AMERICAN ENGINEERING TESTING, INC.

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REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

Creekview Office East Parking Lot Expansion

Bloomington, Minnesota

Report No. 27-20046

Date:
November 19, 2019

Prepared for:
Frauenshuh Commercial Real Estate
7101 West 78th Street
Bloomington, MN 55439

AMERICAN ENGINEERING TESTING, INC.

November 19, 2019

Frauenshuh Commercial Real Estate
7101 West 78th Street
Bloomington, MN 55439

Attn: Allen Hill
Allen.hill@frauenshuh.com

RE: Geotechnical Exploration and Review
Creekview Office East Parking Lot Expansion
Bloomington, Minnesota
AET No. 27-20046

Dear Mr. Hill:

American Engineering Testing, Inc., (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the above referenced project in Bloomington, Minnesota. These services were performed according to our revised proposal to you dated October 17, 2019.

We are submitting an electronic copy of the report to you. If there are additional submissions that you would like, please let us know. Please contact me if you have any questions about the report. I can also be contacted for arranging construction observation and testing services.

Sincerely,
American Engineering Testing, Inc.

Matthew P. Ruble, PE
Vice President – Principal Engineer
Phone: 651-659-1314
mruble@amengtest.com

SIGNATURE PAGE

Prepared for:

Frauenshuh Commercial Real Estate
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Attn: Allen Hill
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Engineer II

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Matthew P. Ruble, PE
Vice President – Principal Engineer

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under Minnesota Statute Section 326.02 to 326.15

Name: Thomas Evans

Date: November 19, 2019

License #: 55092

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1.0 INTRODUCTION

We understand Frauenshuh is proposing to expand the existing Creekview parking lot to the east along West 78th Street in Bloomington, Minnesota. To assist planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a 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 revised proposal dated October 17, 2019. The authorized scope consisted of the following:

- Drilling 4 standard penetration test (SPT) borings to depths of 10 feet.
- Conducting soil laboratory testing.
- Performing a geotechnical engineering review based on the obtained data and preparing this report.

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 Frauenshuh is planning the expansion of the existing Creekview office building parking lot to the east along West 78th Street. Additionally, a rain garden will be constructed south of the parking lot.

Based on the grading plan provided by the client, the parking lot expansion will require up to six feet of fill in the southeast corner, and the proposed elevations will vary from 831 feet to 834 feet. The invert elevation of the rain garden will be near 827 feet. This will require cuts of up to 3 feet.

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 Exploration Program

The subsurface exploration program conducted for the project consisted of four standard penetration test borings drilled on October 25, 2019. Borings B-2 was performed within the proposed rain garden, boring B-1 was performed just south of the proposed rain garden, and borings B-3 and B-4 were performed within the proposed parking lot expansion. Boring B-3 was extended to a depth of 14 feet due to encountering organic soils.

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 is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

AET staked the borings using GPS equipment at locations designated by the client. Elevations at the boring locations were determined by AET personnel using GPS equipment.

4.2 Laboratory Testing

The laboratory test program included water contents of selected soils, two hydrometers within the rain garden, and 2 organic content tests within the parking lot expansion. The water content and the organic content results appear on the individual boring logs adjacent to the samples upon which they were performed. The hydrometer test results are shown on the Gradation Curves sheet in Appendix A following the boring logs.

5.0 SITE CONDITIONS

5.1 Surface Observations

This project is east of the existing Creekview office building on the south side of W 78th Street. The site is mostly covered in trees and slopes downward from north to south. The elevations at the boring locations range from 826.4 feet to 830.1 feet.

5.2 Subsurface Soils/Geology

The soils encountered at the boring locations consists of up to 4 feet of various fill soils including sandy lean clay, silty sand and clayey sand. Below the fill, organic material, till and alluvial soils were encountered and extended to the final drilling depths of 14 feet. Five feet of organic clay was encountered 2 to 7 feet below the surface in boring B-3. Glacial till soils consisted of firm to very stiff clayey sand and stiff lean clay. Alluvial deposits consisted of medium dense gravel with silt, loose sand with silt, and loose to medium dense silty sand.

5.3 Groundwater

The groundwater levels were measured in the borings during drilling and upon completion of drilling. Groundwater was observed in all four borings. Groundwater was observed at depths as shallow as 4.0 feet below existing grade. This equates to elevations of as shallow as 825.0 feet. Table 1 below presents the observed groundwater depth and elevations at our boring locations throughout the site.

