SILT with trace lignite, gray to brown with iron oxide stains, medium dense (ML, A-4)	SENTINEL BUTTE FORMATION	11	M	SS	16	24							
9	LEAN CLAY with trace organics, black, stiff (CL, A-6)													
10	FAT CLAY with trace lignite, gray with white inclusions, stiff (CH, A-7-6)						10	M	SS	16				
11														
12														
13	LEAN CLAY with trace lignite and laminations of silt, gray to brown, very stiff (CL, A-6)		16	M	SS	18	24							
14														
15														
16			16	M	SS	19								
17	LIGNITE , black													
18														
19														
20			50/4	M	SS	14								
21														
Bottom of Boring														

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19½'	3.25" HSA	10/8/14	14:00	21.0	19.5	NA	NA	17.0	
		10/8/14	14:15	21.0	0.0	19.1	NA	18.7	
BORING COMPLETED: 10/8/14									
DR: TB LG: CD Rig: 39									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-29 (p. 1 of 1)**

PROJECT: **Proposed Killdeer Bypass; Killdeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2268.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	SILTY SAND with organics, dark brown (SM, A-2-4)	TOPSOIL	3	M	SS	19	17				
2		COARSE ALLUVIUM					7				
3	SILTY SAND with trace organics, brown, very loose (SM, A-2-4)	SENTINEL BUTTE FORMATION	2	M	SS	18	11				
4							23				
5	LEAN CLAY with sand and trace organics, light brown, soft (CL, A-6)		7	M	SS	18	11				
6											
7	SILTY SAND with laminations of lean clay, gray with iron oxide stains and brown mottling, medium dense (SM, A-2-4)		11	M	SS	18	22				
8											
9											
10											
11	FAT CLAY with trace lignite and laminations of silt, gray with iron oxide stains, stiff to very stiff (CH, A-7-6)		13	M	SS	18					
12											
13											
14	SANDY LEAN CLAY , gray, very stiff (CL, A-6)		18	M	SS	18					
15											
16											
17											
18	LIGNITE		20	M	SS	18	26				
19											
20	FAT CLAY with trace lignite and laminations of silt, gray, hard (CH, A-7-6)		24	M	SS	18					
21											
22	CLAYEY SAND with lenses and laminations of lean clay, gray, dense to medium dense (SC, A-6)		25	W	SS	14					
23											
24	FAT CLAY with trace lignite and laminations of silt, gray, very stiff (CH, A-7-6)		50/3	W	SS	14					
25											
26											
27											
28	CLAYEY SAND with lenses and laminations of lean clay, gray, dense to medium dense (SC, A-6)		37	M	SS	18					
29											
30	FAT CLAY with trace lignite and laminations of silt, gray, very stiff (CH, A-7-6)		19	M	SS	18					
31											
32											
33											
34	FAT CLAY with trace lignite and laminations of silt, gray, very stiff (CH, A-7-6)		20	M	SS	18					
35											
36											
37	Bottom of Boring		18	M	SS	18					
38											
39											
40											
41											
42											
43											
44											
45											
46											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-45'	3.25" HSA	10/2/14	18:20	46.5	0.0	41.5	NA	9.5	
BORING COMPLETED: 10/2/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-30 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2288.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	SILTY SAND with organics, dark brown (SM, A-2-4)	TOPSOIL SENTINEL BUTTE FORMATION	3	M	SS	20					
2	SILTY SAND with trace organics, brown, very loose (SM, A-2-4)										
3	SAND WITH CLAY and a little gravel, fine grained, light brown, loose (SP-SC, A-2-6)										
4											
5				5	M	SS	20				
6			8	M	SS	18	4				
7			7	M	SS	18	3				
8			7	M	SS	18	7				
9			7	M	SS	18	5				
10			7	M	SS	18	6				
11											
12	FAT CLAY with lenses and laminations of silt, gray with iron oxide stains, very stiff (CH, A-7-6)		16	M	SS	18	24				
13											
14											
15	LEAN CLAY with sand and lenses and laminations of fat clay, gray with iron oxide stains, very stiff (CL, A-6)		23	M	SS	18					
16											
17											
18											
19											
20											
21	SILTY SAND with laminations of lean clay, gray with iron oxide stains, medium dense (SM, A-2-4)		29	M	SS	18	18				
	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-20'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/2/14	14:15	21.5	0.0	16.8	NA	None	
BORING COMPLETED: 10/2/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-31 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2271.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with organics, dark brown (CL, A-6)	TOPSOIL	5	M	SS	18	20				
2	CLAYEY SAND , brown, loose (SC, A-6)	MIXED ALLUVIUM					19				
3	SILTY SAND , brown, medium dense to very loose (SM, A-2-4)		18	M	SS	18	10				
4							8				
5			7	M	SS	18	14				
6											
7											
8			4	M	SS	18	19				
9											
10	LEAN CLAY with trace lignite, brown, firm (CL, A-6)	FINE ALLUVIUM	5	M	SS	18					
11											
12	FAT CLAY , gray with brown mottling, very stiff (CH, A-7-6)	SENTINEL BUTTE FORMATION	16	M	SS	18	26				
13											
14											
15			19	M	SS	18					
16											
17											
18	LIGNITE , black										
19											
20			50/.5	M	SS	6					
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH: 0-19½'	DRILLING METHOD: 3.25" HSA	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/21/14	10:21	21.0	19.5	NA	NA	None	
BORING COMPLETED: 10/21/14									
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-32 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2273.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with sand and trace organics, dark brown (CL, A-6)	TOPSOIL	6	M	SS	18	24				
2		FINE ALLUVIUM					16				
3			6	M	SS	18	18				
4							25				
5	LEAN CLAY with sand, brown with white inclusions, stiff (CL, A-6)	SENTINEL BUTTE FORMATION	9	M	SS	18	21				
6											
7											
8			15	M	SS	18	23				
9											
10	SANDSTONE , white to tan, very dense (SP, A-1-a)		50/5	M	SS	1					
11											
12	SANDY LEAN CLAY , brown, very stiff (CL, A-6)		17	M	SS	18					
13											
14											
15			17	M	SS	18	27				
16	CLAYEY SAND with lenses of lignite, gray, medium dense (SC, A-6)										
17											
18											
19											
20			22	M	SS	18					
21	Bottom of Borings										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-19½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/21/14	14:13	21.0	19.5	NA	NA	None	
BORING COMPLETED: 10/21/14									
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-33 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2266.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	SILTY SAND with trace organics, dark brown (SM, A-2-4)	TOPSOIL	4	M	SS	18	15				
2		MIXED ALLUVIUM		4	M	SS	18	22			
3	17										
4	12										
5	24										
6	SAND , fine grained, brown, loose (SP, A-3)	SENTINEL BUTTE FORMATION	5	W	SS	18					
7											
8											
9											
10											
11											
12	CLAYEY SAND , brown, medium dense (SC, A-6)		13	M	SS	18	32				
13											
14											
15											
16	LEAN CLAY with trace lignite, gray, stiff (CL, A-6)		16	M	SS	18					
17											
18											
19											
20											
21	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-19½'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/21/14	14:58	8.5	7.0	8.0	NA	6.8	
		10/21/14	15:16	21.0	19.5	NA	NA	18.0	
BORING COMPLETED: 10/21/14									
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-34 (p. 1 of 1)**

PROJECT: **Proposed Killdeer Bypass; Killdeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2262.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with organics, dark brown (CL, A-6)	TOPSOIL	1	M	SS	4	25				
2	LEAN CLAY , with some sane, brown, soft to firm (CL, A-6)	FINE ALLUVIUM	3	M	SS	18	24				
3							19				
4								23			
5			5	M	SS	18					
6											
7	CLAYEY SAND with gravel, brown, loose to very loose (SC, A-6)	COARSE ALLUVIUM	5	W	SS	18					
8											
9											
10	SAND WITH SILT , fine grained, gray, very loose (SP-SM, A-2-4)		3	M	SS	18	28				
11											
12											
13			3	W	SS	18					
14											
15	CLAYEY SAND , gray, very loose (SC, A-6)		4	M	SS	18	29				
16											
17											
18	SAND WITH SILT , fine grained, gray, very loose to loose (SP-SM, A-2-4)										
19											
20			4	W	SS	18					
21											
22											
23											
24											
25			4	W	SS	18					
26											
27											
28											
29											
30											
31			5	M	SS	18					
32											
33											
34											
35											
36			6	M	SS	18					
37											
38											
39											
40											
41			6	M	SS	18					
Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-39½'	3.25" HSA	10/21/14	16:47	41.0	39.5	NA	NA	16.0	
		10/21/14	17:02	41.0	0.0	6.0	NA	3.0	
BORING COMPLETED: 10/21/14									
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-35 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2264.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS						
							WC	DEN	LL	PL	%-#200		
1	LEAN CLAY with organics, dark brown, soft (CL, A-6) CLAYEY SAND with trace organics, with laminations of lean clay, dark brown to brown-gray, very loose (SC, A-6)	TOPSOIL	2	M	SS	5	22						
2		MIXED ALLUVIUM		4	W	SS	6	19					
3				4	M/W	SS	20	24	22				
4													
5				1	M	SS	18	30					
6													
7				COARSE ALLUVIUM		WH	W	SS	18				
8													
9													
10													
11													
12													
13	3	W	SS	20									
14													
15	W	TW	30										
16													
17	CLAYEY SAND with a little gravel, gray with brown mottling, loose (SC, A-6)		7	W	SS	17							
18													
19													
20													
21													
22	SAND WITH SILT , brown to gray, very loose to loose (SP-SM, A-2-4)		4	W	SS	18							
23													
24													
25													
26													
27	6	W	SS	18									
28													
29													
30													
31													
32	6	W	SS	16									
33													
34													
35													
36													
37	6	W	SS	17									
38													
39													
40													
41	Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-39½'	3.25" HSA	10/8/14	13:20	26.5	0.0	13.0	NA	2.7	
		10/22/14	9:42	41.0	39.5	40.0	NA	15.0	
BORING COMPLETED: 10/21/14		10/22/14	10:05	41.0	0.0	8.0	NA	4.0	
DR: MH LG: RH Rig: ATV									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-36 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2278.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	12	M	SS	16	6				
2							5				
3	FILL , clayey sand with a little gravel, brown (A-6)	FINE ALLUVIUM	8	M	SS	18	15				
4	FILL , sandy lean clay with a little gravel and trace organics, dark brown (A-6)						21				
5	FILL , clayey sand, brown (A-6)						17				
6	LEAN CLAY with trace organics, gray, firm (CL, A-6)						18				
7	SANDY LEAN CLAY with trace lignite, gray, soft (CL, A-6)		3	M	SS	16	26				
8											
9	SILT with sand, light gray, very loose (ML, A-4)		2	M	SS	14	28				
10											
11											
Bottom of Boring											

AET_CORP_37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/3/14	14:55	11.5	0.0	7.9	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-37 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2280.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	9	M	SS	7	5				
2							5				
3	FILL , clayey sand, brown (A-6)	FILL	6	M	SS	20	24				
4	FILL , sandy lean clay, brown with iron oxide stains (A-6)						22				
5	SILTY SAND with a little gravel and trace organics, brown, medium dense to loose (SM, A-2-4)	COARSE ALLUVIUM	13	M	SS	17	11				
6											
7											
8	LEAN CLAY with sand, gray, firm (CL, A-6)	MIXED ALLUVIUM	5	M	SS	16	24				
9											
10	SILTY SAND , brown, very loose (SM, A-2-4)	COARSE ALLUVIUM	4	M	SS	16	20				
11											
Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/3/14	15:50	11.5	0.0	8.0	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-38 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2273.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	10	M	SS	18	7				
2							4				
3	FILL , sandy lean clay, gray with iron oxide stains (A-6)	FINE ALLUVIUM	5	M	SS	20	18				
4							20				
5	LEAN CLAY with sand and trace organics, gray with white inclusions, firm (CL, A-6)	FINE ALLUVIUM	7	M	SS	17	22				
6											
7	LEAN CLAY with trace organics and lenses and laminations of silt, light gray, soft to very soft (CL, A-6)	FINE ALLUVIUM	11	M	SS	15	30				
8											
9											
10											
11			1	M	SS	18	39				
Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/3/14	14:05	11.5	0.0	8.5	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-39 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2267.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	7	M	SS	16	6				
2							5				
3	FILL , sandy lean clay with a little gravel, brown with iron oxide stains (A-6)	FILL	6	M	SS	17	17				
4							21				
5	SILTY SAND , gray, loose (SM, A-2-4)	COARSE ALLUVIUM	7	M	SS	22	18				
6											
7											
8											
9	FAT CLAY , gray with white inclusions, firm (CH, A-7-6)	FINE ALLUVIUM	5	M	SS	17	31				
10											
11	CLAYEY SAND with lenses and laminations of sand, brown, loose (SC, A-6)	MIXED ALLUVIUM	6	M	SS	17	31				
Bottom of Boring											

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/3/14	13:15	11.5	0.0	8.5	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

LOG OF BORING NO. **B-40 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2265.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	FILL , silty sand with gravel, brown (A-2-4)	FILL	8	M	SS	18	6				
2							7				
3	FILL , sandy lean clay, brown (A-6)	FILL	7	M	SS	18	21				
4							21				
5	SILTY SAND with laminations of lean clay, gray, loose (SM, A-2-4)	COARSE ALLUVIUM	8	M	SS	22	19				
6											
7	LEAN CLAY , gray with iron oxide stains, firm (CL, A-6)	FINE ALLUVIUM	4	M	SS	17	30				
8											
9	SILTY SAND , brown, loose (SM, A-2-4)	COARSE ALLUVIUM	6	M	SS	9	19				
10											
11	Bottom of Boring										

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-10'	3.25" HSA	10/3/14	11:15	11.5	0.0	7.8	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



