AMERICAN ENGINEERING TESTING, INC.

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GEOTECHNICAL EXPLORATION, FOUNDATION ANALYSIS AND DESIGN REPORT

Bridge No. 25705 Replacement

Vinehill Road over Minnetonka Regional Trail
Deephaven, Minnesota

AET Report No. 28-00495

Date;

March 30, 2012

Prepared for:

Bolton & Menk. Inc.
2638 Shadow Lane, #200
Chaska, MN 55318

www.amengtest.com

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March 30, 2012

Bolton & Menk, Inc.
2638 Shadow Lane, #200
Chaska, MN 55318

Attn: Andrew Budde

RE: Geotechnical Exploration, Foundation Analysis and Design Report
Bridge No. 25705 Replacement, Vinehill Road over Minnetonka Regional Trail
Deephaven, Minnesota
AET Report No. 28-00495

Dear Mr. Budde:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the proposed Vinehill Road Bridge Replacement over the Minnetonka Regional Trail.

We are submitting this electronic copy of the report to you via email.

Please contact me if you have questions about the report.

Sincerely,
American Engineering Testing, Inc.

Benjamin M. Hoefer, PE
Project Engineer
Phone: (651) 659.1377
bhoefer@amengtest.com

Geotechnical Exploration, Foundation Analysis and Design Report
Bridge No. 25705 Replacement
Vinehill Road Over Minnetonka Regional Trail
Deephaven, Minnesota

AET Report No. 28-00495

March 29, 2012

Prepared for:

Bolton & Menk, Inc,
2638 Shadow Lane
Chaska, MN 55318
Attn: Andrew Budde

Prepared by:

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St. Paul, MN 55114
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Report Authored By:

Benjamin M. Hoefer, PE
Project Engineer

Peer Review Conducted By:

Megan J.L. Hoppe
Staff 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: Benjamin M. Hoefer

Date: 3/30/12 **License #: 47156**

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DEEPHAVEN, MINNESOTA
AET REPORT NO. 28-00495

1.0 INTRODUCTION

The existing Vinehill Road Bridge (Bridge No. 27505) over the Minnetonka Regional Trail in Deephaven, Minnesota is proposed to be reconstructed. To assist in planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program and perform 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

The planned scope appears in our February 22, 2012 proposal. Authorization to proceed with these services was granted by you on February 23, 2012. The scope consists of the following:

- Drill and sample two standard penetration test (SPT) borings near the existing bridge abutments to depths sufficient to evaluate a pile foundation system.
- Perform soil laboratory index testing (water content, density and unconfined compression).
- Conduct geotechnical engineering analysis based on the gained data, and prepare this design report.

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

3.0 PROJECT INFORMATION

The existing Bridge No. 27505 is a triple-span, twin pier steel beam bridge with a concrete deck and bituminous overlay surfacing. The bridge measures about 106 feet in length and about 35 feet in width. We understand this bridge was constructed in the early 1960's.

We understand the new bridge will be a single span, prestressed concrete I-beam structure equal in length to the existing bridge with an increased width of 52 feet wide. We assume the bottom of abutment footing elevations will be close to the existing footing elevations, at or near 953 feet. The abutment slopes will be at 1V:2H and consist of typical concrete slope paving. We also understand the future approach roadway grade will remain at or near the existing profile grade (within plus or minus 1-foot). The trail elevation below the bridge is about 937 feet. We understand the Factored Design Loads will be about 110 tons per pile.

The stated information represents our current 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 consisted of two standard penetration test (SPT) borings for pile foundation design. The logs of these borings and details of the methods used appear in Appendix A.

The SPT 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).

The boring locations appear on Figure 1, with Boring 1 located near the south abutment and Boring 2 located near the north abutment. The locations were established by AET in the field, and the surface elevations were estimated by Bolton & Menk, Inc from existing survey plans.

4.2 Laboratory Testing of Soils

During laboratory classification logging, water content tests were conducted all soil samples retrieved; the results appearing on the individual boring logs, opposite the samples upon which they were performed. Unconfined compression testing was also performed on select thinwall tube samples of cohesive soils.

5.0 SITE CONDITIONS

5.1 Subsurface Soils/Geology

The borings were drilled through the existing bridge approach embankments. Accordingly, fill is present in the upper portion of the profile. The fill mainly consists of sandy loam and loam. The total thickness of fill ranged from approximately 25 feet at B-1 to about 14 feet at B-2.

The underlying naturally deposited soils consist of layers of glacial till overlying predominantly alluvial soils (soils deposited by water). The glacial till consisted of plastic sandy loam, loam, and silt loam with a plastic soil consistency of stiff to very stiff. The alluvium is mostly sand and loamy sand with a relative density of medium dense to very dense.

Cobbles were noted while drilling. Cobbles and boulders are common within the soil formations found at this site, and these oversized particles may be encountered during pile installation

5.2 Ground Water

Water levels were measured in the boreholes at depths of 30.5 feet in B-1 and 30 feet in B-2, which correspond to elevations of 933.8 feet and 932.3 feet, respectively. Based on relatively

close proximity to Lake Minnetonka, the ground-water level is expected to fluctuate over time, generally consistent with fluctuations in the lake level.

6.0 PILE FOUNDATION ANALYSIS

6.1 Methods

Pile foundation depths were estimated using *DRIVEN* software, available from FHWA. This program uses the Nordlund Method for granular soils and the Tomlinson Method for cohesive soils. The granular soil internal friction angle used in the analysis is based on its relationship to standard penetration test values as presented by Peck, Hanson, and Thorburn (1974), with the N-values being corrected for the influence of the effective overburden pressure. For cohesive soils, we estimated the undrained shear strength based on correlations with the SPT data as well as laboratory results, when available.