Table 1 – Groundwater Depth/Elevations

Boring	Ground Elevation (feet)	Measured Groundwater Depth (feet)	Measured Groundwater Elevation	Estimated Water Depth (feet)*	Estimated Groundwater Elevation*
B-1	828.5	4.6	823.9	4½	824*
B-2	829.6	10.3	819.3	6	823½
B-3	826.4	4.0	822.4	4	822½
B-4	830.1	5.1	825.0	5	825*

*Clayey soil was more prevalent at borings B-1 and B-4 and it was more difficult to estimate the water level. A piezometer would be needed to more accurately determine the groundwater level at the boring locations.

In our judgment, the groundwater levels observed during our soil boring exploration may not represent the actual hydrostatic groundwater condition due to the relatively impermeable nature of the clayey site soils which would require a longer time for groundwater to stabilize in an open borehole than that which the borings were left open. Generally, groundwater levels do not remain constant. Groundwater levels fluctuate due to varying seasonal and annual rainfall and snow melt amounts, local irrigation practices, as well as other factors.

6.0 RAIN GARDEN RECOMMENDATIONS

We understand a rain garden infiltration system is proposed near borings B-1 and B-2. The Minnesota Pollution Control Agency's (MPCA) *Minnesota Stormwater Manual* provides recommendations for design infiltration rates based on soil type (http://stormwater.pca.state.mn.us/index.php/Design_infiltration_rates). Based on the soils encountered in the borings, the recommended design infiltration rates are shown in Table 1.

Table 2 – Minnesota Stormwater Manual Recommended Design Infiltration Rates

USCS Soil Classification	Recommended Design Infiltration Rate (inches/hour)
Gravel with silt (GP-GM)	1.63
Sands with silt (SP-SM) Silty sand (SM)	0.45
Clayey sand (SC)	0.2
Lean clay (CL)	0.06

These infiltration rates represent the long-term infiltration capacity of a practice and are not meant to exhibit the capacity of the soils in their natural state. These values also assume a minimum separation of 3 feet between the bottom of the infiltration practice and the seasonably high ground water table. Based on the pond invert elevation of 826.75 feet, groundwater was encountered approximately 3 feet below this elevation. MPCA recommends that infiltration practices not be used in existing fill soils (http://stormwater.pca.state.mn.us/index.php/Design_criteria_for_Infiltration_basin) due to the potentially variability in these materials.

To provide additional information for design of infiltration, we have calculated the hydraulic conductivity values from one soil sample based on the results of the particle size distribution from the sieve analysis tests using the Kozeny-Carman Equation. However, the Kozeny-Carman equation is not valid in clayey soils; therefore, only results for the sand with silt soils tested are provided below in Table 2.

Table 3 – Kozeny-Carman Equation Estimated Hydraulic Conductivity

Boring No.	Depth (feet)	USCS Soil Type	Estimated Hydraulic Conductivity, k (inches/hour)
B-2	6-7	Sand with silt (SP-SM)	18.2

It should be noted that no correction or safety factors have been applied to these values, including infiltration degradation with time or reduced flow due to high ground-water table.

6.1 Excavation

We recommend removing topsoil or organic soil from beneath pond and particularly berm areas with fill around the pond. Stability analysis of the berm was not part of the scope of this project. We should be contacted to review stability of the berm if excessive topsoil and organics is encountered during construction.

7.0 PARKING LOT RECOMMENDATIONS

7.1 Definitions and Specifications

This report references the latest MnDOT Standard Specifications for Construction 2018 (MnDOT Spec.). Please see the attached standard data sheets entitled “Definitions Relating to Pavement Construction” for definitions and more information related to pavement construction.

7.2 Discussion and Excavation

We understand up to 6 feet of fill is required in the southern and southeast sections of the parking lot to obtain the proposed grade of 831 to 833 feet. Five feet of organic clay topsoil was encountered in boring B-3 at a depth of 2 feet. Based on our calculations of the conditions at Boring B-3, we estimate less than six inches of settlement will occur will occur in the existing soils due to placement and weight of new fill and the settlement could be significantly less than six inches. . If soil conditions are worse away from the boring the settlement would be greater. Additionally, this settlement will not be uniform as it is relative to the thickness and moisture content of the organic layer and other soils encountered.

There are two approaches for supporting the parking lot. The cheapest short-term costs would be to float the parking lot on top of the organic soils (leave the organic soils in place) and manage the post-construction settlement, if desired, with bituminous patches, overlays or potential localized correction of moving and cracking areas. Over-time the settlement will stabilize such that future bituminous placements will realize less post-placement cracking due to reduced settlement. With this option, we strongly recommend grading the soils to finished grade and leave the fill in place as long as possible to stabilize the soils before bituminous placement. A surcharge could also be used to expedite the settlement and reduce the long-term settlement but will not eliminate it.

If the organic soils are left in place, we still recommend the excavation of enough organic soils to allow a minimum of 2 to 3 feet of inorganic soils to be in place below the bottom of base course for parking lot stability. If these organic soils are left in place the pavement will likely have a shorter life expectancy with more service problems than if they were removed.