SUBSURFACE BORING LOG

AET JOB NO: **37-01518**

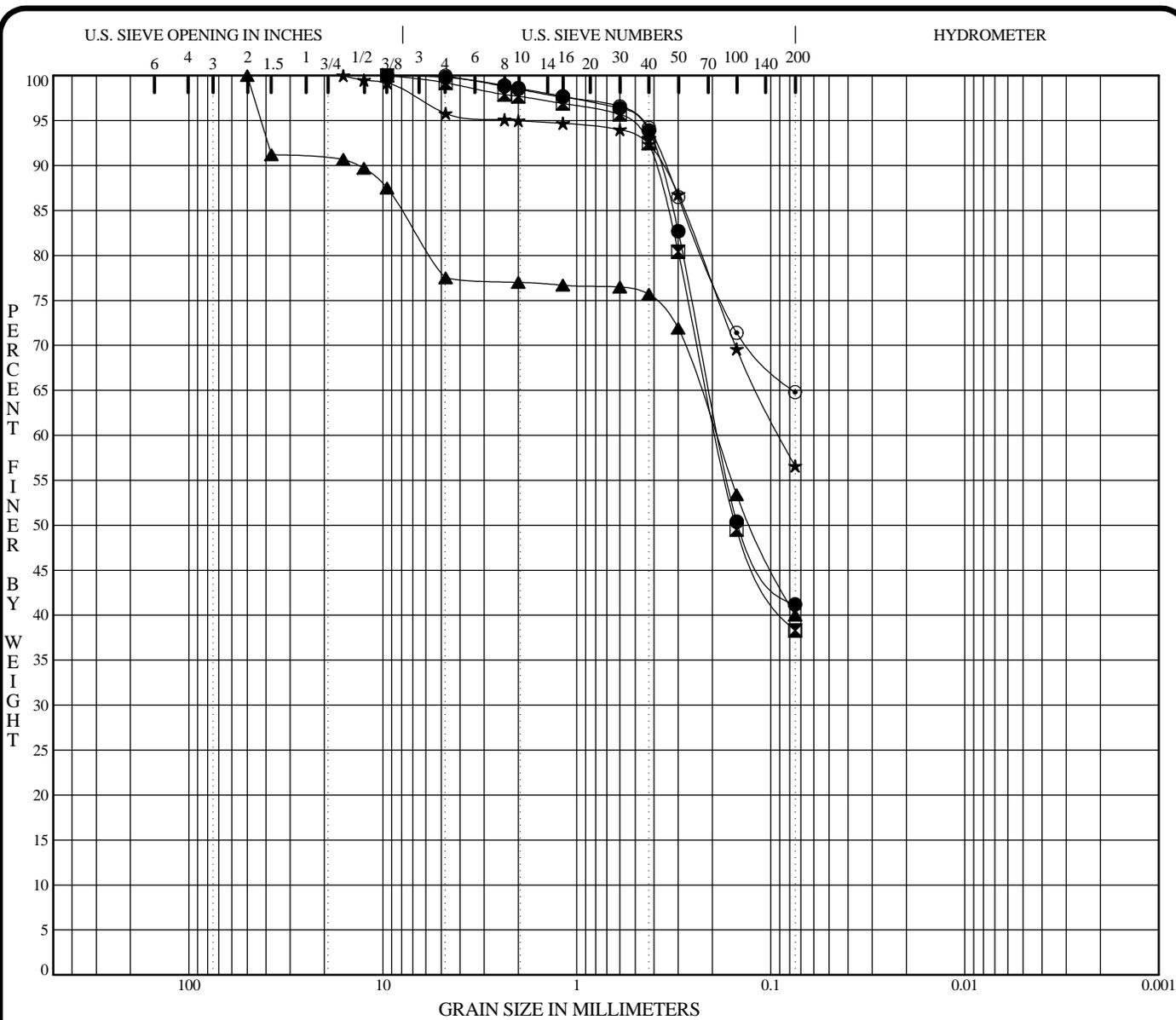
LOG OF BORING NO. **B-41 (p. 1 of 1)**

PROJECT: **Proposed Kildeer Bypass; Kildeer, ND**

DEPTH IN FEET	SURFACE ELEVATION: <u>2261.0</u> MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS					
							WC	DEN	LL	PL	%-#200	
1	FILL , sandy lean clay with a little gravel and trace organics, brown (A-6) FILL , silty sand with gravel, brown (A-2-4)	FILL	10	M	SS	22	24					
2	FILL , sandy lean clay with a little gravel, brown (A-6)	FILL	6	M	SS	20	8					
3							18					
4							16					
5							23					
6			6	M	SS	18						
8			8	M	SS	16	18					
11			4	M	SS	NR						
Bottom of Boring												

AET_CORP 37-01518.GPJ AET+OPT+WELL.GDT 11/12/14

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-10'	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/3/14	10:15	11.5	0.0	9.0	NA	None	
BORING COMPLETED: 10/3/14									
DR: CK LG: TT Rig: 14									



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

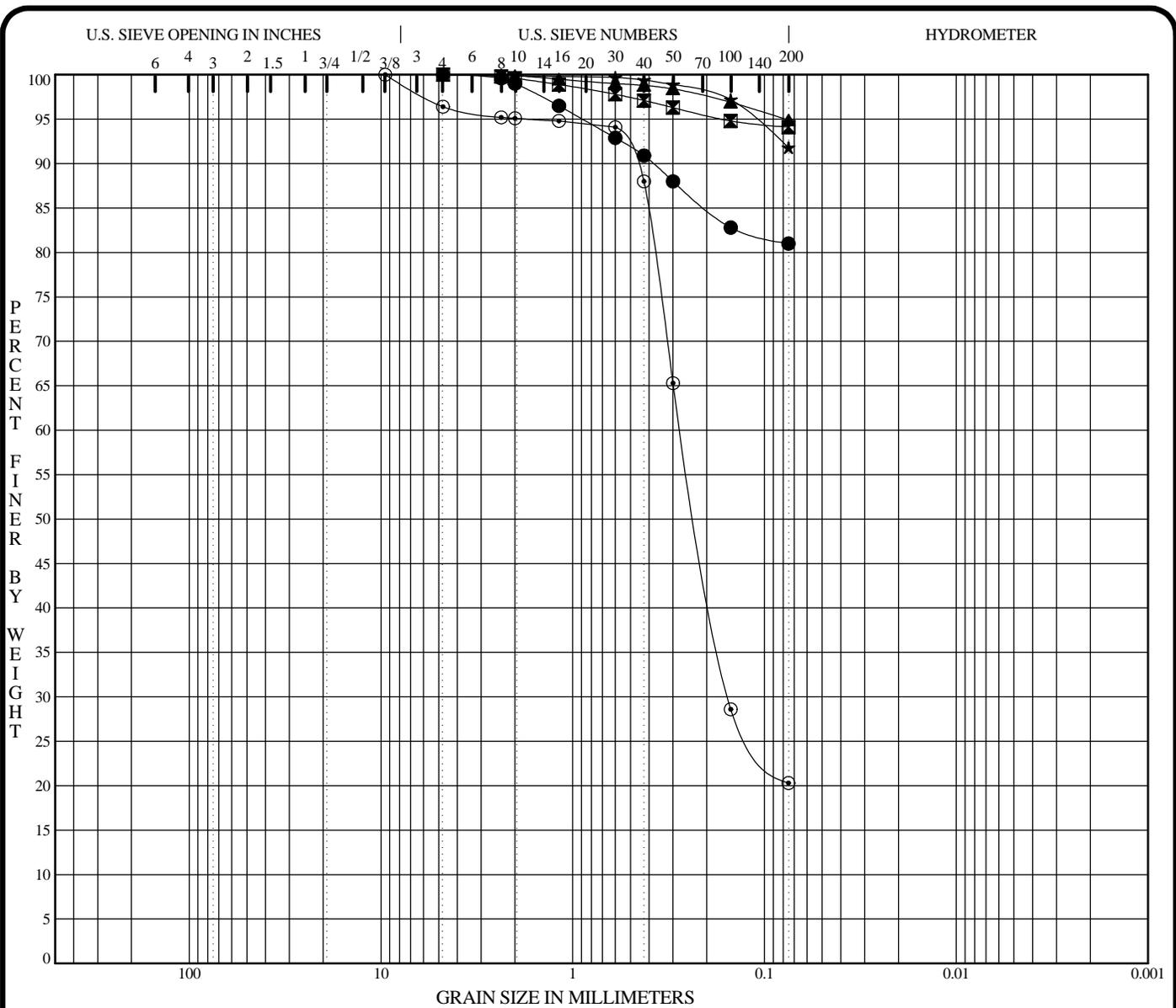
Specimen Identification	Classification		MC%	LL	PL	PI	Cc	Cu
● Bulk B-12 1' 5.0'	Clayey Sand, brown (SC, A-4)			29	16	13		
⊠ Bulk B-13 1' 5.0'	Silty, Clayey Sand, brown (SC-SM, A-2-4)			23	17	6		
▲ Bulk B-15 0.5' 5.0'	Clayey Sand with gravel, brown (SC, A-4)			27	19	8		
★ Bulk B-17 1' 5.0'	Sandy Lean Clay, brown (CL, A-6)			31	17	14		
◎ Bulk B-20 1' 5.0'	Sandy Lean CLay, brown (CL, A-6)			40	17	23		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● Bulk B-12 1' 5.0'	9.50	0.18			0.2	58.6	41.2	
⊠ Bulk B-13 1' 5.0'	9.50	0.19			0.8	60.9	38.3	
▲ Bulk B-15 0.5' 5.0'	50.00	0.19			22.5	37.5	40.0	
★ Bulk B-17 1' 5.0'	16.00	0.09			4.2	39.2	56.6	
◎ Bulk B-20 1' 5.0'	4.75				0.0	35.2	64.8	

PROJECT Proposed Killdeer Bypass; Killdeer, ND AET JOB NO. 37-01518
DATE 10/1/14



GRADATION CURVES



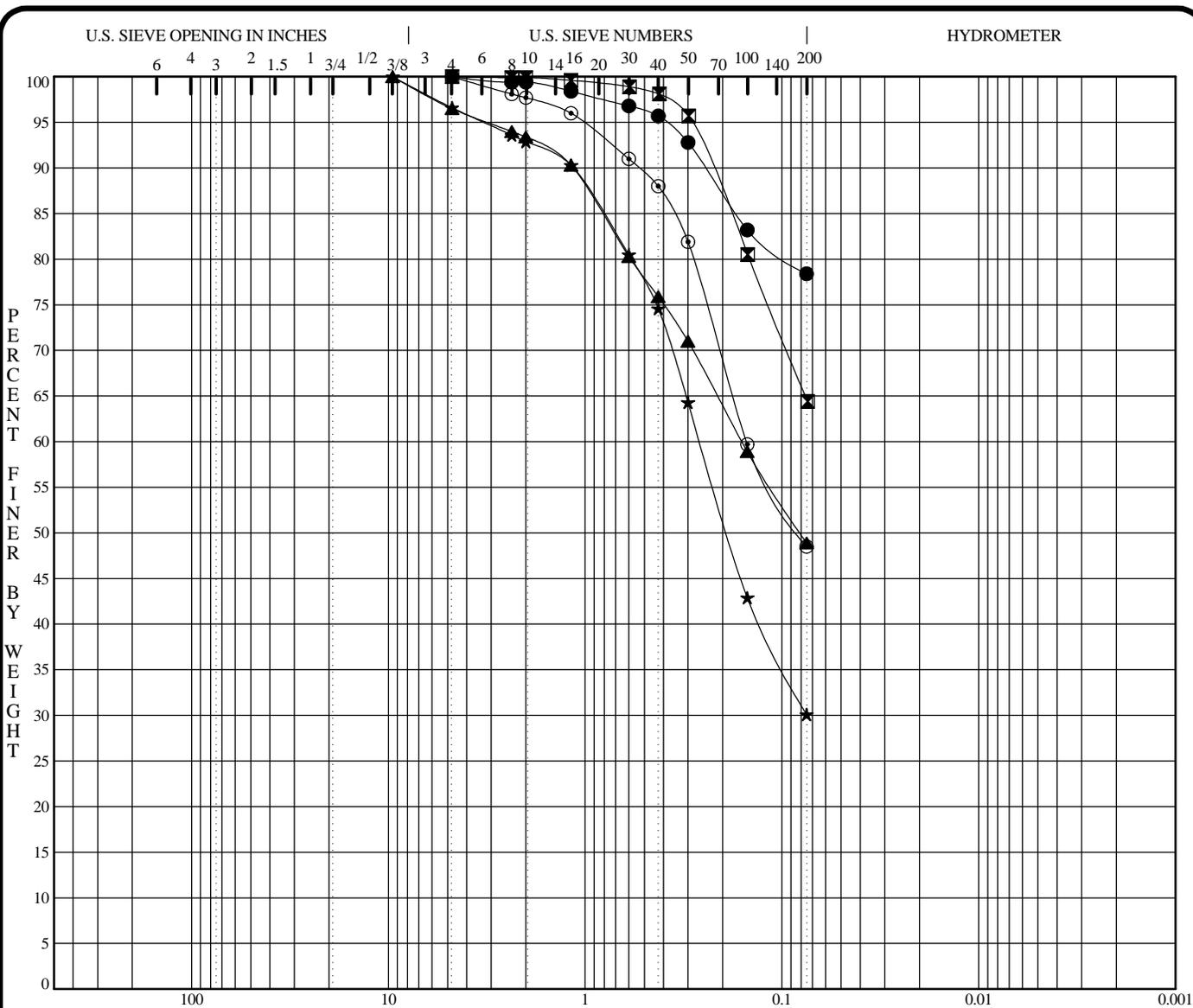
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification		MC%	LL	PL	PI	Cc	Cu
● Bulk B-22 1' 5.0'	Lean Clay with sand, brown (CL, A-7-6)			41	21	20		
⊠ Bulk B-24 0' 5.0'	Lean Clay, brown (CL, A-7-6)			45	21	24		
▲ Bulk B-27 1' 5.0'	Fat Clay, brown (CH, A-7-6)			90	18	72		
★ Bulk B-28 0' 5.0'	Lean Clay, brown (CL, A-6)			40	18	22		
⊙ Bulk B-30 1' 5.0'	Clayey Sand, brown (SC, A-2-4)			26	18	8		
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● Bulk B-22 1' 5.0'	4.75				0.0	19.0	81.0	
⊠ Bulk B-24 0' 5.0'	4.75				0.0	5.9	94.1	
▲ Bulk B-27 1' 5.0'	2.36				0.0	5.1	94.9	
★ Bulk B-28 0' 5.0'	4.75				0.0	8.2	91.8	
⊙ Bulk B-30 1' 5.0'	9.50	0.27	0.154		3.6	76.1	20.3	