The ultimate capacity determined from this *DRIVEN* analysis is used to determine the Nominal Resistance of Single Pile in Axial Compression (R_n).

6.2 Assumptions

Our analysis included closed-end, 12-inch diameter, CIP steel pipe piles. We understand the Factored Design Load (FDL) for this bridge will be 110 tons (220 kips). For our analyses, we assumed that the pile will have a cutoff elevation of 954 feet.

The Required Nominal Bearing Resistance will depend on the Resistance Factor allowed by the Field Control Method used. In the case where dynamic (PDA) testing is used to substantiate capacity during construction (hence a higher confidence level), a higher Resistance Factor can be used versus the approach with no PDA testing. Mn/DOT allows a Resistance Factor (φ_{dyn}) of 0.65 when dynamic analysis is employed. If dynamic testing is not used and the piles are evaluated using the Mn/DOT dynamic resistance formula, a Resistance Factor (φ_{dyn}) of 0.40

must be used, which will require driving the piles deeper in order to demonstrate 62.5% higher capacity.

6.3 Results

If dynamic analysis (PDA) will be used to demonstrate field capacity, a resistance factor φ_{dyn} of 0.65 applies and the Required Nominal Bearing Resistance (R_n) will be 169 tons (338 kips). Based on our analysis, we estimate that the pile will need to be driven to depths of about 53 feet below cutoff (pile toe elevation of 901 feet) at the South Abutment and about 64 feet below cutoff (pile toe elevation of 890 feet) at the North Abutment to for this field control method.

If Mn/DOT Nominal Resistance Formula is used as the field control method, then a φ_{dyn} of 0.40 must be applied in the field. For this case, the piles need to achieve a Required Nominal Bearing Resistance (R_n) of 275 tons (550 kips). We estimate that piles driven to depths of about 71 feet below cutoff (pile toe elevation of 883 feet) at the South Abutment and about 84 feet below cutoff (pile toe elevation of 870 feet) at the North Abutment will achieve this capacity.

7.0 RECOMMENDATIONS

7.1 Pile Foundations

Roadway approach grades will remain unchanged, and settlement around the piles is not anticipated. Therefore, it is our opinion that negative loads or Down Drag (DD) loads do not need to be considered when calculating the Factored Design Load for these pile.

We recommend the abutment foundations be supported on 12-inch diameter, steel pipe piles which are filled with concrete after driving. Based on a Factored Design Load of 110 tons per pile, we recommend the piles have a wall thickness of 0.3125 inches. The steel should have a minimum yield strength (f_y) of 45 ksi.

Pile points should be considered to reduce the potential for damage while driving into the dense soils found at this site. Cobbles and/or boulders may be present within the soil profile at this site. If pile penetration appears to be obstructed at abnormally variable depths (due to apparent cobbles or boulders) or if piles become damaged during driving, additional piles and foundation review may be needed.

If the test piles are evaluated in the field using high strain dynamic (PDA) testing, the field capacity determination can assume the use of a Resistance Factor of 0.65. The dynamic testing should meet the minimum requirements listed in Section 10.5.5 of the *AASHTO LRFD Bridge Design Specifications, 6th Edition (2012)*. This approach includes Quality Control of non-tested pile by calibrated wave equation analyses. If the test piles are evaluated in the field using the Mn/DOT driving formula, a Resistance Factor of 0.40 is required.

Table 7.1 presents the estimated pile lengths predicted to achieve the Required Nominal Pile Bearing Resistance. The pile lengths are based on analyses which use assumed soil parameters, and the actual capacity often differs from the theoretical capacity. The required pile lengths must be confirmed at the time of driving, and the installed lengths may be more or less than that shown.

TABLE 7.1 - Estimated Pile Lengths for Factored Design Load of 110 tons

			South Abutment		North Abutment	
Field Control Method	Resistance Factor φ_{dyn}	Required Nominal Bearing Resistance R_n (tons)	Pile Toe Elevation (feet)	Pile Length below Cutoff* (feet)	Pile Toe Elevation (feet)	Pile Length below Cutoff* (feet)
High Strain Dynamic Testing (PDA)	0.65	169	901	53	890	64
Mn/DOT Nominal Resistance Formula	0.40	275	883	71	870	84

*Assumed pile cutoff elevation of 954 feet.

If capacity is not achieved during initial driving to the estimated depths, the pile driving should

cease, and the piles should be re-struck after a period of at least 18 hours to assess potential pile capacity increase due to soil setup. If capacity is not achieved during restrike, the piles should be driven deeper.

The pile contractor should perform a pre-construction wave equation analysis with the proposed hammer and pile wall thickness to determine if the piles can be driven to the required depths and capacity without damage.

The pipe piles should be inspected and concrete filled in accordance with Mn/DOT specification 2452.D6. The minimum compressive strength of the concrete should be 3000 psi at 28-days.

Based on the number of pile and spacing, reduction factors for redundancy and group effects may need to be applied.

7.2 Abutment Backfilling

We recommend the abutments be backfilled with material meeting Mn/DOT Specification 3149.2B2 for Select Granular Borrow, which is modified to containing less than 10% by weight passing the #200 sieve. The Select Granular Borrow should be maintained within 4 feet of the wall to the elevation matching final grade on the low side of the wall, and then it should have a backslope no steeper than 2V:1H above this elevation. In addition, all excavation backsloping should meet OSHA requirements.

For proper roadway approach performance, we recommend frost tapering of the Select Granular Borrow below the roadway away from the abutments. Tapers of at least 1V:10H are recommended within a frost zone extending 4½ feet below the surface.