The more expensive option to support the parking lot would be to remove all of the organic soils. To do this, the excavation would be approximately 2-3 feet below the groundwater table and would likely require significant dewatering to properly perform the excavation. Another option would be to excavate and fill with the water intact but this process risks leaving organic soil in place and makes it more difficult to compact fill.

Regardless if the organic soils are excavated, we recommend the excavation of surface vegetation from the proposed parking lot areas. Additionally, table 3, below, shows estimated excavation depths at the boring locations if organic soils are to be removed including topsoil. Required excavation depths should be evaluated by QC/QA personnel during the actual construction activities.

Table 4 – Estimated Excavation Depths

Boring No.	Surface Elevation (ft)	Excavation Depth (ft)*	Excavation Elevation (ft)*
B-3	826.4	7	819½
B-4	830.1	2	828

*Rounded to the nearest ½ foot

In any subcut, if organic soils or inorganic wet or otherwise unsuitable materials are encountered within or below the subcut, they should be removed to a firm bottom. We recommend suitable grading material with material drainage characteristics similar to those found in the parking lot subcut areas used in embankment construction.

If organic soils are encountered below proposed utilities, the organic soils should be subcut a minimum of 12 inches below the utility invert and replaced with a non-organic soil. An AET representative should perform excavation observations to judge the suitability of the soils below the subcut elevation prior to fill placement.

7.3 Fill Placement

Embankment fill for pavement support, should be placed and compacted per the requirements of Compacting Embankments (MnDOT Spec. 2105.3.F), which includes moisture content and density requirements. In general, this specification requires soils placed within the critical subgrade zone be compacted to a minimum of 100% of the standard maximum dry unit weight defined in ASTM D698 (Standard Proctor test), at a water content within 65% to 102% of the standard optimum water content. A reduced minimum compaction level of 95% of the standard maximum dry unit weight can be used below the critical subgrade zone.

7.4 Subgrade Preparation

Prior to placing the aggregate base, the subgrade stability should be evaluated using the test roll procedure. A geotechnical engineer from AET should observe the roll test. Where unstable soils are found using the test roll process, these soils should be improved by means of scarification, drying, and recompaction; or by subcutting and replacement. If highly variable conditions are present (either stability-wise or frost-wise), a compaction subcut should be performed to provide a more consistent subgrade condition. We caution that instability of underlying soils present beneath the soils that are being reworked and compacted may limit the ability to compact the upper soils. In this case, greater depths of subcutting and stability improvement may be needed to properly construct the subgrade. A smooth-bladed bucket and low-vibration equipment should be used to minimize disturbance to the sensitive soils at depth.

Where granular soils are exposed (i.e., sands to silty sands), we recommend performing surface compaction prior to aggregate base placement. This compaction should take place with at least 4 passes of a self-propelled vibratory roller compactor having a drum diameter of at least 3 feet. Stability should be evaluated during the compaction process, with deflection judgments by an AET geotechnical or pavement engineer.

7.5 Aggregate Base

Aggregate base imported for pavement support should meet the gradation and quality requirements for Class 5, 5Q, or 6 per MnDOT Spec. 3138. Aggregate base placement and compaction should be performed according to MnDOT Spec. 2211. All aggregate base material should be tested for compaction using the Penetration Index Method per MnDOT Spec. 2211.3.D.2.c.

7.6 Bituminous Pavement Section

The table below provides our recommended pavement section for the bituminous parking lot, based on an assumed design ESALs of up to 100,000; the design R-value of 10; and a 20-year pavement life.

Table 5 – Parking Lot Pavement Design

Layer	MnDOT Material Type (Spec.)	Thickness
Bituminous Wear Upper	SPWEA240F (PG58V-34)	2.0"
Bituminous Wear Lower	SPWEB240F (PG58V-34)	2.0"
Aggregate Base	Class 5, 5Q, or 6 (3138)	8"

7.7 Pavement Maintenance

Bituminous pavements require on-going maintenance to reach their design life. Even if placed and compacted properly over stable subgrade conditions, bituminous pavements typically experience cracking in 1 to 3 years, primarily due to temperature-related expansion and shrinkage. We recommend that a regularly scheduled maintenance program consisting of patching of cracks and local distressed areas be implemented. Seal coating of the pavement surface after 3 to 5 years also helps prolong the pavement life.

7.8 Posts

If posts are used to support lighting or other features, the posts should extend through any organic soil and not utilize the organic soil to provide axial or lateral support.