PROJECT Proposed Killdeer Bypass; Killdeer, ND AET JOB NO. 37-01518
DATE 10/2/14



GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

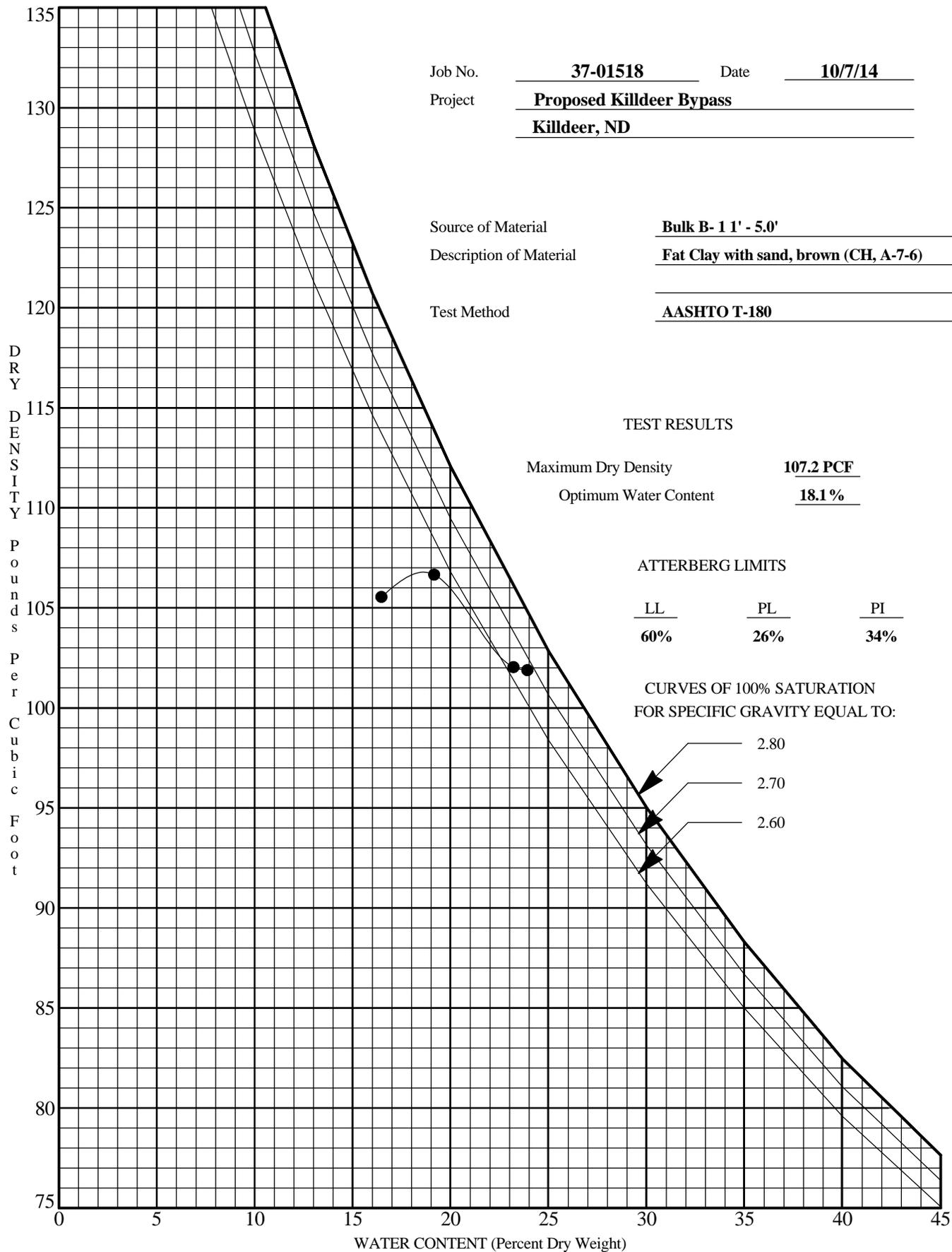
Specimen Identification	Classification		MC%	LL	PL	PI	Cc	Cu
● Bulk B-31 1' 5.0'	Lean Clay with sand, brown (CL, A-6)			40	20	20		
☒ Bulk B-33 1' 5.0'	Sandy Lean Clay, brown (CL, A-6)			28	18	10		
▲ Bulk B-36 1' 5.0'	Clayey Sand, brown (SC, A-6)			35	17	18		
★ Bulk B-37 1' 5.0'	Clayey Sand, brown (SC, A-2-4)			28	18	10		
◎ Bulk B-40 1' 5.0'	Clayey Sand, brown (SC, A-4)			28	18	11		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● Bulk B-31 1' 5.0'	4.75				0.0	21.6	78.4	
☒ Bulk B-33 1' 5.0'	4.75				0.0			
▲ Bulk B-36 1' 5.0'	9.50	0.16			3.5	47.6	48.9	
★ Bulk B-37 1' 5.0'	9.50	0.26			3.4	66.5	30.1	
◎ Bulk B-40 1' 5.0'	4.75	0.15			0.0	51.5	48.5	