Fill should be compacted per the Specified Density Method (Mn/DOT 2105.3F1).

The wall design can be based on equivalent fluid pressures of 35 pcf for the active case and 50 pcf for the at-rest case; or on Mn/DOT design charts.

For roadway design considerations, loamy sand, loamy fine sand, and slightly plastic sandy loam (A-6, A-2-4) are present near the upper zone of the current subgrade. These soils are estimated to have an R-value of 20.

8.0 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".

Appendix A

AET Report No. 28-00495

Geotechnical Field Exploration and Testing
Boring Log Notes
Mn/DOT Boring Log Descriptive Terminology
AASHTO Soil Classification System
Unified Soil Classification System
Figure 1 – Boring Locations
Subsurface Boring Logs
Figure 2 – *DRIVEN* Analyses, 12-inch Steel Pipe Pile, South Abutment
Figure 3 – *DRIVEN* Analyses, 12-inch Steel Pipe Pile, North Abutment

Appendix A
Geotechnical Field Exploration and Testing
AET Report No. 28-00495

A.1 FIELD EXPLORATION

The subsurface conditions at the bridge site were explored by conducting two standard penetration test borings. The test locations appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SOIL BORING 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 it=s potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

Most newer 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 calibration 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 ADS or ASU 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 SOIL BORING CLASSIFICATION METHODS

Soil classifications shown on the boring logs are based on the Mn/DOT Triangular Textural classification system, described in Section 3-2.02 of the Mn/DOT "Geotechnical and Pavement Manual." Classifications are also provided based on the AASHTO Soil Group classifications and 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 Mn/DOT Triangular, AASHTO Soil Groups, 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.

A.4 SOIL BORING 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.

A.5.2 Unconfined Compressive Strength of Cohesive Soil/Unit Weight
Conducted in general accordance with current AASHTO: T 208. The soil unit weight is also determined during this test (sample is trimmed to known diameter and height).

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 (approximate)
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

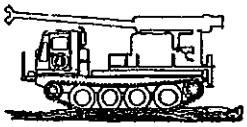
STANDARD PENETRATION TEST NOTES

(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").

Minnesota Department of Transportation
Geotechnical Section
Boring Log Descriptive Terminology (English Units)



USER NOTES, ABBREVIATIONS AND DEFINITIONS - Additional information available in Geotechnical Manual.

This boring was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this boring was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this boring.

Since subsurface conditions outside each borehole are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this boring will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water levels recorded on this log should be used with discretion since the use of drilling fluids in borings may seriously distort the true field conditions. Also, water levels in cohesive soils often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

WATER MEASUREMENT

AB	After Bailing
AC	After Completion
AF	After Flushing
w/C	with Casing
w/M	with Mud
WSD	While Sampling/Drilling
w/AUG	with Hollow Stem Auger

MISCELLANEOUS

NA	Not Applicable
w/	with
w/o	with out
sat	saturated

DRILLING OPERATIONS

AUG	Augered
CD	Core Drilled
DBD	Disturbed by Drilling
DBJ	Disturbed by Jetting
PD	Plug Drilled
ST	Split Tube (SPT test)
TW	Thinwall (Shelby Tube)
WS	Wash Sample
NSR	No Sample Retrieved
WH	Weight of Hammer
WR	Weight of Rod
Mud	Drilling Fluids in Sample
CS	Continuous Sample

SOIL/CORE TESTS

SPT N_{60}	ASTM D1586 Modified Blows per foot with 140 lb. hammer and a standard energy of 210 ft-lbs. This energy represents 60% of the potential energy of the system and is the average energy provided by a Rope & Cathead system.
MC	Moisture Content
COH	Cohesion
γ	Sample Density
LL	Liquid Limit
PI	Plasticity Index
F	Phi Angle
REC	Percent Core Recovered
RQD	Rock Quality Description (Percent of total core interval consisting of unbroken pieces 4 inches or longer)
ACL	Average Core Length (Average length of core that is greater than 4 inches long)
Core Breaks	Number of natural core breaks per 2-foot interval.

DISCONTINUITY SPACING

Fractures	Distance	Bedding
Very Close	<2 Inches	Very Thin
Close	2-12 Inches	Thin
Mod. Close	12-36 inches	Medium
Wide	>36 inches	Thick

RELATIVE DENSITY

Compactness - Granular Soils	BPF
very loose	0-4
loose	5-10
medium dense	11-24
dense	25-50
very dense	>50

Consistency - Cohesive Soils	BPF
very soft	0-1
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	31-60
very hard	> 60

COLOR

blk	Black	wht	White
grn	Green	brn	Brown
orng	Orange	yel	Yellow
dk	Dark	lt	Light
IOS	Iron Oxide Stained		

GRAIN SIZE /PLASTICITY

VF	Very Fine	pl	Plastic
F	Fine	slpl	Slightly Plastic
Cr	Coarse		

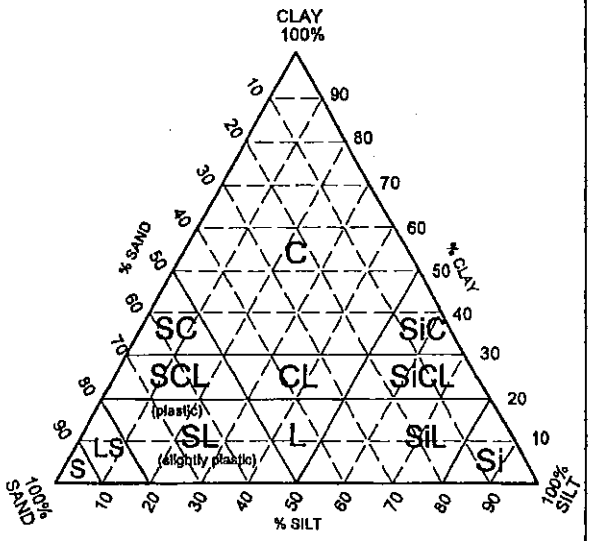
SOIL/ROCK TERMS

C	Clay	Lmst	Limestone
L	Loam	Sst	Sandstone
S	Sand	Dolo	Dolostone
Si	Silt	wx	weathered
G	Gravel (No. 10 Sieve to 3 Inches)		
Bldr	Boulder (over 3 Inches)		
T	till (unsorted, nonstratified glacial deposits)		