8.0 RETAINING WALL RECOMMENDATIONS

8.1 Excavation

We recommend removing any existing fill and organic soil below retaining walls including the oversizing area. The oversizing area should extend two feet horizontally for every foot of excavation below the wall down to the excavation bottom (2:1 horizontal:vertical oversizing). An AET field representative should observe the entire excavation bottom to evaluate the suitability of the surficial soils to support the fill and wall loads prior to fill placement.

8.2 Fill Placement

Embankment fill for pavement support, should be placed and compacted to a minimum of 95% of the standard maximum dry unit weight defined in ASTM D698 (Standard Proctor test). Fill placed below the water table should have a maximum of 5% of the soil by weight passing the number 200 sieve.

8.3 Bearing Capacity and Settlement

The approved natural soils or compacted fill should be suitable to support a bearing capacity of up to 2,000 pounds per square foot (psf). It is our judgment this design pressure will have a factor of safety of at least 3 with respect to the ultimate bearing capacity. We estimate that total settlements under this loading should not exceed 1-inch and differential settlements over a 30-foot distance and at the interface between the new and previous construction should not exceed ½-inch.

9.0 CONSTRUCTION CONSIDERATIONS

9.1 Potential Difficulties

9.1.1 Disturbance of Soils

The on-site soils can become disturbed by construction traffic, especially if the soils are wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompacted back into place, or they should be removed and replaced with drier imported fill.

9.1.2 Water in Excavations

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the runoff water will infiltrate into the granular subgrade soils, or can be handled with conventional sump pumping.

9.1.3 Cobbles and Boulders

The till soils at this site can include cobbles and boulders. This may make excavating procedures somewhat more difficult than normal if they are encountered.

9.2 Excavation Backsloping

If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce slope erosion or running which could require slope maintenance.

9.3 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observations by AET geotechnical personnel during construction to evaluate these potential changes. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been satisfied.

10.0 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 express 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."

STANDARD SHEETS

Definitions Related to Pavement Construction

DEFINITIONS RELATING TO PAVEMENT CONSTRUCTION

Top of subgrade: Grade which contacts the bottom of the aggregate base layer.

Sand subbase: Uniform thickness sand layer placed as the top of subgrade which is intended to improve the frost and drainage characteristics of the pavement system by increasing drainage of excess water in the aggregate base and subbase, by reducing and "bridging" frost heaving, and by reducing spring thaw weakening effects.

Critical subgrade zone: The subgrade portion beneath and within three vertical feet of the top of subgrade. A sand subbase, if placed, would be considered the upper portion of the critical subgrade zone.

Suitable Grading Material: Mineral soil materials, typically from the project site, excluding the following: 1) soils which have an organic content exceeding 3%, 2) cohesive soils having a Liquid Limit exceeding 50%, 3) soils which include debris, cobbles, and/or boulders, and 4) soils which are considered acceptable from an environmental standpoint. The soil must also be capable of attaining the specified compaction level at its current water content or at a water content that can be reasonably scarified, blended, and moisture conditioned to a uniform water content in order to uniformly meet compaction requirements.

Granular Material: Soils meeting MnDOT Specification 3149.2B.1. This refers to granular soils which, of the portion passing the 1" sieve, contain less than 20% by weight passing the #200 sieve.

Select Granular Material: Soils meeting MnDOT Specification 3149.2B.2. This refers to granular soils which, of the portion passing the 1" sieve, contain less than 12% by weight passing the #200 sieve.

Select Granular Material (Super Sand): Soils meeting MnDOT Specification 3149.2B.3. This material is cleaner and coarser than Select Granular Material (see specification for specific requirements).

Compaction Subcut: Construction of a uniform thickness subcut below a designated grade to provide uniformity and compaction within the subcut zone. Replacement fill can be the materials subcut, although the reused soils should be blended to a uniform soil condition, moisture conditioned as needed to meet MnDOT Specification 2105.F; and re-compacted per the Specified Density Method defined in MnDOT Specification 2105.3F.1.

Test Roll: A means of evaluating the near-surface stability of subgrade soils (usually non-granular). Suitability is determined by the depth of rutting or deflection caused by passage of heavy rubber-tired construction equipment, such as a loaded dump truck, over the test area. Yielding of less than 1" is normally considered acceptable, although engineering judgment may be applied depending on the equipment used, soil conditions present, and/or depth below final grade.

Unstable Soils: Subgrade soils which do not pass a test roll. Unstable soils typically have water content exceeding the *standard optimum water content* defined in ASTM:D698 (Standard Proctor test).

Organic Soils: Soils which have sufficient organic content such that the soils engineering properties are negatively affected (typically more than 3% organic content). These soils are usually black to dark brown in color.