PROJECT Proposed Killdeer Bypass; Killdeer, ND AET JOB NO. 37-01518
DATE 10/3/14

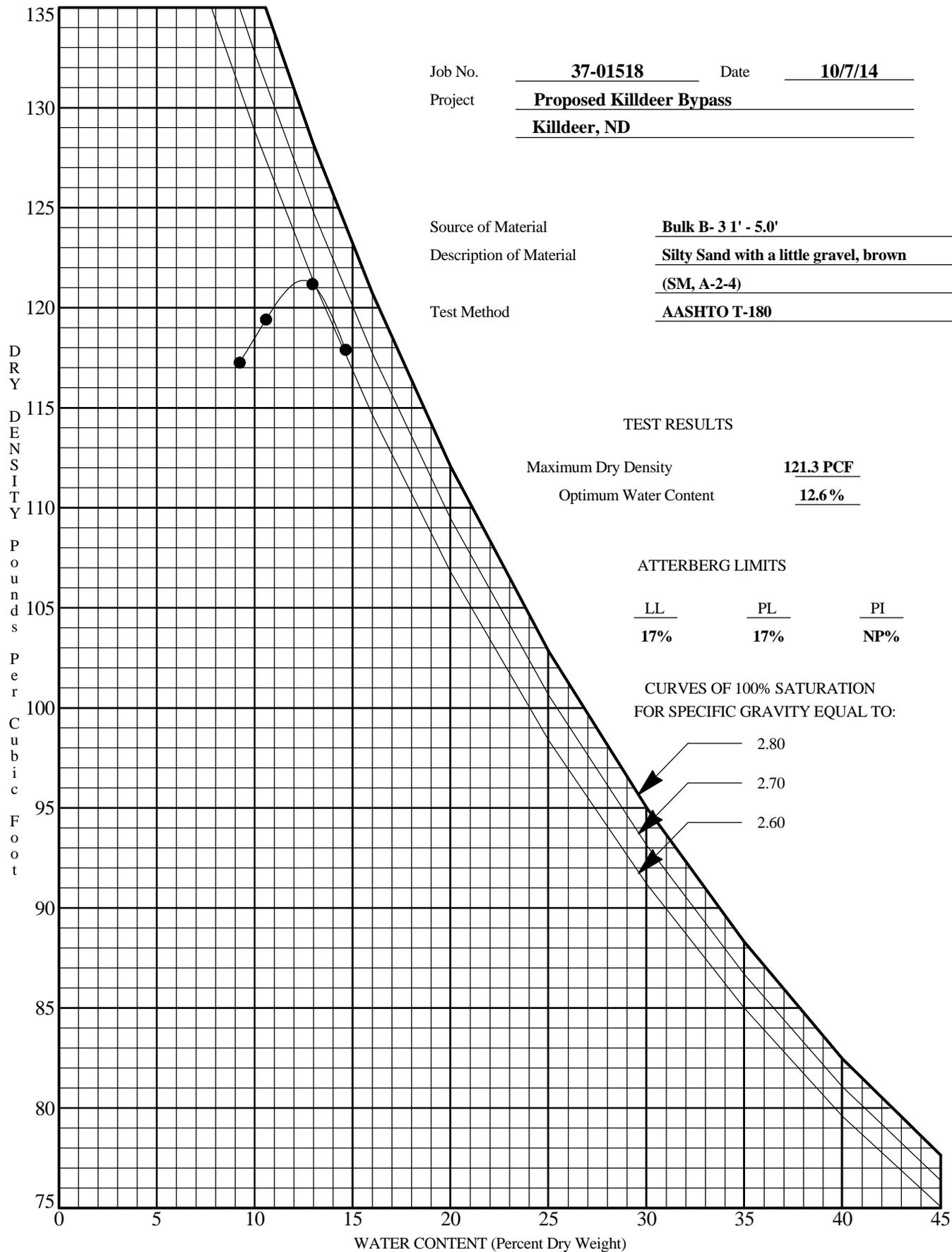


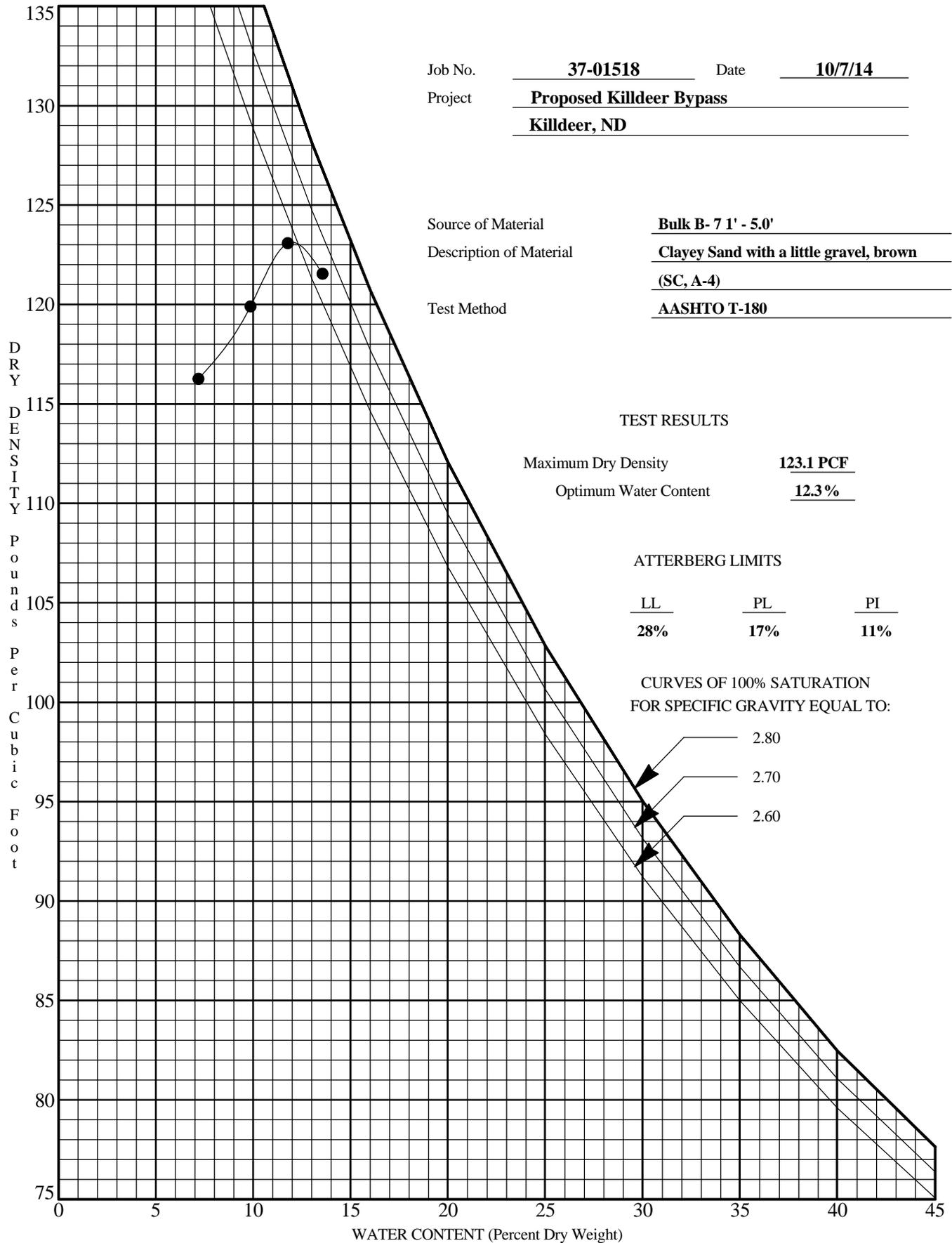
GRADATION CURVES

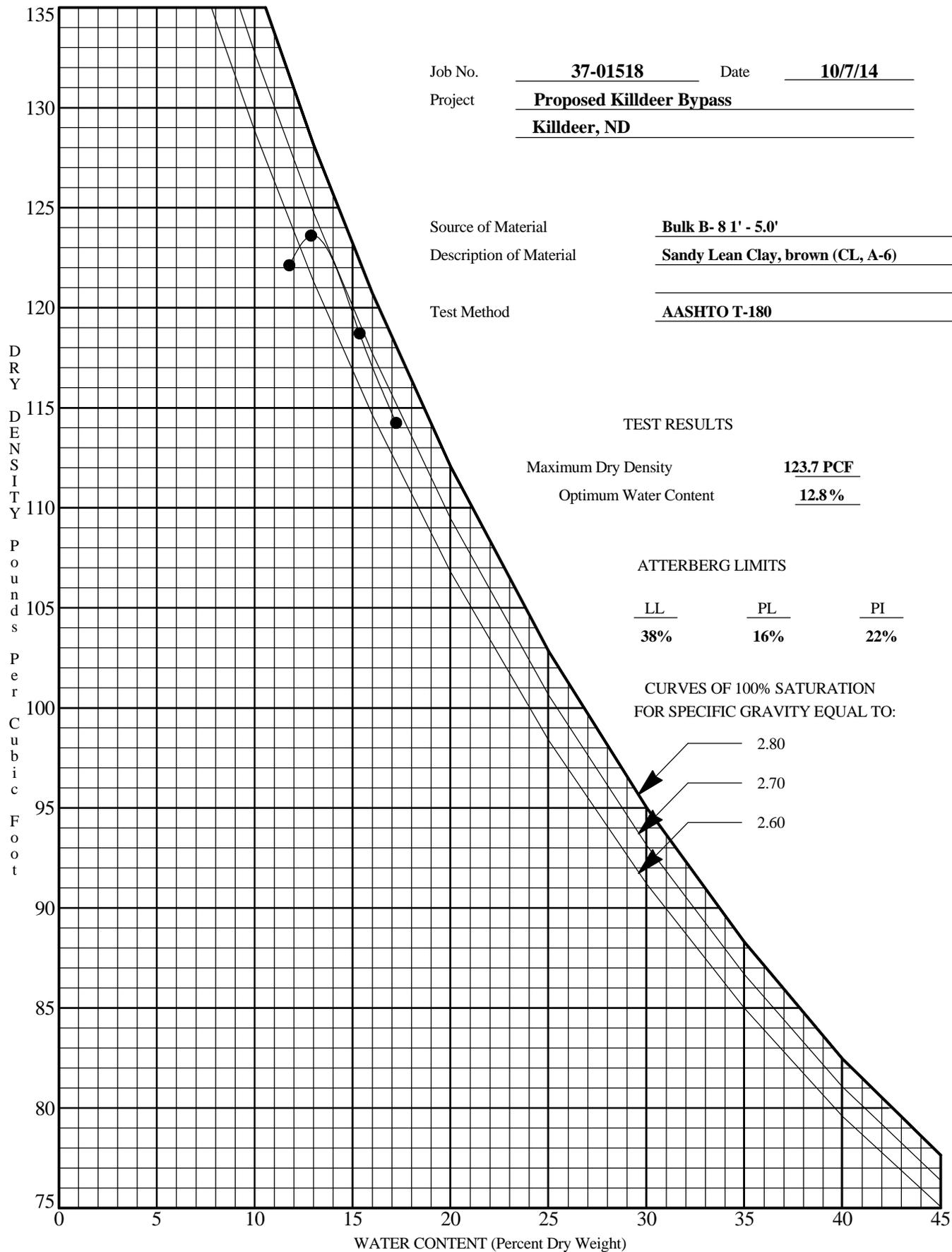


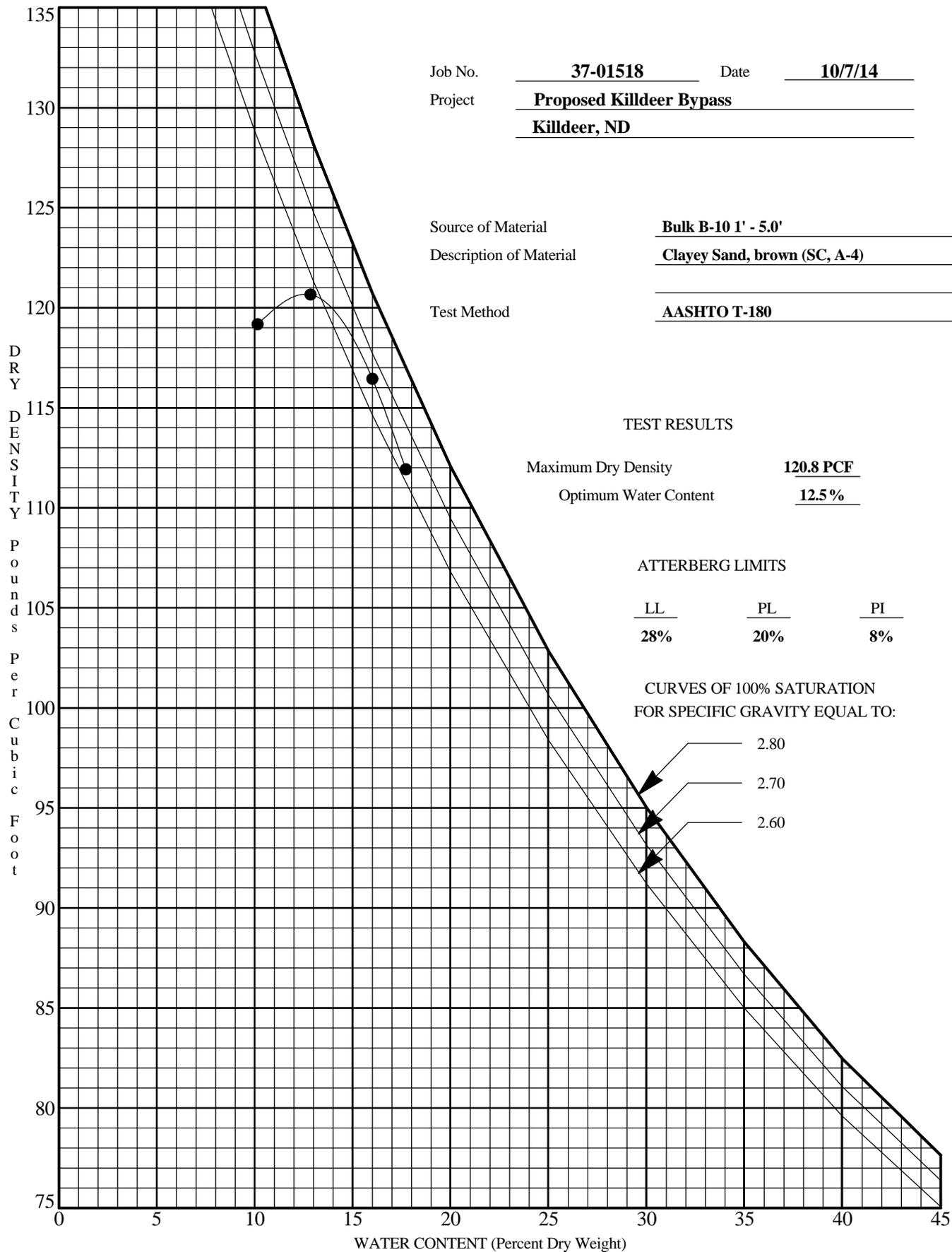
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TESTING, INC.