DRILLING SYMBOLS

	Vane Shear Test
WS	Washed Sample (Collected during plug drilling)
	Augered
PD	Plug Drilled (Rotary drilled with fluid)
	Split Tube Sample (SPT N_{60} with 2 in. split tube with liners)
	Thin Wall Sample (3 Inch Thin Wall Tube)
	Core Drilled (NV Core Barrel, unless otherwise noted)
CS	Continuous Soil Sample
A/P	Augered and Plug Drilled
Jet	Jetted
A/J	Augered and Jetted

Mn/DOT TRIANGULAR TEXTURAL CLASSIFICATION SYSTEM



AASHTO SOIL CLASSIFICATION SYSTEM

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

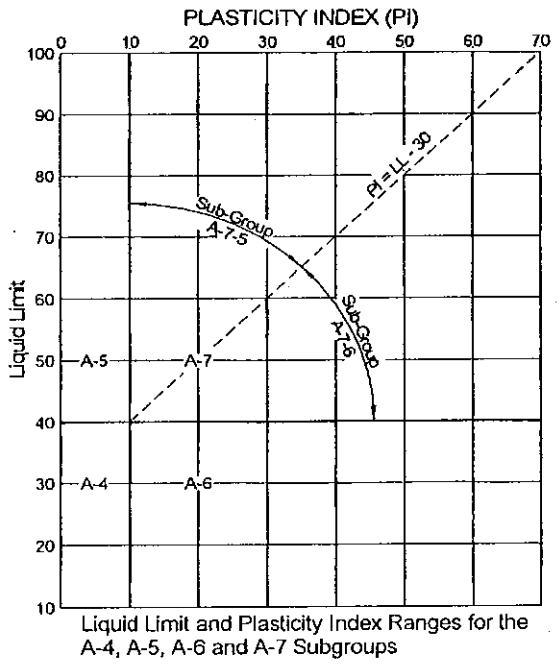
Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35% or less passing No. 200 sieve)							Silt-Clay Materials (More than 35% passing No. 200 sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, Percent passing:											
No. 10 (2.00 mm)	50 max.	....	....	....	....	....	....	....	....	....	....
No. 40 (0.425 mm)	30 max.	50 max.	51 min.	....	....	....	....	....	....	....	....
No. 200 (0.075 mm)	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of Fraction Passing No. 40 (0.425 mm)											
Liquid limit	....		....	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.
Usual Types of Significant Constituent Materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Ratings as Subgrade	Excellent to Good							Fair to Poor			

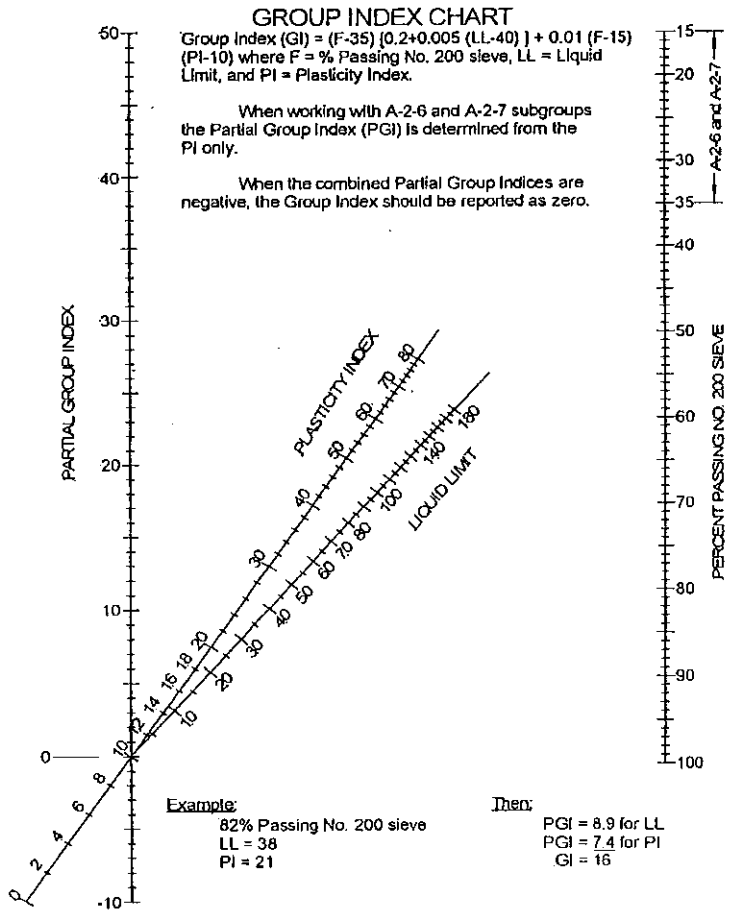
The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

Group A-8 soils are organic clays or peat with organic content >5%.



Liquid Limit and Plasticity Index Ranges for the A-4, A-5, A-6 and A-7 Subgroups



Definitions of Gravel, Sand and Silt-Clay

The terms "gravel", "coarse sand", "fine sand" and "silt-clay", as determinable from the minimum test data required in this classification arrangement and as used in subsequent word descriptions are defined as follows:

GRAVEL - Material passing sieve with 3-in. square openings and retained on the No. 10 sieve.