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Boring Location Map
Subsurface Boring Logs
Sieve Analysis Test Results

Appendix A
Geotechnical Field Exploration and Testing
Report No. 27-20046

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling 4 borings 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 with one primary modification. 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. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

The most recent drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET's hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30 inches. The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviation of the N-values using this method is significantly better than the standard ASTM Method.

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 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.

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.

Appendix A
Geotechnical Field Exploration and Testing
Report No. 27-20046

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
- 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 in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Sieve Analysis Tests
Conducted in general accordance with ASTM: D422 and AASHTO T-27.

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.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
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
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
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
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push 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.
SS:	Standard split-spoon sampler (steel; 1.5" 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 hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	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 Designation of Rock Core, 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, remolded (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
(Calibrated Hammer Weight)

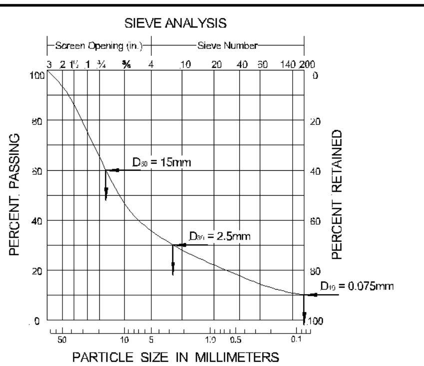
The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N_{60} values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), 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").

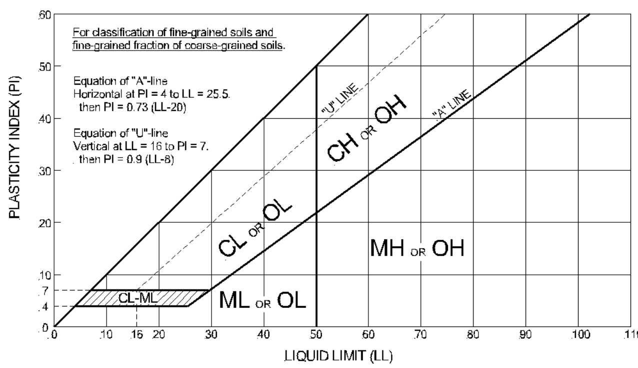
UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

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



$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$ $\quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{2.5^2}{0.075 \times 15} = 5.6$



Plasticity Chart

Notes

[A]Based on the material passing the 3-in (75-mm) sieve.
[B]If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C]Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

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

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

[F]If soil contains ≥15% sand, add "with sand" to group name.
[G]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H]If fines are organic, add "with organic fines" to group name.
[I]If soil contains ≥15% gravel, add "with gravel" to group name.
[J]If Atterberg limits plot is hatched area, soil is a CL-ML silty clay.
[K]If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
[L]If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
[M]If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N]PI≥4 and plots on or above "A" line.
[O]PI<4 or plots below "A" line.
[P]PI plots on or above "A" line.
[Q]PI plots below "A" line.
[R]Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

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

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

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

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition (MC Column)

- D (Dry): Absence of moisture, dusty, dry to touch.
- M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").
- W (Wet/ Waterbearing): Free water visible, intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.
- F (Frozen): Soil frozen

Layering Notes

- Laminations: Layers less than ½" thick of differing material or color.
- Lenses: Pockets or layers greater than ½" thick of differing material or color.