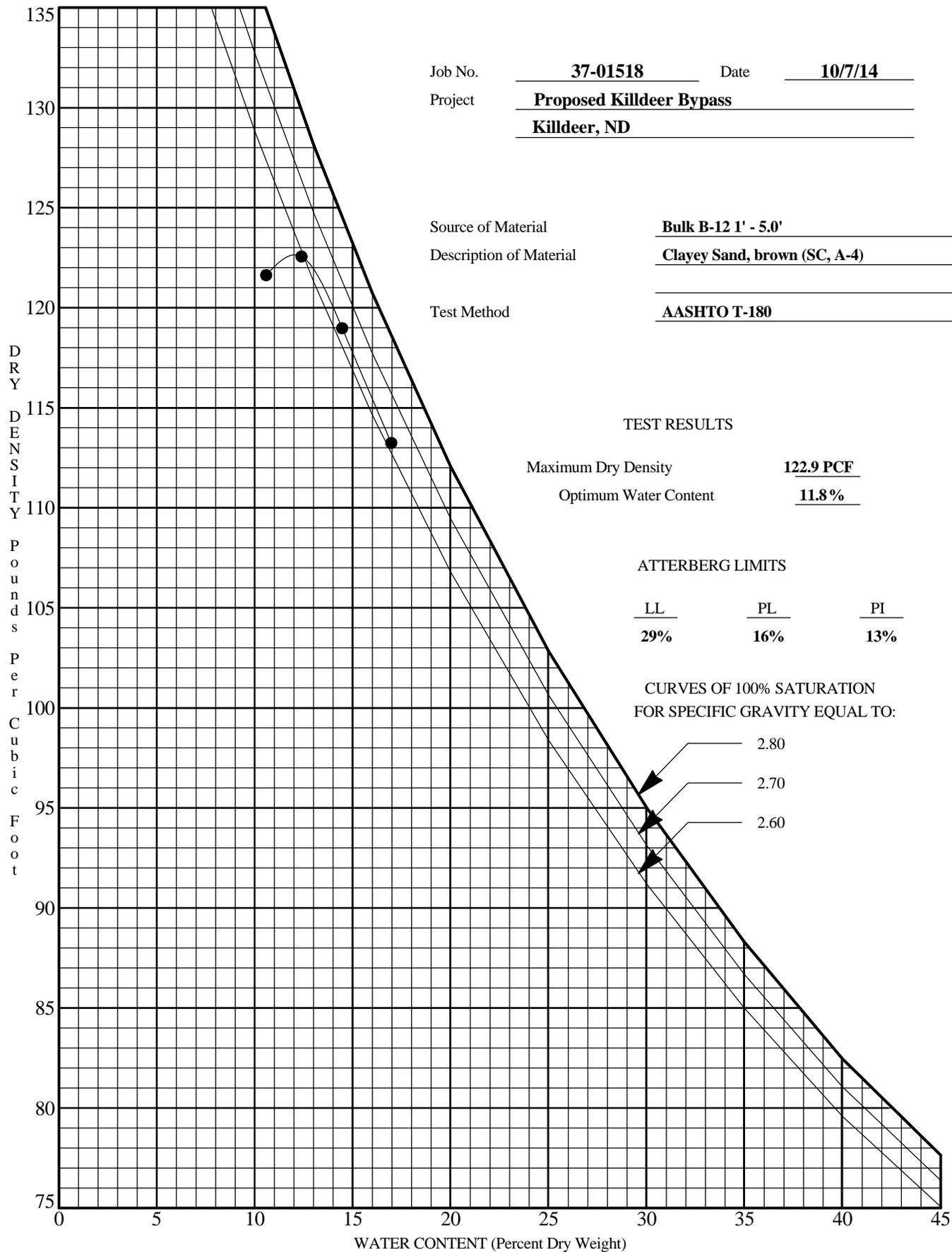
MOISTURE-DENSITY RELATIONSHIP

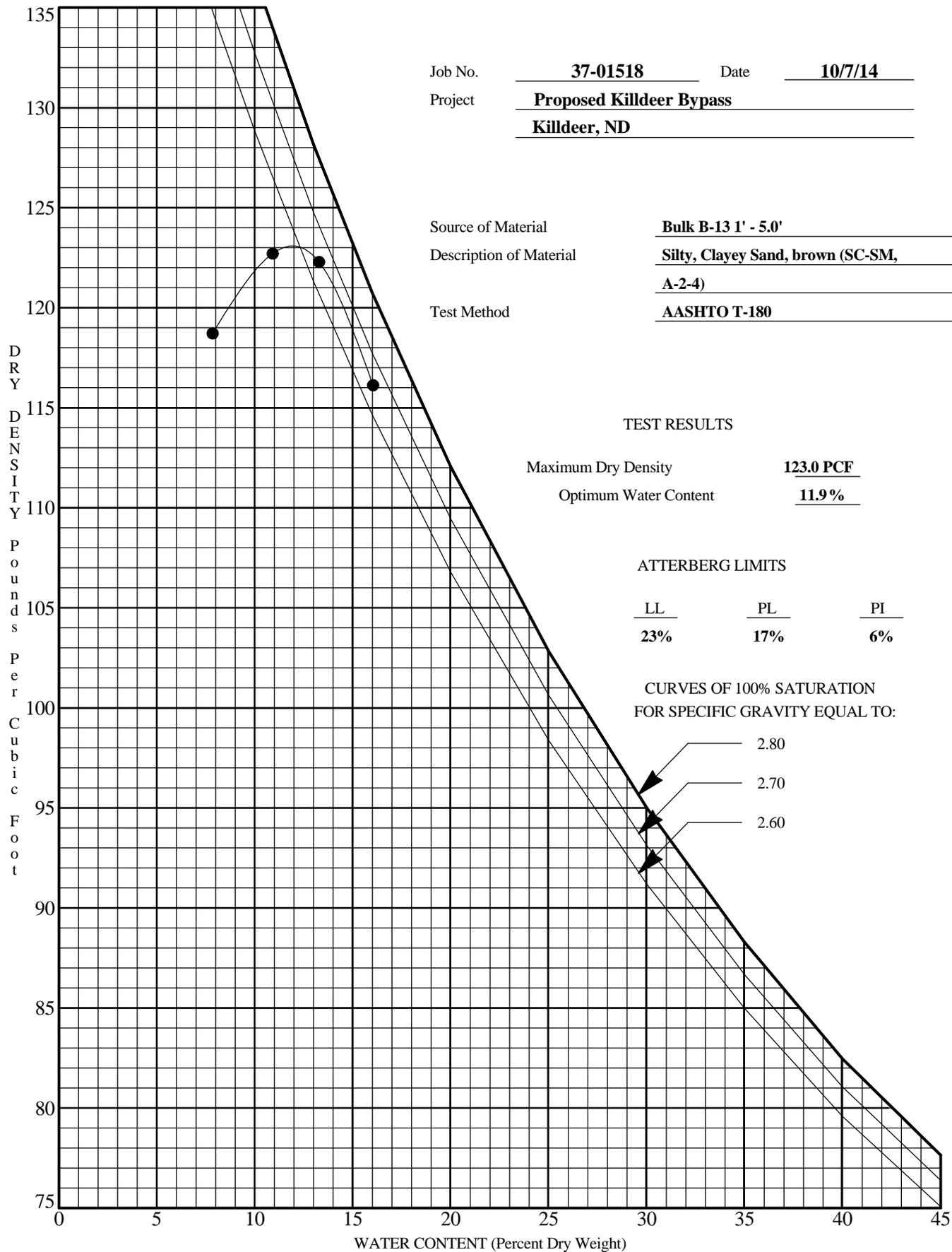


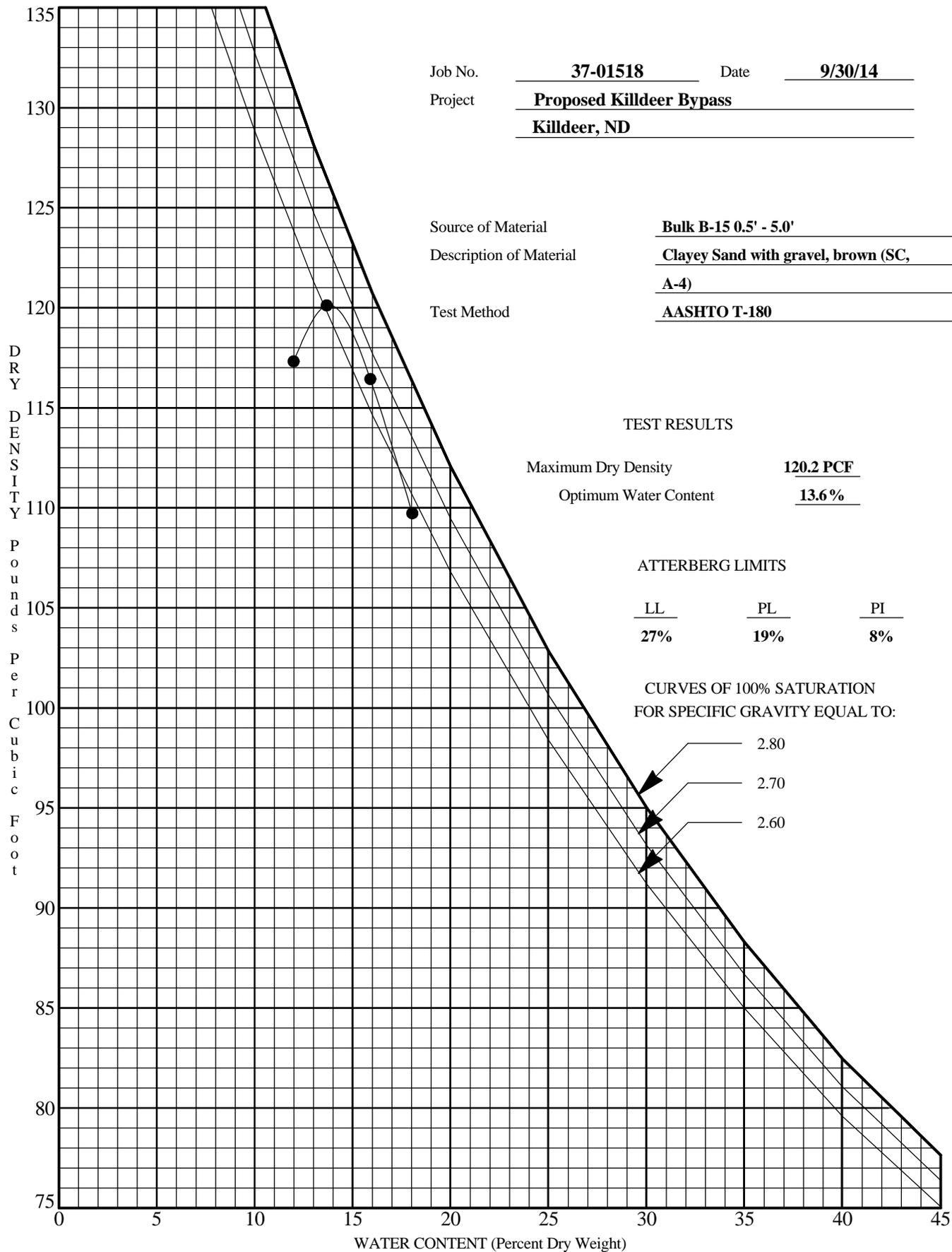






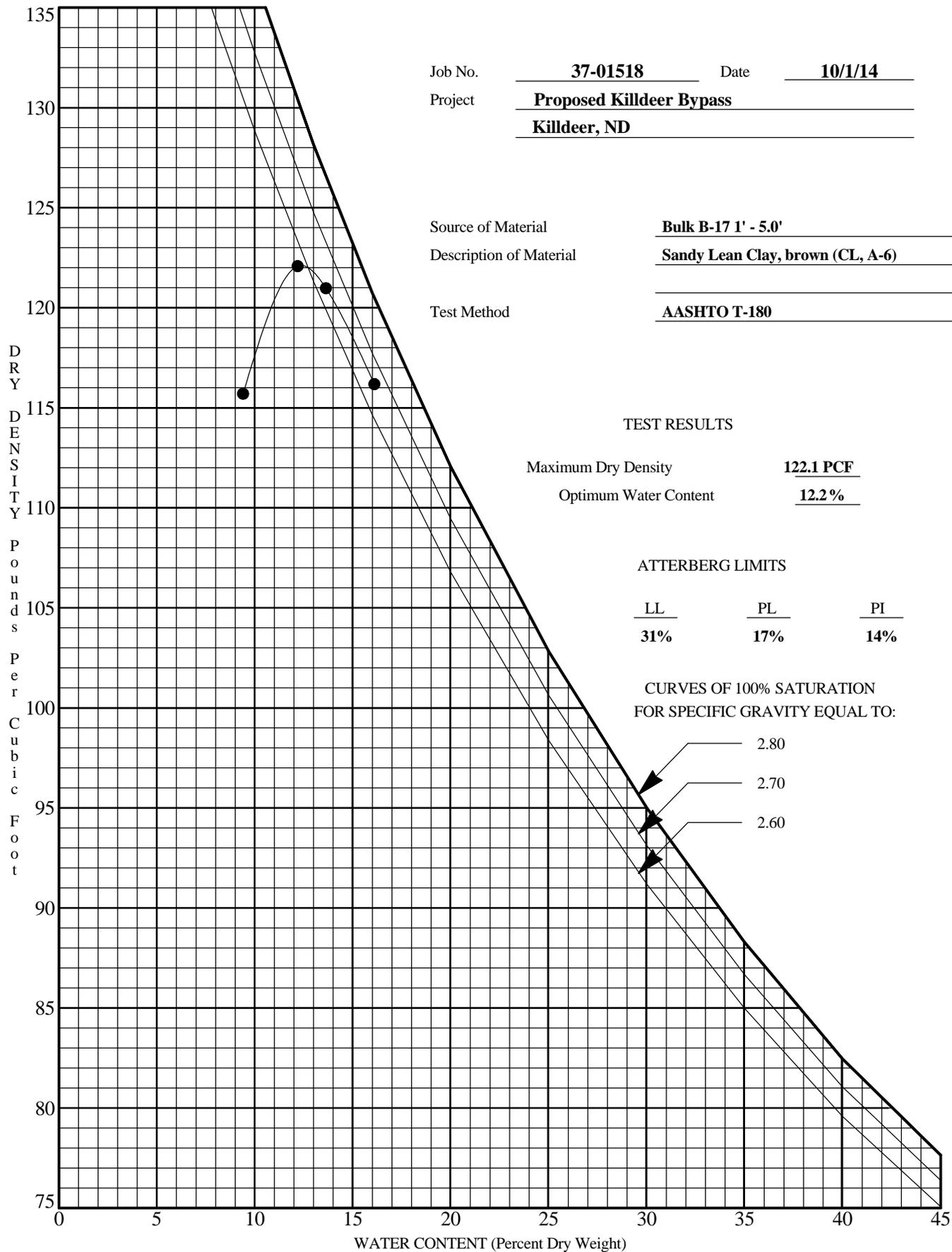






AMERICAN
ENGINEERING
TESTING, INC.

MOISTURE-DENSITY RELATIONSHIP



Job No. 37-01518 Date 10/1/14
 Project Proposed Killdeer Bypass
Killdeer, ND

Source of Material Bulk B-17 1' - 5.0'
 Description of Material Sandy Lean Clay, brown (CL, A-6)
 Test Method AASHTO T-180