COARSE SAND - Material passing the No. 10 sieve and retained on the No. 40 sieve.

FINE SAND - Material passing the No. 40 sieve and retained on the No. 200 sieve.

COMBINED SILT AND CLAY - Material passing the No. 200 sieve

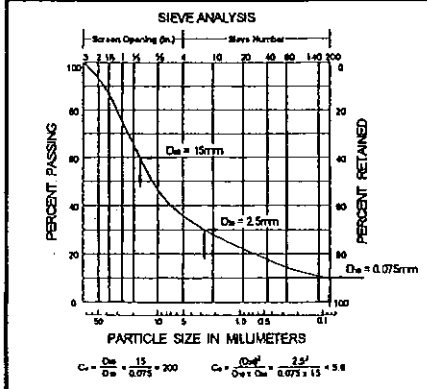
BOULDERS (retained on 3-in. sieve) should be excluded from the portion of the sample to which the classificaiton is applied, but the percentage of such material, if any, in the sample should be recorded.

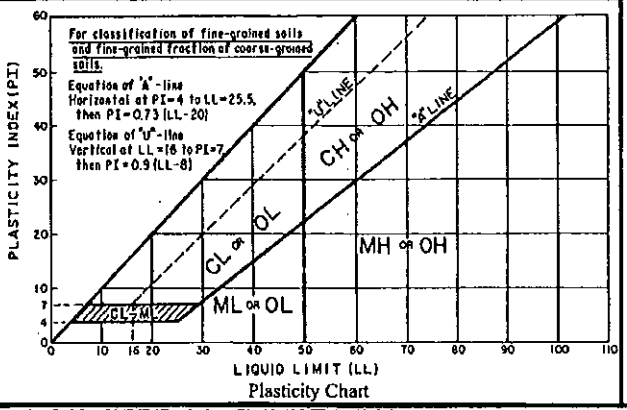
The term "silty" is applied to fine material having plasticity index of 10 or less and the term "clayey" is applied to fine material having plasticity index of 11 or greater.

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]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[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]





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

[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, soils 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): Absense 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%

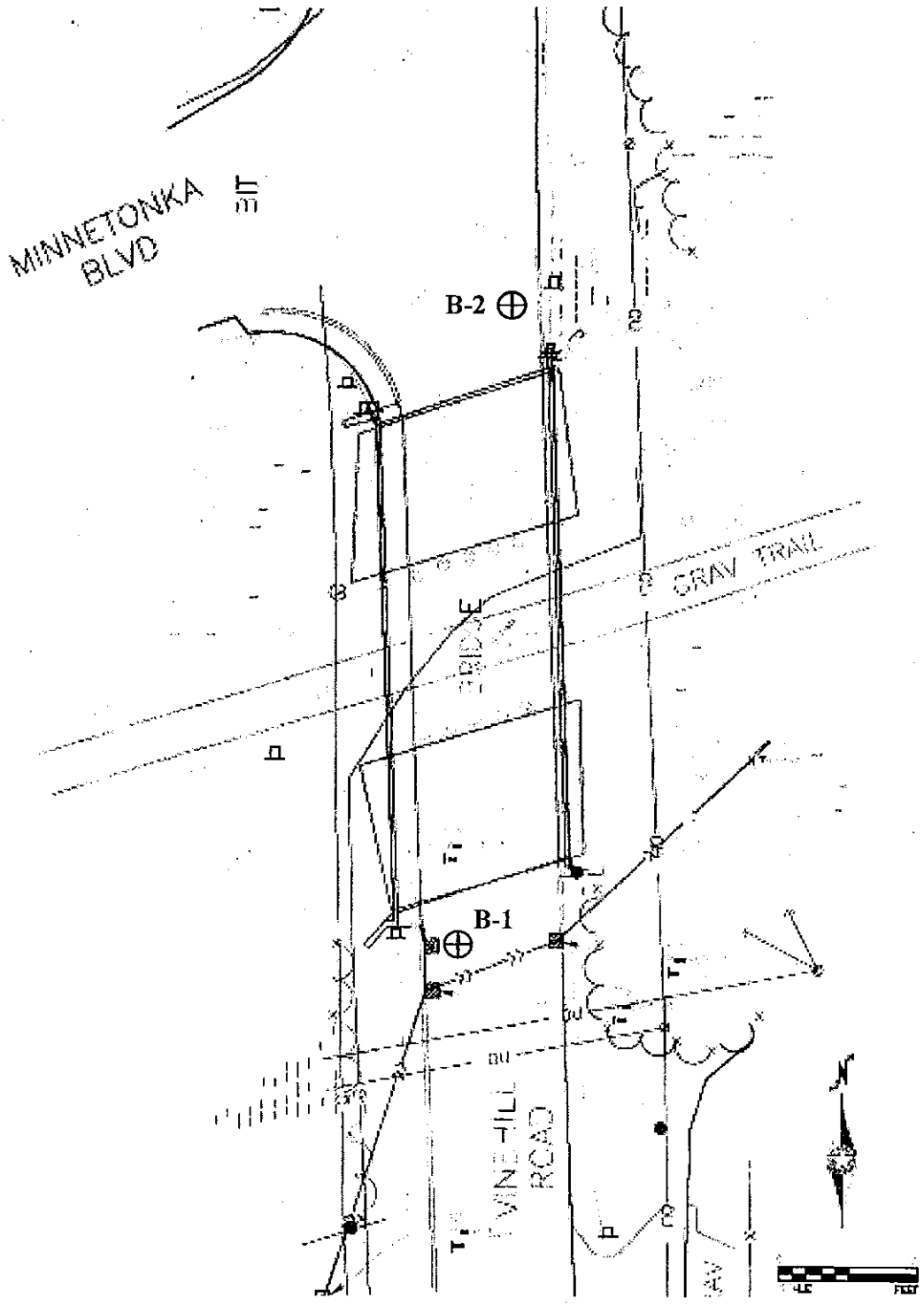
Organic Description (if no lab tests)

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.