Peat Description

Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

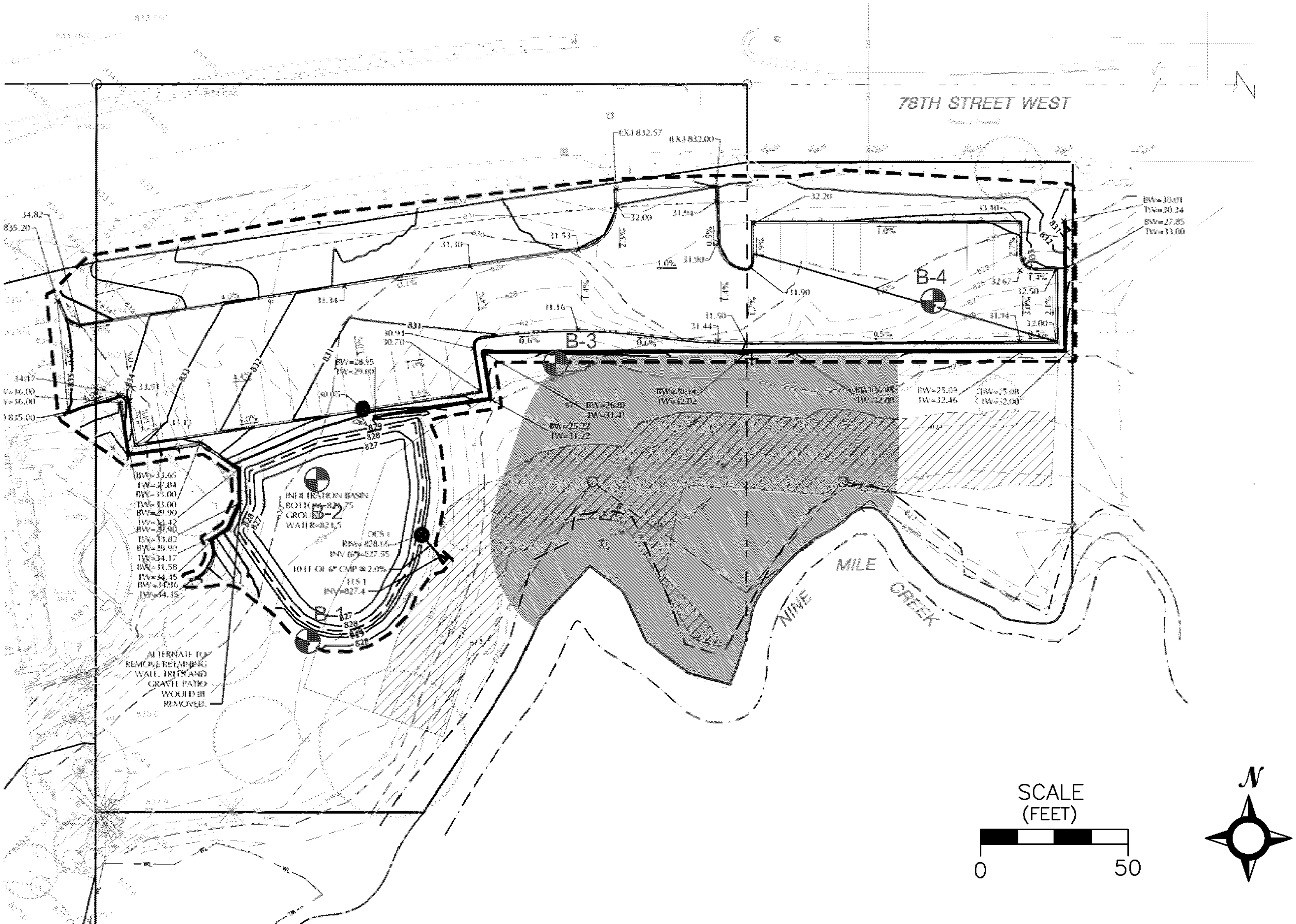
Organic Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the Liquid Limit properties. *Slightly organic* used for borderline cases.

Root Inclusions

- With roots: Judged to have sufficient quantity of roots to influence the soil properties.
- Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.

CASE FILE #PL201900220



AMERICAN ENGINEERING TESTING, INC.	PROJECT: Creekview Office East Parking Lot Expansion Bloomington, Minnesota		PROJECT NO. 27-20046
	SUBJECT: Boring Location Map		DATE: Nov. 18, 2019
	SCALE: Approximate Scale 1"=50'	DRAWN BY: TE	REVIEWED BY: MR

CASE FILE #PL201900220

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **27-20046** LOG OF BORING NO. **B-1 (p. 1 of 1)**

PROJECT: **Creekview Office East Parking Lot Extension; Bloomington, MN**

SURFACE ELEVATION: **828.5** LATITUDE: **44.86146335** LONGITUDE: **-93.37563132**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	OC	LL	PL	%-#200
0–2	FILL, mostly clayey sand with organic fines, a little gravel, trace roots, dark brown	FILL	7	M	SS	18	16				
2–2.5	FILL, mostly clayey sand, a little gravel, trace roots, dark brown and brown						17				47
2.5–4.5	FILL, mostly clayey sand, a little silty sand, silt and gravel, brown, gray and dark brown		10	M	SS	22	22				
4.5–7	LEAN CLAY, gray, a little brown, stiff, laminations of sandy silt (CL)	FINE ALLUVIUM	10	W	SS	18	26				
7–9.5	GRAVEL WITH SILT AND SAND, brown, waterbearing, medium dense (GP-GM)	COARSE ALLUVIUM	19	W	SS	14					
9.5–11.5	CLAYEY SAND, a little gravel, gray, stiff (SC)	TILL	15	M	SS	18	12				
	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-9½'	**3.25" HSA**	**10/25/19**	**12:45**	**9.0**	**7.0**	**7.7**		**5.6**
		10/25/19	**12:50**	**9.0**	**7.0**	**7.3**		**4.6**

BORING COMPLETED: **10/25/19**

DR: **SS** LG: **RG** Rig: **70**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 27-20046.GPJ AET+CPT+WELL_20181012_JG.GDT 11/19/19

03/2011 01-DHR-060

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: 27-20046 LOG OF BORING NO. B-2 (p. 1 of 1)