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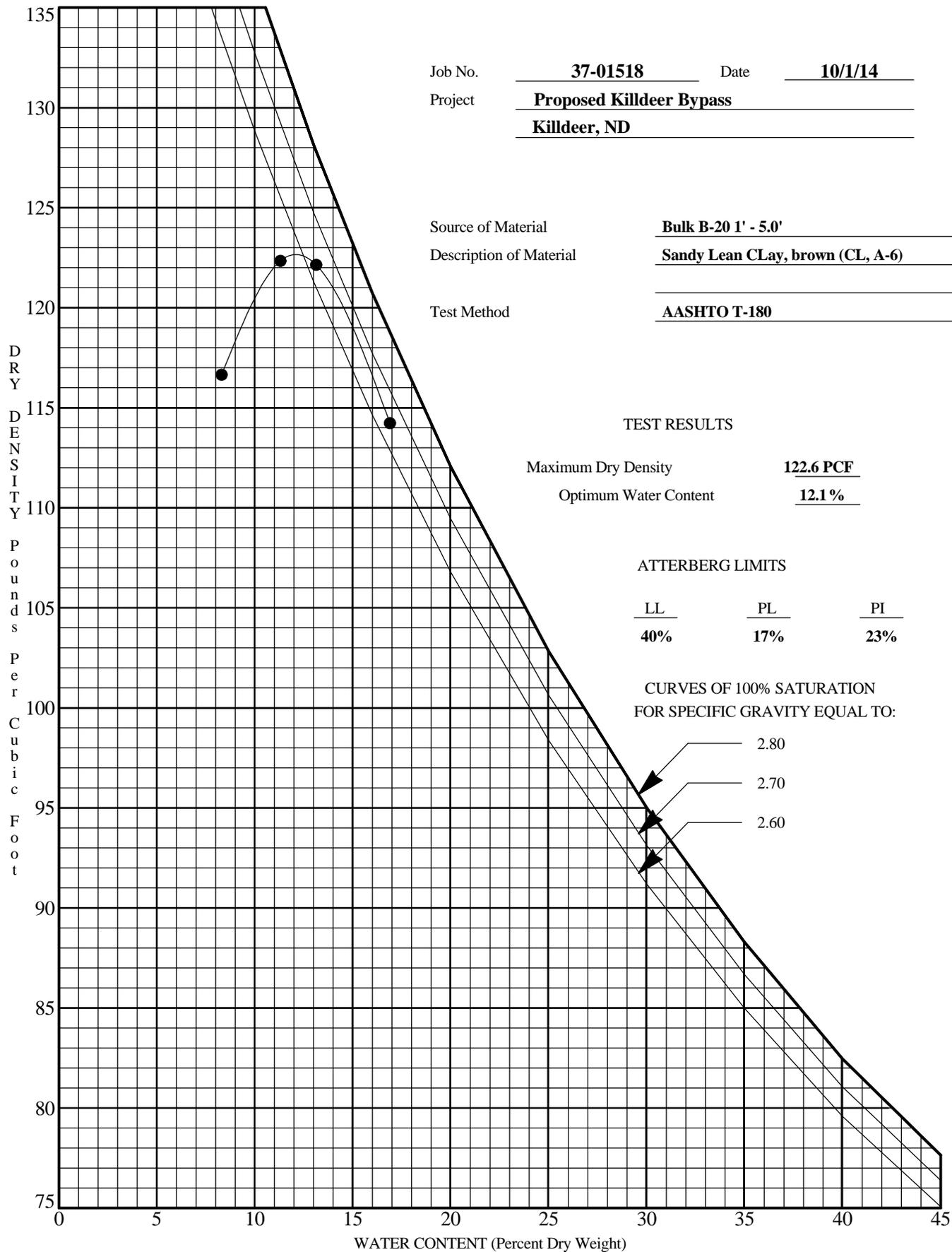
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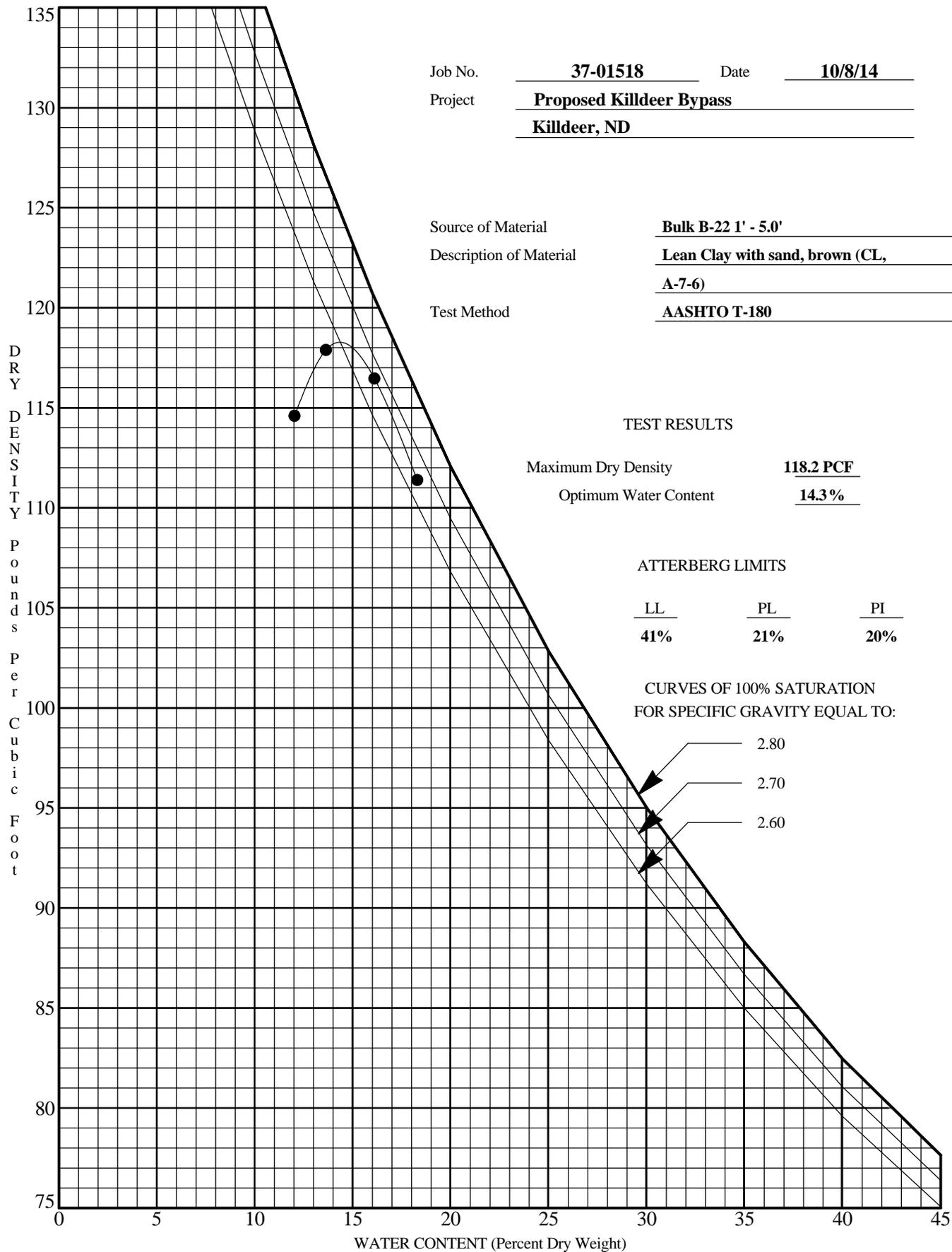
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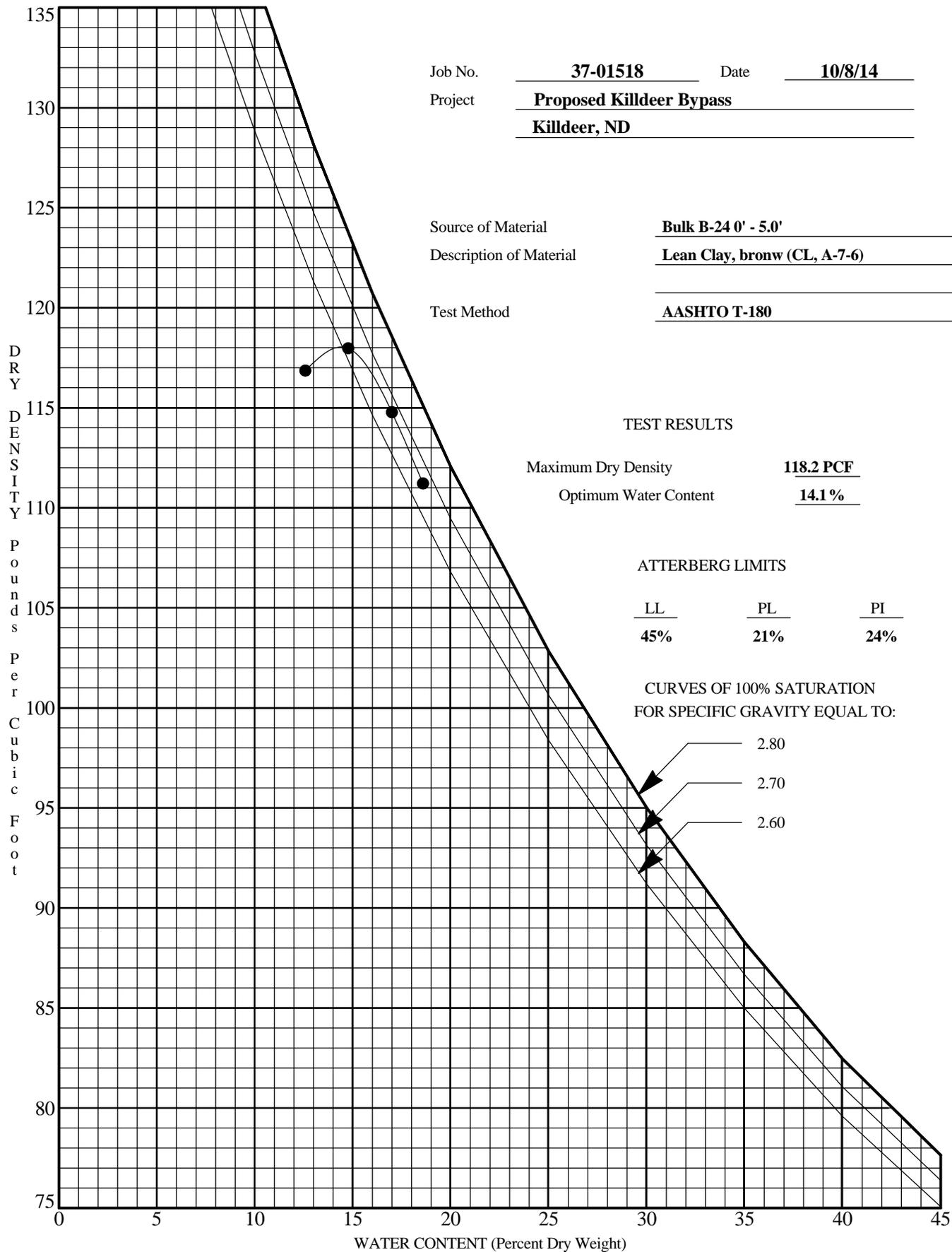
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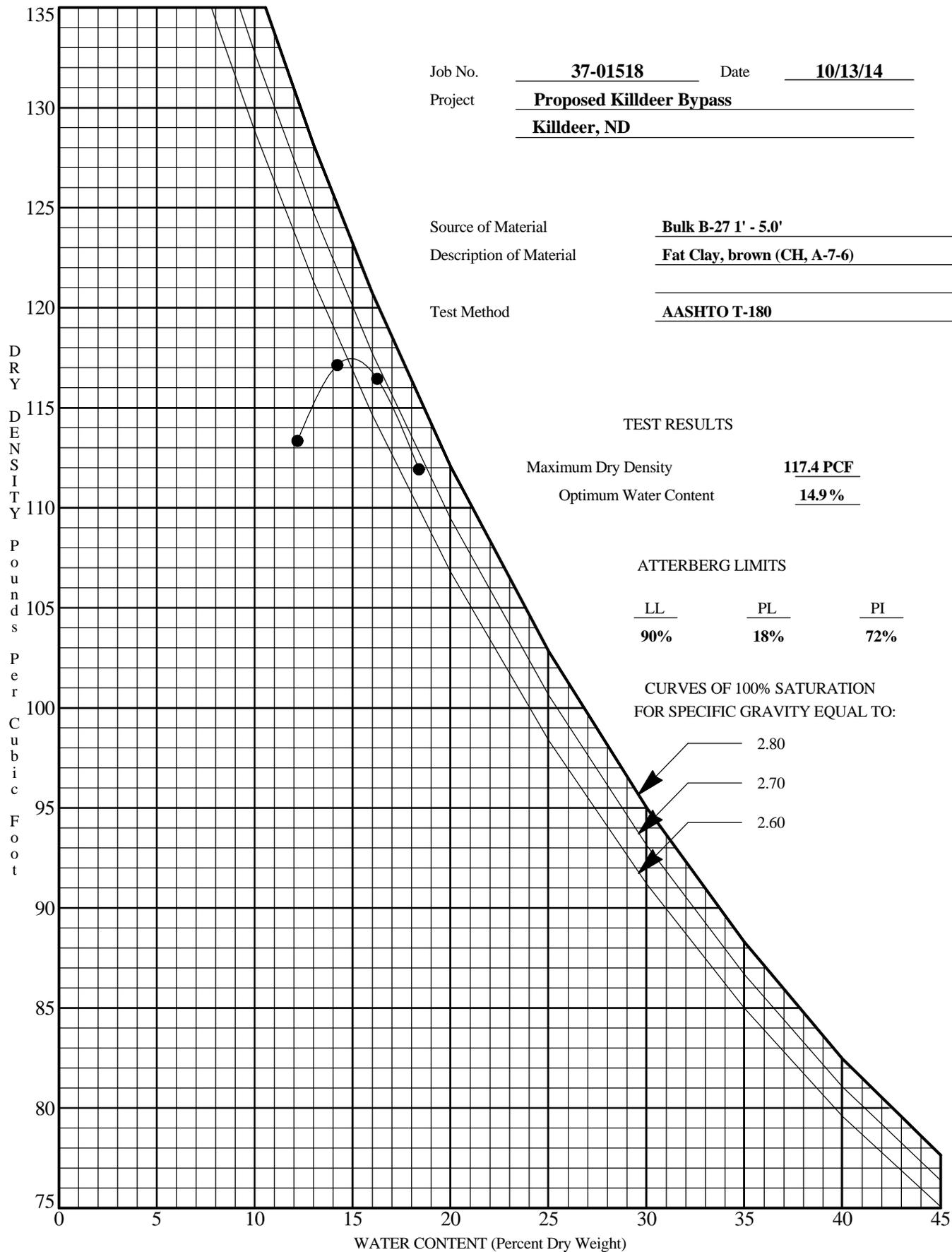
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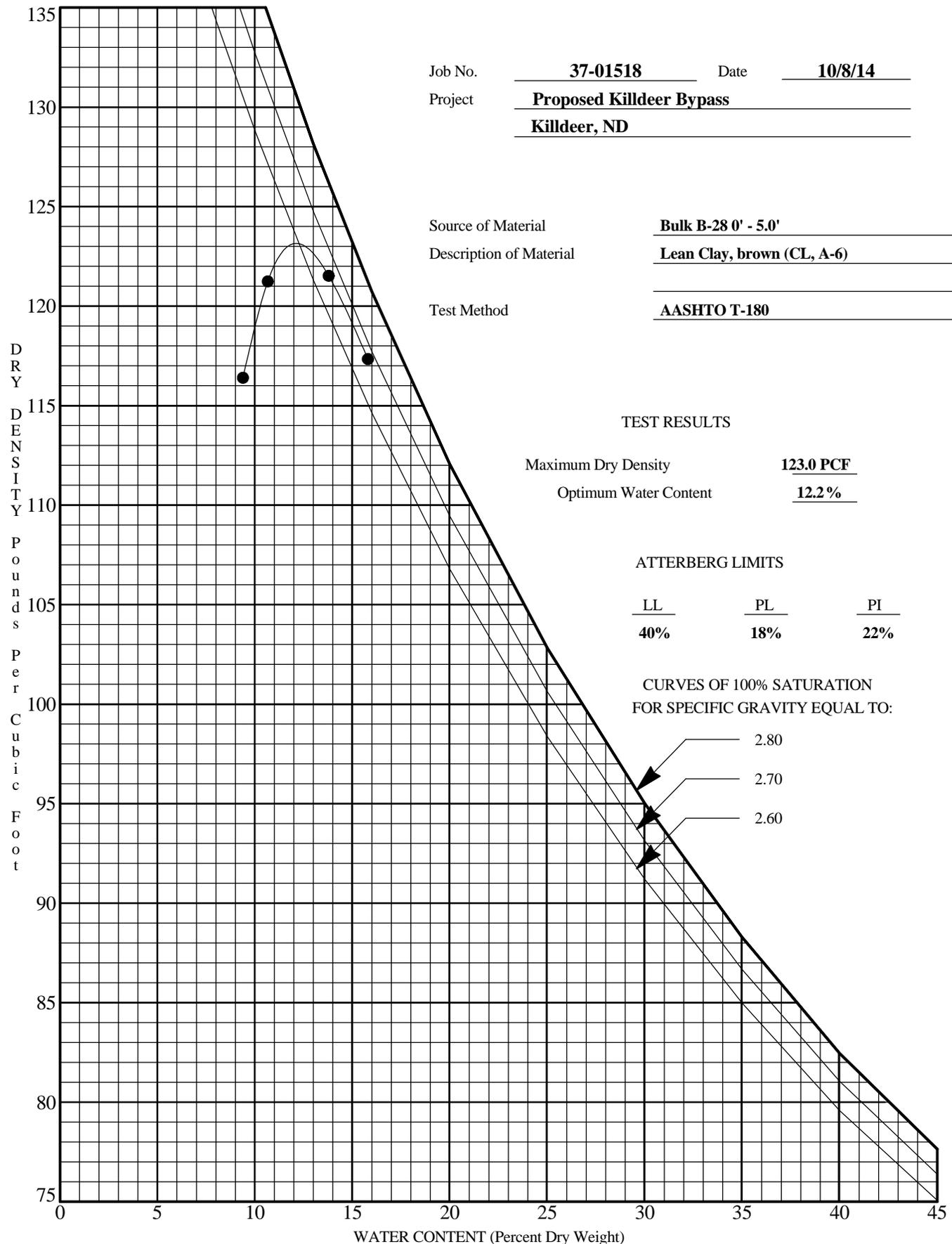
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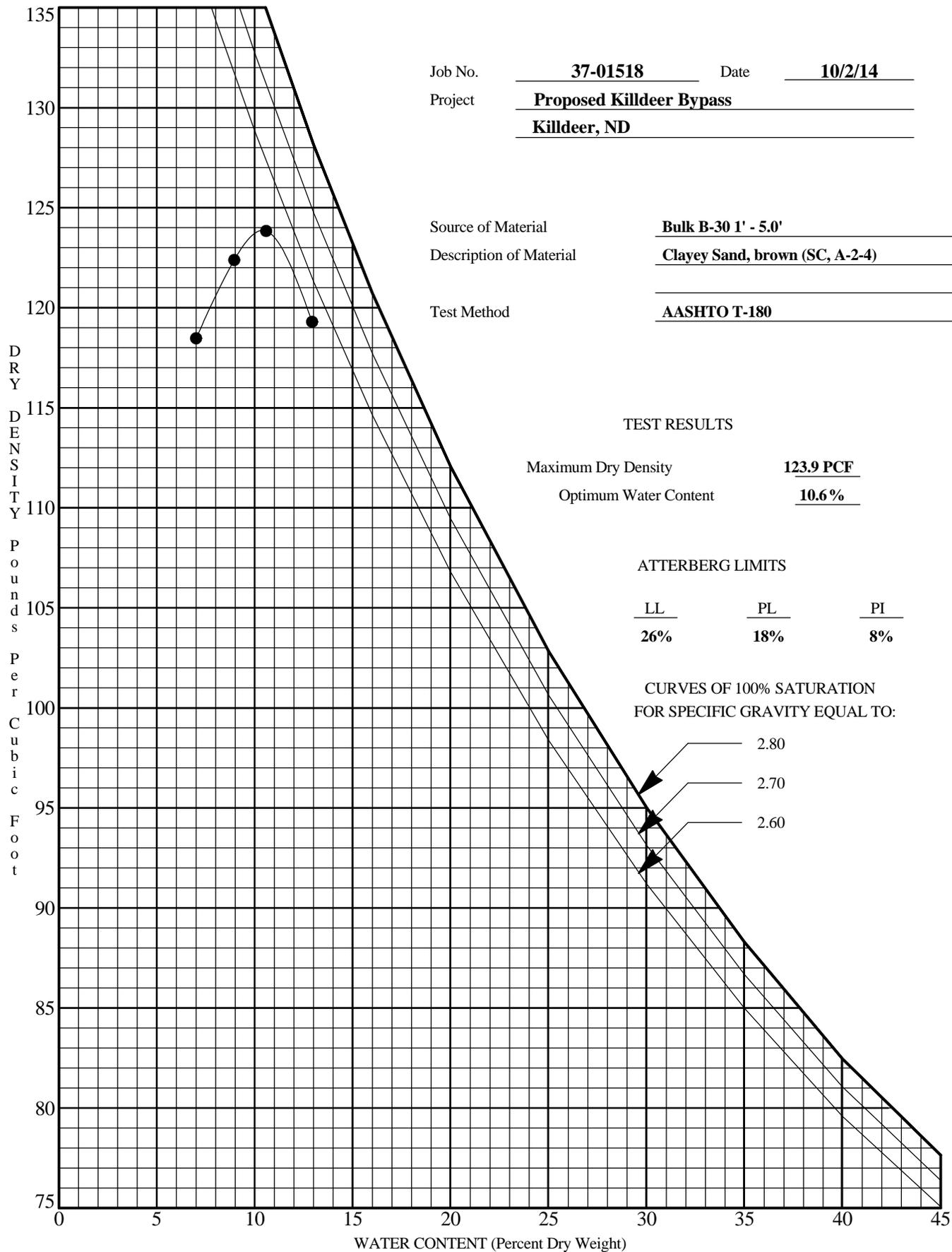