AMERICAN ENGINEERING TESTING, INC.	**PROJECT** **Deephaven Bridge Replacement** **Deephaven, MN**	**AET NO.** 28-00495
	SUBJECT Soil Boring Location Map	**FIGURE 1**

AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

AMERICAN ENGINEERING TESTING, INC.

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	Br. No. 27505	Vinehill Road, Deephaven, MN	B-1	964.3 (from Plan)

Location: South Abutment

Coordinate: X= Y= (ft.)

Latitude (North)= Longitude (West)=

Drill Machine: 91

Hammer: CME Automatic Calibrated

SHEET 1 of 5

Drilling Completed: 3/5/12

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.8 963.5		9.5" Bituminous pavement							SPT hammer calibrated to 64.5% efficiency on 9/13/07 and on 10/9/08 (110 lb hammer)
	2.0 962.3		SAND, brown, frozen, A-1-b, fill (SP-SM)			5				
	4.0 960.3		PLASTIC SANDY LOAM, dark brown, frozen, A-6, fill (SC)			10				
5			SLIGHTLY PLASTIC SANDY LOAM, a little plastic sandy loam, brown, damp, medium dense to dense, A-2-4, fill (SM)		30	9				
					36	9				
10					22	8				
					17	9				
	14.0 950.3		PLASTIC SANDY LOAM, brownish gray, moist, stiff, A-6, fill (SC)		15	13				
15	16.5 947.8		PLASTIC SANDY LOAM, pieces of bituminous, gray, moist, very stiff, A-6, fill (SC)		18	10				
	19.0 945.3		LOAM, brown, a little light tan, damp, very stiff, laminations of loamy sand and silt loam, A-6, alluvium or fill (CL)		16	18				
20					14	17				
	24.0 940.3									
25										

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 2 of 5*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-1**	**964.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	26.5 937.8		PLASTIC SANDY LOAM, brown; a little gray, damp, very stiff, lenses and laminations of silt loam and loamy sand, A-6, alluvium or fill (SC) *(continued)*		23	14				
	29.0 935.3		SAND WITH GRAVEL, brown, damp, dense, A-1-b, alluvium or fill (SP-SM)		46	4				
30 ▼	31.5 932.8		PLASTIC SANDY LOAM, brown, damp, very stiff, A-6, alluvium (SC)		19	13				H2O at 30.6' w/HSA at 32' and SS to 33.5'
	34.0 930.3		SAND, brown, saturated, medium dense, A-3, alluvium (SP-SM)		15	14				
35	36.5 927.8		LOAM, brown and gray mottled, moist, very stiff, lenses and laminations of loamy sand, A-6, alluvium (CL)	PD	17	17				
				PD	17	22				
40				PD		13	2640	141		
			CLAY LOAM, gray, moist, very stiff, A-6, till (CL)	PD						
45					20	17				
				PD		14	1190	140		
	49.5 914.8			PD						
50			PLASTIC SANDY LOAM, brown, wet, very stiff, A-6, till (SC)							

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 3 of 5*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-1**	**964.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
					26	14				
			PLASTIC SANDY LOAM, brown, wet, very stiff, A-6, till (SC) *(continued)*	PD						
	53.0 911.3									
55			SILT LOAM, brown, wet, dense, A-4, alluvium (ML)		43	17				
	58.0 906.3			PD						
60					71	18				
				PD						
65			SAND, brown to gray, saturated, very dense to dense, A-3, alluvium (SP)		45	19				
				PD						
70					41	19				
	73.0 891.3			PD						
75			LOAMY FINE SAND, gray, wet, dense, A-2-4, alluvium (SM)							

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 4 of 5*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-1**	**964.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			LOAMY FINE SAND, gray, wet, dense, A-2-4, alluvium (SM) *(continued)*		49	23				
	78.0 886.3			PD						
80					60	23				
				PD						
85					40	18				
			SAND, brownish gray, saturated, very dense to dense, A-3, alluvium (SP)	PD						
90					60	20				
				PD						
95					42	17				
	98.0 866.3			PD						
100			SAND, brownish gray, saturated, medium dense, A-1-b, alluvium (SP)							

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 5 of 5*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-1**	**964.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SAND, brownish gray, saturated, medium dense, A-1-b, alluvium (SP) *(continued)*		30	16				
105	105.0 859.3		FINE SAND, brownish gray, saturated, dense, A-3, alluvium (SP)	PD						
110	110.0 854.3					20				
	111.0 853.3		FINE LOAMY SAND, gray, wet, dense, A-2-4, alluvium (SP-SM) Bottom of Hole - 111'		49	32				

Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	Br. No. 27505	Vinehill Road, Deephaven, MN	B-2	962.3 (from Plan)

Location: North Abutment

Coordinate: X= Y= (ft.)