PROJECT: Creekview Office East Parking Lot Extension; Bloomington, MN

SURFACE ELEVATION: 829.6 LATITUDE: 44.8616082 LONGITUDE: -93.3756224

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	OC	LL	PL	%-#200
0–2	FILL, mostly silty sand with organic fines, a little clayey sand and gravel, pieces of wood, trace roots, dark brown	FILL	6	M	SS	18					
2–4½	FILL, mostly clayey sand, a little gravel, trace roots, brown		9	M	SS	18	13				21
4½–6	CLAYEY SAND, a little gravel, trace roots, light brown and brown, firm, laminations of silty sand (SC) (possible fill)	TILL OR FILL	8	W	SS	18	14				10
6–7	SAND WITH SILT, fine to medium grained, brown, waterbearing, moist, loose (SP-SM)	COARSE ALLUVIUM									
7–9½	GRAVELLY SILTY SAND, fine to medium grained, brown, waterbearing, medium dense (SM)	COARSE ALLUVIUM OR TILL	13	W	SS	4					
9½–11½	SILTY SAND, a little gravel, gray, with a little brown, moist, loose, laminations of clayey sand (SM)	TILL	10	▼ W	SS	6					
	END OF BORING										

DEPTH:	DRILLING METHOD
0-9½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/25/19	12:20	11.5	9.5	10.6		10.3

BORING COMPLETED: 10/25/19

DR: SS LG: RG Rig: 70

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **27-20046**   LOG OF BORING NO. **B-3 (p. 1 of 1)**

PROJECT: **Creekview Office East Parking Lot Extension; Bloomington, MN**

SURFACE ELEVATION: **826.4**   LATITUDE: **44.86171052**   LONGITUDE: **-93.37531935**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	OC	LL	PL	%-#200
0–2	FILL, mostly sandy lean clay, slightly organic, a little organic clay, trace roots, dark brown	FILL	12	M	SS	12	27				
2–7	ORGANIC CLAY, trace roots, black, firm (OH) (possible fill)	TOPSOIL OR FILL	8	W	SS	14	27	5.5			
			5	W	SS	6	49	8.8			
7–9.5	SILTY SAND, a little gravel, fine to medium grained, gray, wet, loose (SM)	COARSE ALLUVIUM	5	W	SS	10					
9.5–12	SILTY SAND, fine grained, gray, wet, loose, lenses of silt (SM)		9	W	SS	20					
12–14.5	SILTY SAND, fine to medium grained, gray, wet, loose (SM)		7	W	SS	20					
	END OF BORING										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-12½'	**3.25" HSA**	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		10/25/19	**10:41**	**9.0**	**7.0**	**7.0**		**6.2**	
		10/25/19	**10:51**	**9.0**	**7.0**	**6.5**		**4.8**	
BORING COMPLETED: **10/25/19**		**10/25/19**	**11:20**	**14.5**	**12.5**	**10.0**		**4.0**	
DR: **SS** LG: **RG** Rig: **70**									

CASE FILE #PL201900220

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **27-20046**   LOG OF BORING NO. **B-4 (p. 1 of 1)**

PROJECT: **Creekview Office East Parking Lot Extension; Bloomington, MN**

SURFACE ELEVATION: **830.1**   LATITUDE: **44.86176806**   LONGITUDE: **-93.3748375**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	OC	LL	PL	%-#200
0–2	FILL, mostly silty sand with organic fines, a little gravel, trace roots, black	FILL	3	M	SS	14					
2–3	FILL, mostly clayey sand, a little gravel, dark brown						20				
3–8	CLAYEY SAND, a little gravel, brown to grayish brown, a little light brown, firm to very stiff, laminations of silty sand (SC)	TILL	5	W	SS	18	12				
			17	W	SS	20	14				
							16				
8–9.5	CLAYEY SAND, a little gravel, gray, stiff (SC)		15	W	SS	22	11				
9.5–11.5	SILTY SAND, a little gravel, gray, wet, loose (SM)	COARSE ALLUVIUM	9	W	SS	18					
	END OF BORING										