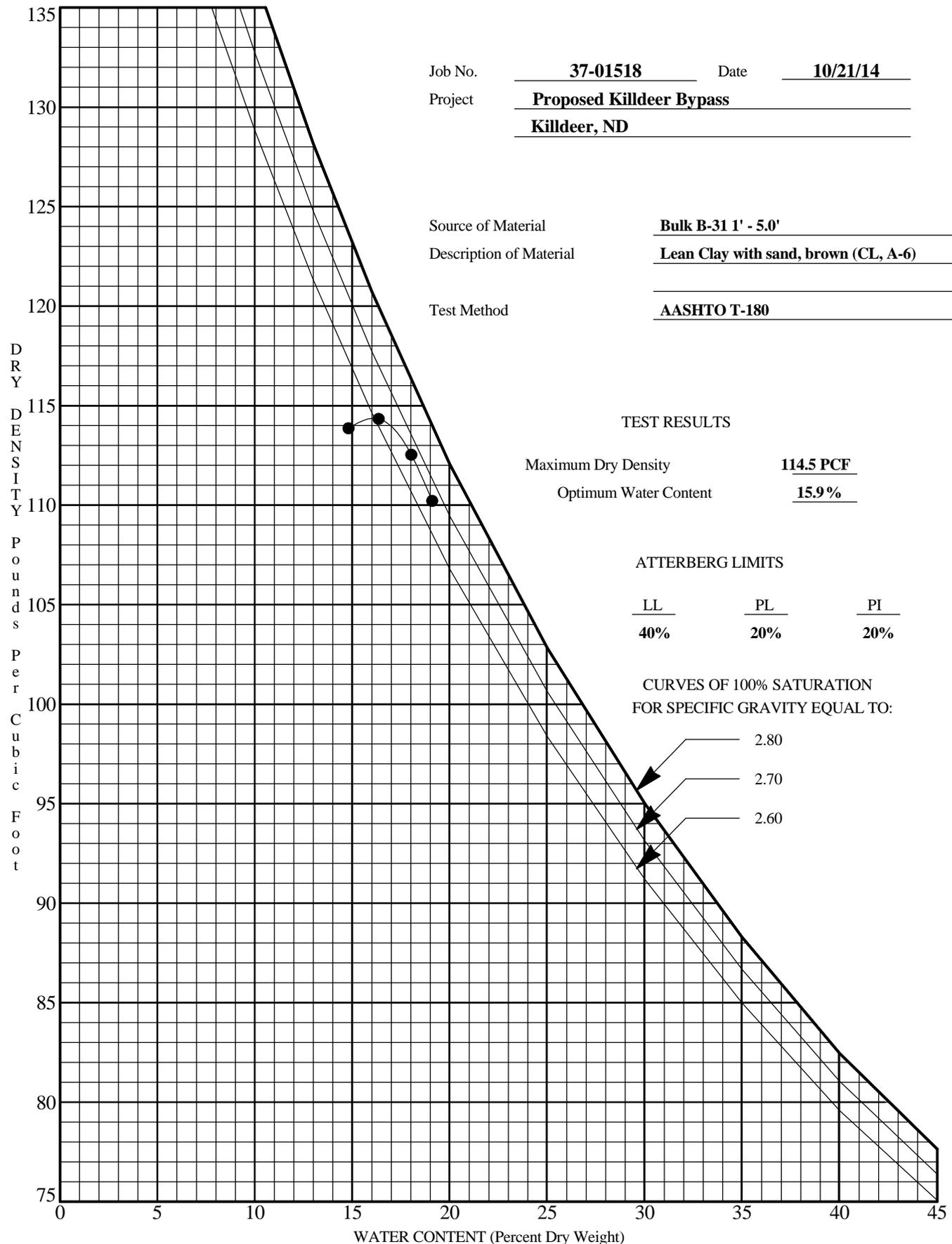


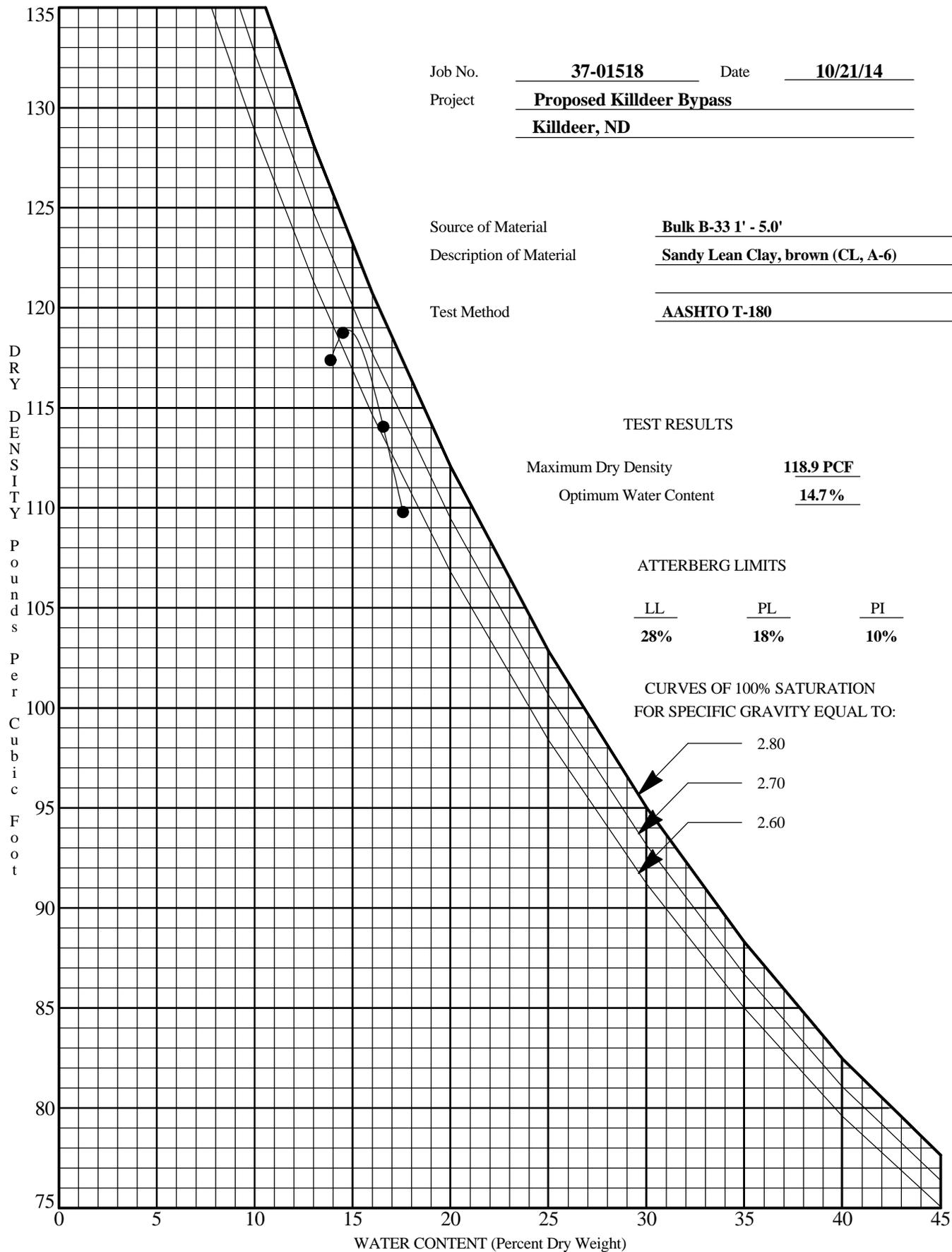


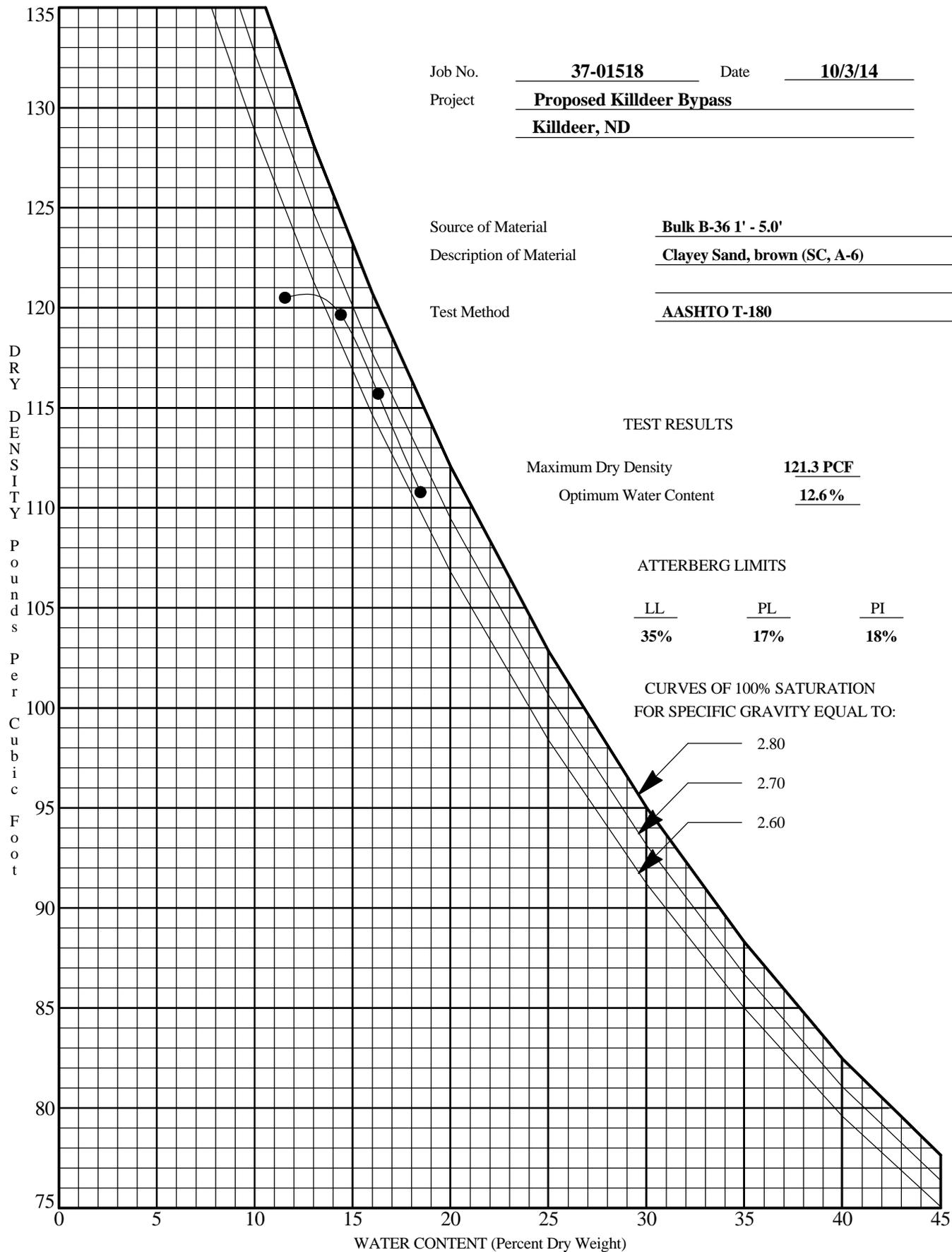


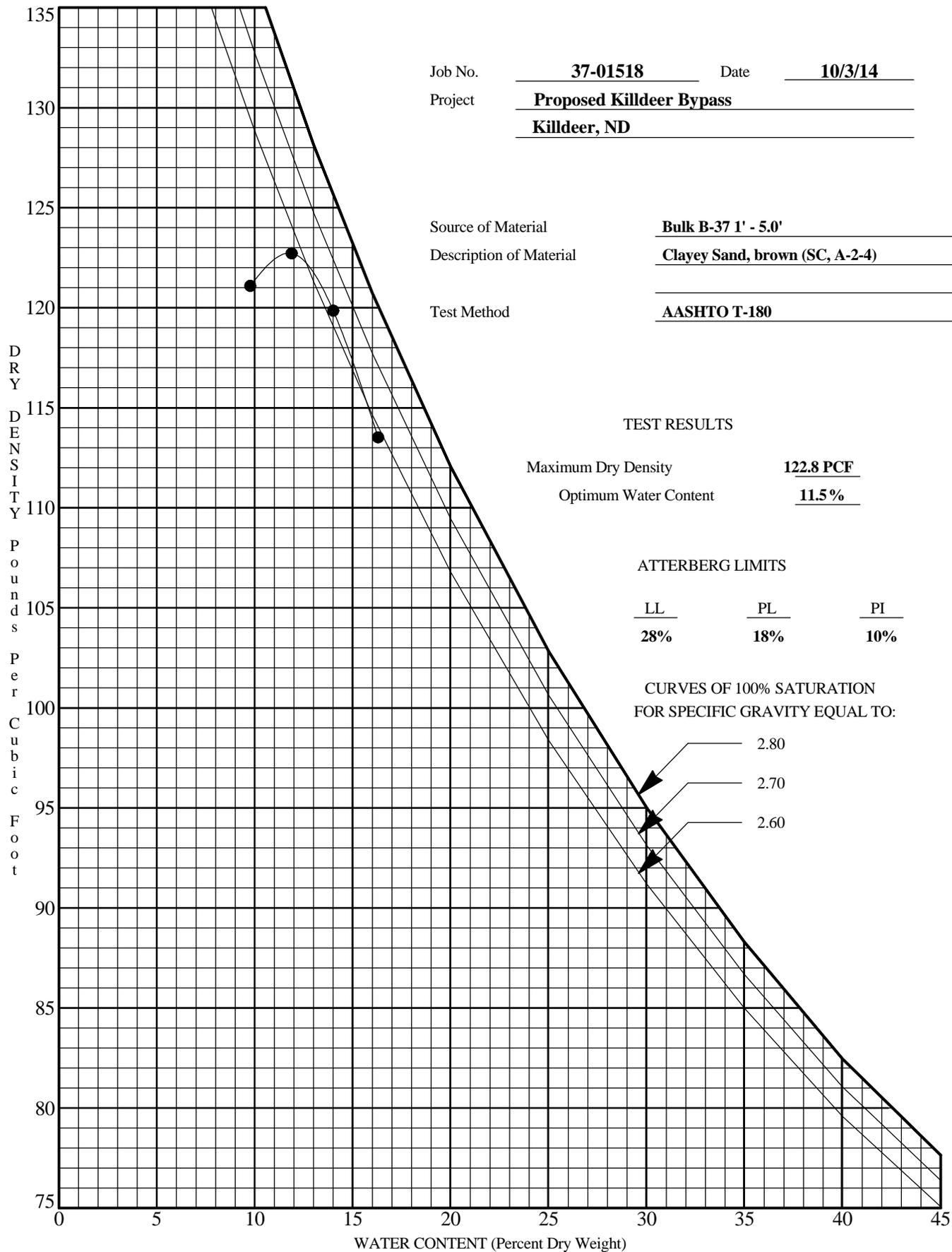


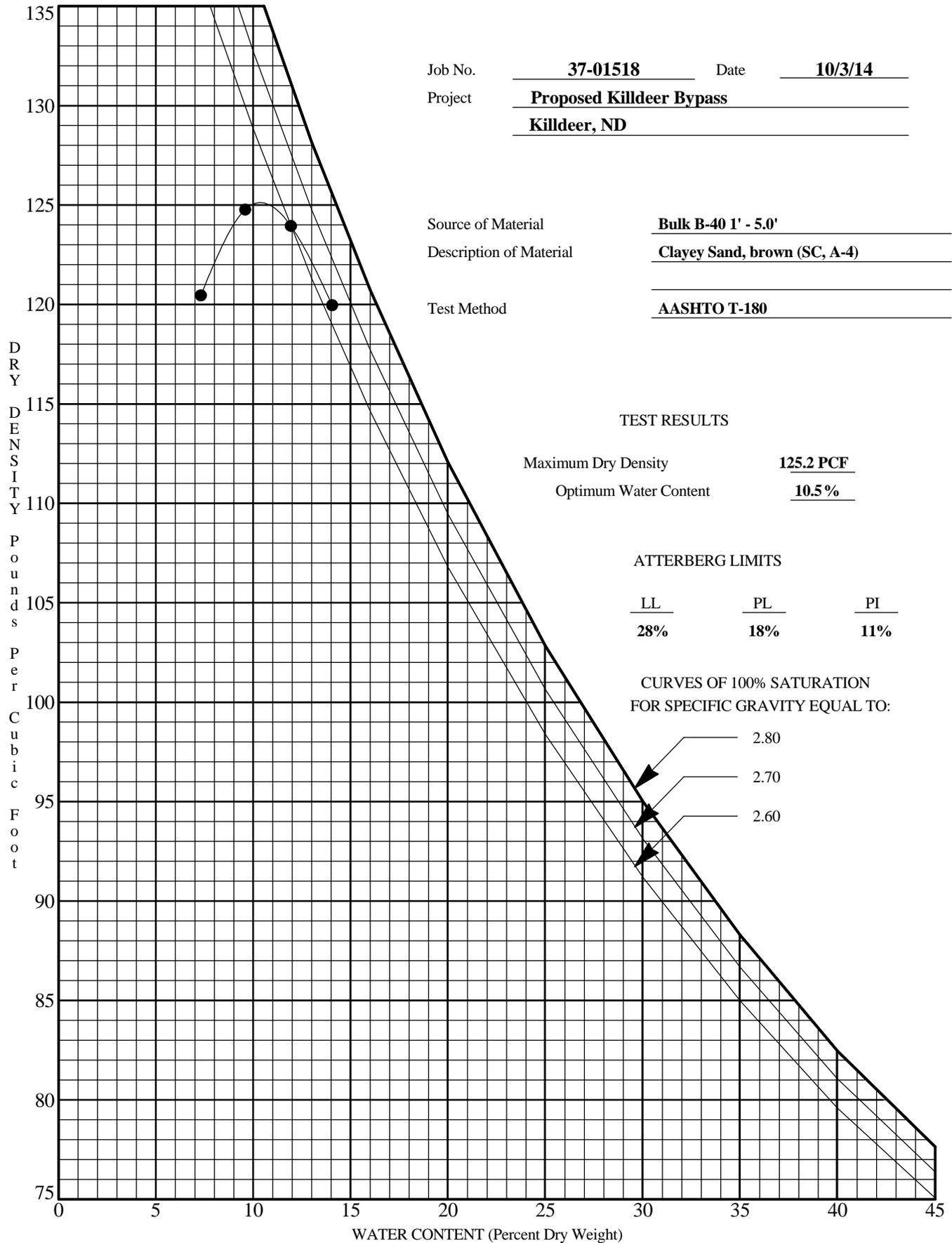












Linear Laboratory Analysis

Project: Killdeer Bypass

Killdeer, North Dakota

AET Project No. 37-01518



Boring Number	B-1	B-3	B-7	B-8	B-10
Northing (°)	47° 21' 14.86"	47° 21' 27.65"	47° 21' 26.88"	47° 21' 27.45"	47° 21' 27.52"
Easting (°)	102° 45' 31.05"	102° 45' 29.79"	102° 46' 27.42"	102° 46' 41.75"	102° 47' 10.44"
Elevation (ft)	Not Determined				
Sample Depth (ft)	1-5	1-5	1-5	1-5	1-5

% Passing 3/8" Sieve	99.9	100	91	100	98.9
% Passing No. 4 Sieve	99.8	93.2	85.1	97.5	97.7
% Passing No. 10 Sieve	95.9	90.4	82.8	96	95.4
Coarse Sand (No. 10 - No. 40)	7.3	5.9	11.8	7.8	6.9
Fine Sand (No. 40 - No. 200)	6.1	54	32.8	29.7	43.8

% Fines (- No. 200)	82.5	30.5	38.2	58.5	44.7
Liquid Limit	61	17	28	38	28
Plastic Limit	26	17	17	16	20
Plasticity Index	35	0	9	22	8
Soil Color	BRN	BRN	BRN	BRN	BRN
USCS Soil Classification	CH	SM	SC	CL	SC
AASHTO M-15 Soil Classification	A-7-6	A-2-4	A-4	A-6	A-4
Frost Class					

Optimum Moisture (%)	107.2		121.3		123.1		123.7		120.8	
Max. Dry Density (pcf)	18.1		12.6		12.3		12.8		12.5	
Depth (ft)	Moisture Content (%)		0.0	13.00%	0.0	14.00%	0.0	8.00%	0.0	8.00%
	1.0	25.00%	1.0	12.00%	1.0	12.00%	1.0	22.00%	1.0	14.00%
	2.0	35.00%	2.0	8.00%	2.0	20.00%	2.0	20.00%	2.0	25.00%
	3.0	30.00%	3.0	28.00%	3.0	13.00%	3.0	24.00%	3.0	26.00%
	4.0	30.00%	4.0	0.00%	4.0	17.00%	4.0	18.00%	4.0	21.00%
Average Moisture Content (%)	25.75%		15.50%		13.25%		18.50%		18.25%	

Linear Laboratory Analysis

Project: Killdeer Bypass

Killdeer, North Dakota

AET Project No. 37-01518



Boring Number	B-12	B-13	B-15	B-17	B-20
Northing (°)	47° 21' 27.5"	47° 21' 27.64"	47° 21' 31.12"	47° 21' 50.01"	47° 22' 19.86"
Easting (°)	102° 47' 47.6"	102° 48' 7.62"	102° 48' 4.82"	102° 48' 5.9"	102° 48' 5.89"
Elevation (ft)	Not Determined				
Sample Depth (ft)	1-5	1-5	0.5-6	1-5	1-5

% Passing 3/8" Sieve	100	100	87.5	99.2	100
% Passing No. 4 Sieve	99.8	99.2	77.5	95.8	100
% Passing No. 10 Sieve	98.6	97.7	77	95	98.5
Coarse Sand (No. 10 - No. 40)	4.7	5.2	1.3	2.6	4.3
Fine Sand (No. 40 - No. 200)	52.7	54.2	35.7	35.8	29.4

% Fines (- No. 200)	41.2	38.3	40	56.6	64.8
Liquid Limit	29	23	27	31	39.65
Plastic Limit	16	17	19	17	17
Plasticity Index	13	6	8	14	23
Soil Color	BRN	BRN	DK BRN	BRN	BRN
USCS Soil Classification	SC	SC-SM	SC	CL	CL
AASHTO M-15 Soil Classification	A-4	A-2-4	A-4	A-6	A-6
Frost Class					

Optimum Moisture (%)	122.9		123		120.2		122.1		122.6		
Max. Dry Density (pcf)	11.8		11.9		13.6		12.2		12.1		
Depth (ft)	Moisture Content (%)	0.0	12.00%	0.0	7.00%	0.0	10.00%	0.0	19.00%	0.0	22.00%
		1.0	13.00%	1.0	13.00%	1.0	13.00%	1.0	17.00%	1.0	18.00%
		2.0	14.00%	2.0	14.00%	2.0	11.00%	2.0	12.00%	2.0	18.00%
		3.0	12.00%	3.0	16.00%	3.0	16.00%	3.0	16.00%	3.0	17.00%
		4.0	13.00%	4.0	0.00%	4.0	15.00%	4.0	17.00%	4.0	19.00%
Average Moisture Content (%)	12.75%		12.50%		13.00%		16.20%		18.80%		

Linear Laboratory Analysis

Project: Killdeer Bypass

Killdeer, North Dakota

AET Project No. 37-01518



Boring Number	B-22	B-24	B-27	B-28	B-30
Northing (°)	47° 22' 39.9"	47° 23' 0.71"	47° 23' 29.15"	47° 23' 39.02"	47° 23' 57.69"
Easting (°)	102° 48' 4.37"	102° 48' 4.48"	102° 48' 7.41"	102° 48' 7.06"	102° 48' 6.16"
Elevation (ft)	Not Determined				
Sample Depth (ft)	1-5	0-5	1-5	0-5	1-5

% Passing 3/8" Sieve	100	100	100	100	100
% Passing No. 4 Sieve	100	100	100	100	96.4
% Passing No. 10 Sieve	99	99.6	100	99.9	95.1
Coarse Sand (No. 10 - No. 40)	8.1	2.5	1.1	0.5	7.1
Fine Sand (No. 40 - No. 200)	9.9	3	4	7.6	67.7

% Fines (- No. 200)	81	94.1	94.9	91.8	20.3