Latitude (North)= Longitude (West)=

Drill Machine: 91

Hammer: CME Automatic Calibrated

SHEET 1 of 5

Drilling Completed: 3/6/12

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.5 961.8		6.5" Bituminous pavement							SPT hammer calibrated to 64.5% efficiency on 9/13/07 and on 10/9/08 (110 lb hammer)
			LOAMY SAND AND GRAVEL, brown, frozen, A-1-b, fill (SP-SM)			4				
	2.0 960.3		SLIGHTLY PLASTIC SANDY LOAM, gray, frozen, A-2-4, fill (SM)			7				
	4.0 958.3		PLASTIC SANDY LOAM, brown, damp, very stiff, A-2-6, fill (SC)		17	11				
5	6.5 955.8		LOAM, a little loamy sand, brown, a little gray, moist, stiff to very stiff, A-6, fill (CL)		11	17				
					13	13				
					17	10				
10	14.0 948.3		LOAM, brown, moist, very stiff, A-6, till (CL)		19	15				
						15	1850	136		
15	19.0 943.3		LOAM, grayish brown, a little brown, damp, very stiff, laminations of loamy sand, A-6, till (CL)		23	15				
						16	2950	133		
20	23.5 938.8		SAND, brown, damp, medium dense, A-3, alluvium (SP-SM)							
25										

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 2 of 5*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-2**	**962.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SAND, brown, damp, medium dense, A-3, alluvium (SP-SM) *(continued)*		23	12				
	26.5 935.8									
			LOAMY SAND, brown, moist, medium dense, A-2-4, alluvium (SM)		20	16				
	29.0 933.3									
30 ▼			LOAM, gray, damp, A-6, till (CL)			14	1200	135		H2O at 30' w/HSA at 32' and SS to 33.5'
	31.0 931.3									
			LOAMY SAND AND GRAVEL, brown, wet, medium dense, A-1-b, alluvium (SM)	PD	25	8				
						22				
35	35.0 927.3				19	16				
			LOAM, brown to grayish brown, wet, very stiff, A-6, till (CL)	PD						
	37.0 925.3									No Recovery
				PD						
40			SAND, brown, saturated, medium dense, apparent cobble about 43', A-3, alluvium (SP-SM)		20	17				
				PD						
					79	15				Blow count influenced by cobble.
	44.0 918.3			PD						
45			LOAM, gray, moist, very stiff, A-6, till (CL)		17	18				
				PD						
	47.0 915.3									Damaged Tube
			LOAMY SAND, brown, wet, dense, possible cobbles, A-2-4, alluvium (SM)	PD						
50										

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 3 of 5*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-2**	**962.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / AGL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			LOAMY SAND, brown, wet, dense, possible cobbles, A-2-4, alluvium (SM) *(continued)*	PD	32	13				
	53.0 / 909.3									
55			SLIGHTLY PLASTIC FINE SANDY LOAM, brown, wet, dense, A-4, alluvium (SM)	PD	37	21				
	58.0 / 904.3									
60			LOAMY SAND, gray, wet, dense, A-2-4, alluvium (SP-SM)	PD	41	21				
	63.0 / 899.3									
65			FINE SAND, gray, saturated, dense, A-3, alluvium (SP-SM)	PD	44	18				
70				PD	38	22				
	73.0 / 889.3									
75			SAND, brownish gray, saturated, dense, A-3, alluvium (SP)							

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Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 4 of 5*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-2**	**962.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SAND, brownish gray, saturated, dense, A-3, alluvium (SP) *(continued)*	PD	31	19				
	78.0 884.3									
80				PD	32	20				
85			SAND, gray, saturated, dense, A-3, alluvium (SP-SM)	PD	32	23				
90				PD	32	17				
	93.0 869.3									
95			SAND, gray, saturated, dense, A-3, alluvium (SP)	PD	44	19				
100										

(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 3/30/12

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AMERICAN ENGINEERING TESTING, INC. - Mn/DOT TEMPLATE

SUBSURFACE BORING LOG

UNIQUE NUMBER

U.S. Customary Units

AMERICAN ENGINEERING TESTING, INC.

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS — *SHEET 5 of 5*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	Br. No. 27505	**Vinehill Road, Deephaven, MN**	**B-2**	**962.3** *(from Plan)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	101.0 861.3		SAND, gray, saturated, dense, A-3, alluvium (SP) *(continued)* Bottom of Hole - 101'	X	45	20				

Soil Class: Rock Class: Edit: Date: 3/30/12

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Filename: C:\PROGRA~1\DRIVEN\B112.DVN