DEPTH:	DRILLING METHOD
0-9½'	3.25" HSA

BORING COMPLETED: **10/25/19**

DR: **SS**   LG: **RG**   Rig: **70**

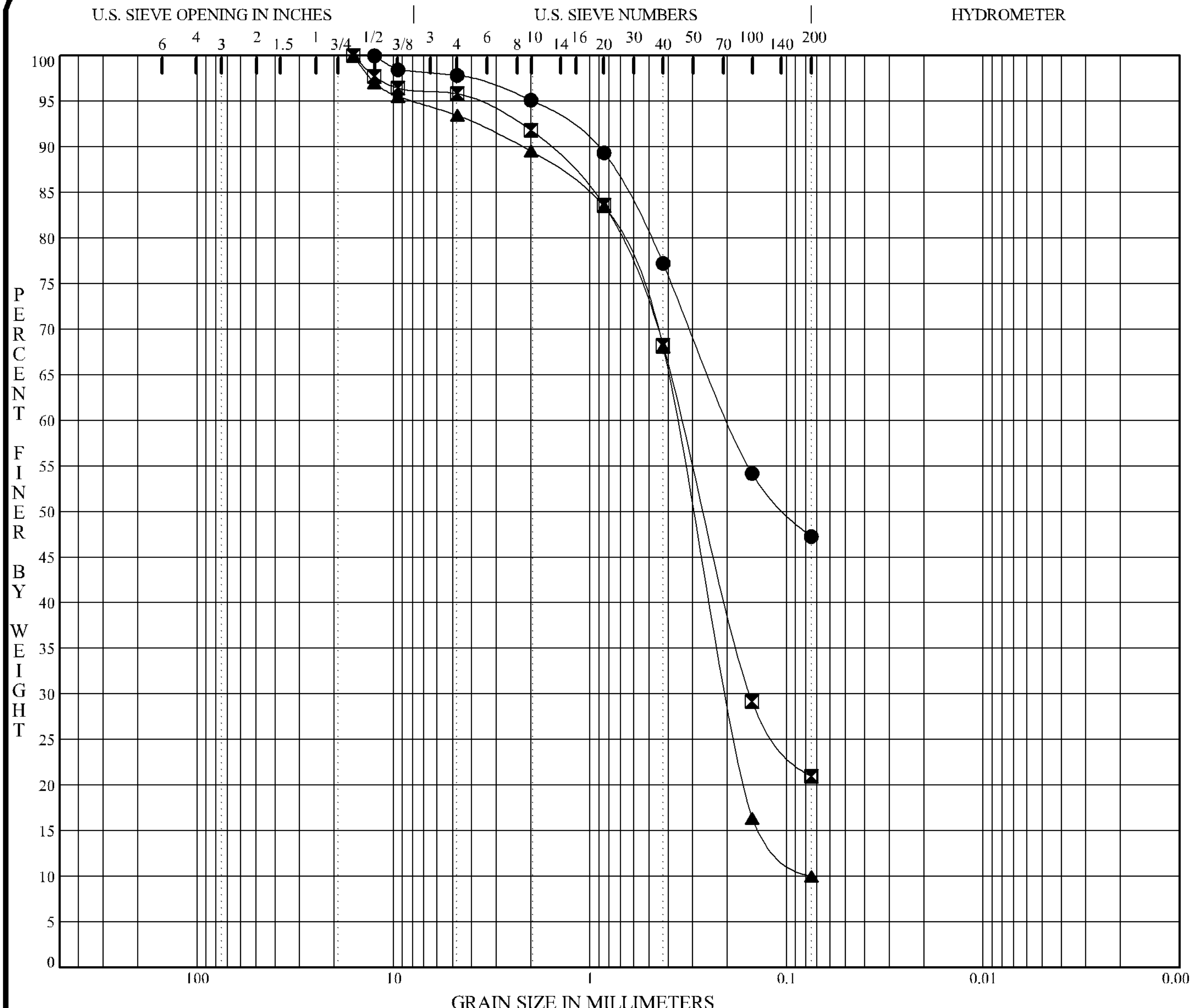
WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/25/19	1:25	9.0	7.0	8.5		7.3
10/25/19	1:30	9.0	7.0	8.3		5.1

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AET_CORP W-LAT-LONG 27-20046.GPJ AET+CPT+WELL_20181012_JG.GDT 11/19/19

CASE FILE #PL201900220



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-1**	**2.5'**	**Fill, Clayey sand, brown (SC)**	**17**					
⊠	**B-2**	**2.0'**	**Fill, Clayey sand, brown (SC)**	**13**					
▲	**B-2**	**6.0'**	**Sand with silt, brown (SP-SM)**					**1.44**	**4.8**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**2.5'**	**12.50**	**0.20**			**2.1**	**50.6**	**47.3**	
⊠	**B-2**	**2.0'**	**16.00**	**0.34**	**0.153**		**4.2**	**74.9**	**21.0**	
▲	**B-2**	**6.0'**	**16.00**	**0.36**	**0.197**	**0.0750**	**6.5**	**83.5**	**10.0**	

PROJECT **Creekview Office East Parking Lot Extension; Bloomington, MN**

AET JOB NO. **27-20046**
DATE **10/25/19**

AMERICAN ENGINEERING TESTING, INC.

GRADATION CURVES

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. 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.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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