Liquid Limit	41	45	90	40	26
Plastic Limit	21	21	18	18	18
Plasticity Index	20	24	72	22	8
Soil Color	BRN	BRN	BRN	BRN	BRN
USCS Soil Classification	CL	CL	CH	CL	SC
AASHTO M-15 Soil Classification	A-7-6	A-7-6	A-7-6	A-6	A-2-4
Frost Class					

Optimum Moisture (%)	118.2		118.2		117.4		123		123.9			
Max. Dry Density (pcf)	14.3		14.1		14.9		12.2		10.6			
Depth (ft)	Moisture Content (%)		0.0	24.00%	0.0	17.00%	0.0	15.00%	0.0	18.00%	0.0	4.00%
	1.0	20.00%	1.0	20.00%	1.0	12.00%	1.0	15.00%	1.0	3.00%		
	2.0	22.00%	2.0	19.00%	2.0	20.00%	2.0	15.00%	2.0	7.00%		
	3.0	24.00%	3.0	29.00%	3.0	22.00%	3.0	18.00%	3.0	5.00%		
	4.0	33.00%	4.0	25.00%	4.0	27.00%	4.0	16.00%	4.0	6.00%		
Average Moisture Content (%)	22.50%		21.25%		17.25%		16.50%		5.00%			

Linear Laboratory Analysis

Project: Killdeer Bypass

Killdeer, North Dakota

AET Project No. 37-01518



Boring Number	B-31	B-33	B-36	B-37	B-40
Northing (°)	47° 24' 7.96"	47° 24' 27.97"	47° 24' 56.89"	47° 25' 6.79"	47° 24' 32.02"
Easting (°)	102° 48' 7.75"	102° 48' 5.64"	102° 48' 3.12"	102° 48' 3.3"	102° 47' 35.31"
Elevation (ft)	Not Determined				
Sample Depth (ft)	0-5	0-5	1-5	1-5	1-5

% Passing 3/8" Sieve	100	100	100	100	100
% Passing No. 4 Sieve	100	100	96.5	96.6	100
% Passing No. 10 Sieve	99.4	99.9	93.4	92.9	97.7
Coarse Sand (No. 10 - No. 40)	3.7	1.8	17.5	18.3	9.7
Fine Sand (No. 40 - No. 200)	17.3	33.7	27	44.5	39.5

% Fines (- No. 200)	78.4	64.4	48.9	30.1	48.5
Liquid Limit	40	28	35	28	28
Plastic Limit	20	18	17	18	18
Plasticity Index	20	10	18	10	10
Soil Color	BRN	BRN	BRN	BRN	BRN
USCS Soil Classification	CL	CL	SC	SC	SC
AASHTO M-15 Soil Classification	A-6	A-6	A-6	A-2-4	A-4
Frost Class					

Optimum Moisture (%)	114.5		118.9		121.3		122.8		125.2		
Max. Dry Density (pcf)	15.9		14.7		12.6		11.5		10.5		
Depth (ft)	Moisture Content (%)	0.0	20.00%	0.0	15.00%	0.0	6.00%	0.0	5.00%	0.0	6.00%
		1.0	19.00%	1.0	22.00%	1.0	5.00%	1.0	5.00%	1.0	7.00%
		2.0	10.00%	2.0	17.00%	2.0	15.00%	2.0	24.00%	2.0	21.00%
		3.0	8.00%	3.0	12.00%	3.0	21.00%	3.0	22.00%	3.0	21.00%
		4.0	0.1	4.0	24.00%	4.0	17.00%	4.0	11.00%	4.0	19.00%
Average Moisture Content (%)	14.25%		16.50%		12.80%		13.40%		14.80%		

Appendix B

AET Project No. 37-01518

Geotechnical Report Limitations and Guidelines for Use

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Report No. 37-01518

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE¹, of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

B.2.2 Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

B.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- ♦ not prepared for you,
- ♦ not prepared for your project,
- ♦ not prepared for the specific site explored, or
- ♦ completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- ♦ the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- ♦ elevation, configuration, location, orientation, or weight of the proposed structure,
- ♦ composition of the design team, or
- ♦ project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

B.2.4 Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

¹ ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733: www.asfe.org

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Report No. 37-01518

B.2.5 Most Geotechnical Findings Are Professional Opinions

Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

B.2.6 A Report's Recommendations Are Not Final

Do not overrely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

B.2.8 Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognizes that separating logs from the report can elevate risk.

B.2.9 Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

B.2.10 Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.11 Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.