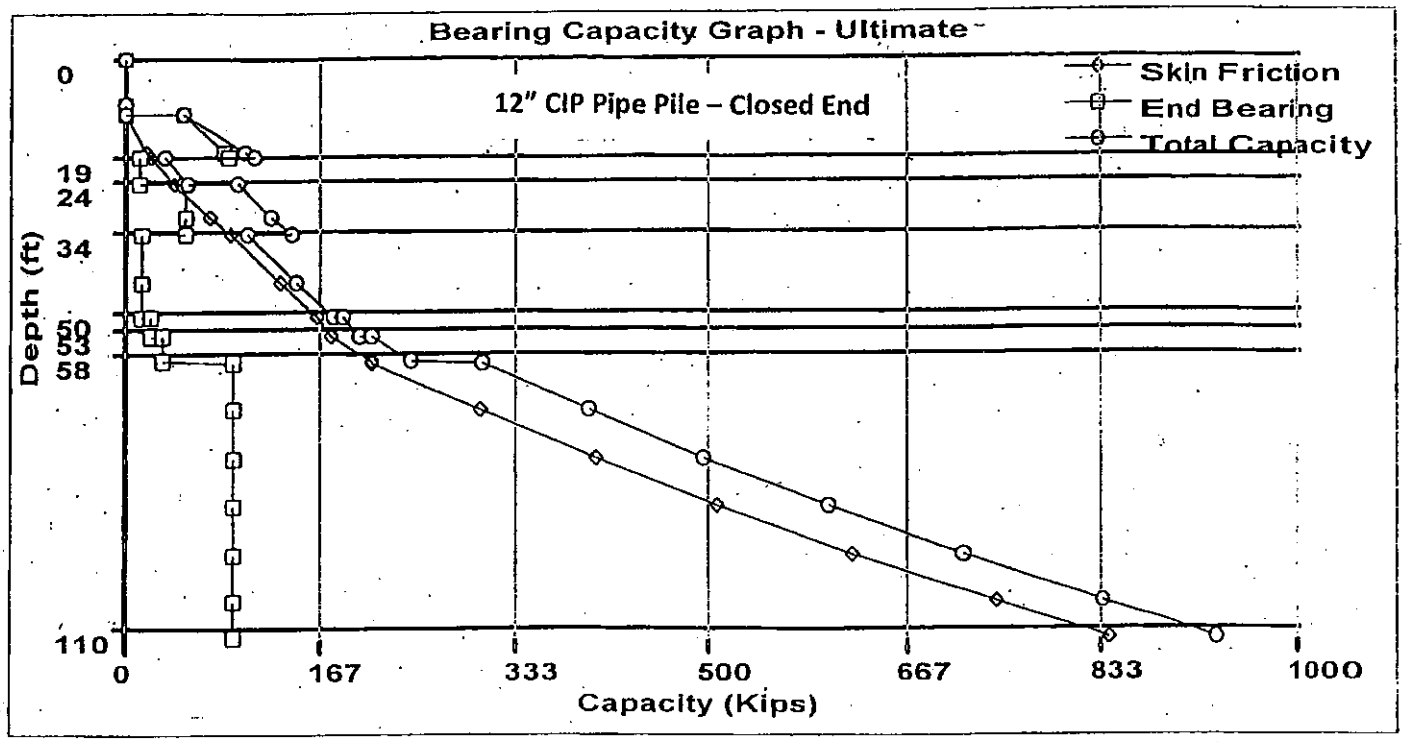

Figure 2 – *DRIVEN* Analyses, B-1, South Abutment - Surface Elevation : 964.3 feet

Filename: C:\PROGRA~1\DRIVEN\B212.DVN

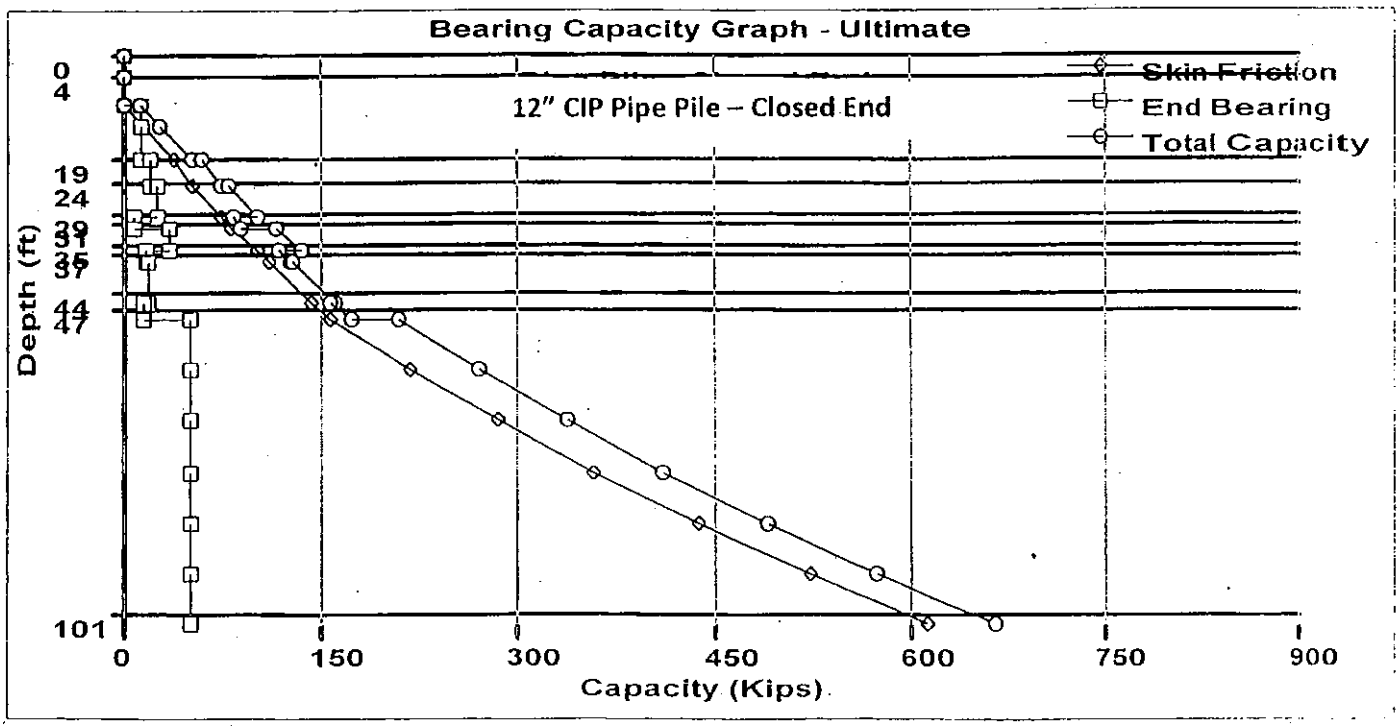

Figure 3 – DRIVEN Analyses, B-2, North Abutment - Surface Elevation : 962.3 feet

Appendix B
Geotechnical Report Limitations and Guidelines for Use
AET Report No. 28-00495

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 ASFE[1], 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

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 recognize 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 to 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.