Swift Contract No. 59321

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
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- MATERIALS
- FORENSICS

REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

Lake Vermilion State Park Welcome Plaza

Near Soudan, Minnesota

AET Project No. 07-05637

Date:
April 3, 2013

Prepared For:

Minnesota Department of Natural Resources
Division of Operations Services
500 Lafayette Road
St. Paul, Minnesota 55155

www.amengtest.com

Consultant's Report

AMERICAN ENGINEERING TESTING, INC.

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April 3, 2013

Mr. Trent Luger, Senior Landscape Architect
Minnesota Department of Natural Resources
Division of Operations Services
500 Lafayette Road
St. Paul, Minnesota 55155

RE: Report of Geotechnical Exploration and Review
Lake Vermilion State Park
Welcome Plaza
Near Soudan, Minnesota
AET Report No. 07-05637

Dear Mr. Luger:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration for this project. We performed these services following your acceptance of our proposal dated February 7, 2013. We are submitting three copies of this report to you; this report is the instrument of service described in our proposal.

We have enjoyed working with you on this phase of the project. Please contact us if you have questions about the report.

Sincerely,
American Engineering Testing, Inc.

Taryn J. Kuusisto, EIT
Staff Engineer II
tkuusisto@amengtest.com

SIGNATURE PAGE

Prepared for:

MN Department of Natural Resources
Division of Operations Services
500 Lafayette Road
St. Paul, Minnesota 55155

Attn: Mr. Trent Luger

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Staff Engineer II

Reviewed By:

Gregory R. Reuter, P.E.
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

Print Name: Gregory R. Reuter

Date: 4/3/13 **License #:** 19885

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1.0 INTRODUCTION

The Minnesota Department of Natural Resources (Mn/DNR) is planning the construction of a new Welcome Plaza at Lake Vermilion State Park. To assist in the planning and design, Mr. Trent Luger, Mn/DNR, authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration at the site, perform routine soil laboratory testing, and prepare a geotechnical engineering report for the project. This report presents the results of these services and our engineering recommendations.

2.0 SCOPE OF SERVICES

AET's services were performed according to our proposal to the Mn/DNR dated February 7, 2013, which was authorized on March 14, 2013 by Contract 59231/PO 3-34084. The authorized scope is limited to the following:

* Arrange for the locating of existing public underground utilities through Gopher State One Call;
* Drill five Standard Penetration Test (SPT) borings to 20 feet or to refusal to auger or split-barrel penetration; and
* Prepare a geotechnical report with the boring logs, a summary of the soil and groundwater conditions, and geotechnical engineering recommendations for earthwork, foundation and road design, and construction.

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination in the soil and groundwater, nor to comment on lead, mold, asbestos, radon, or silica.

3.0 PROJECT INFORMATION

3.1 Project Plans

The project will consist of the construction of a new Welcome Plaza, two vault toilets, and a bituminous paved road and parking lot to be used by vehicles with a GVW of 9 tons.

Final plans for the shelter have not yet been made, but the building will either be an unheated, open timber frame structure or an enclosed heated structure. The building will cover a footprint of approximately 26 feet by 56 feet. We assume the vault toilets will be precast reinforced concrete structures; the vault bottoms will be at 5 feet below grade.

At this time we have not been provided with the structural loads for the shelter, however we anticipate that the loads will be light, with wall loads less than 2 kips per linear foot. We have also not been provided with the traffic count, but anticipate that the traffic will consist of camper trailers, RVs, ATVs, light trucks and cars.

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

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The Mn/DNR specified the number and depths of the borings, and staked the boring locations. We drilled four SPT borings to 21 feet and one SPT boring to 15.6 feet below the current ground surface. The approximate boring locations are shown on the figure in Appendix A. The surface elevations at the locations were provided to us by the Mn/DNR.

We drilled the borings with a CME-750 all-terrain rig, using 3¼-inch I.D. hollow-stem augers and sampling the soils by the split-barrel method (ASTM D1586). Representative portions of the recovered soil samples were sealed in jars in the field by our drill crew to prevent moisture loss and submitted to our laboratory. The boreholes were backfilled in accordance with Minnesota Department of Health (MDH) regulations.

Please refer to Appendix A for details on the drilling and sampling, field classification, water level measurement methods, and the boring logs. The logs contain information concerning soil strata, soil classifications, geologic origins, and soil moisture condition. The relative density or consistency is also noted for the natural soils, based on the Standard Penetration Resistances (N-values).

4.2 Soil Classification

We visually-manually classified the samples based on texture and plasticity according to the Unified Soil Classification System (USCS, ASTM D2488). Data sheets describing the USCS, the descriptive terminology, and the symbols used on the boring logs are included in Appendix A.

5.0 SITE CONDITIONS

5.1 Surface Features

The proposed site is wooded. To the north of the site is a swamp area. Currently, access to the site is along the old 169 gravel road, which has been abandoned.

5.2 Soils/Geology

Shelter

We drilled borings SB-3 and SB-4 in the area of the proposed shelter. Boring SB-3 shows 6 inches of topsoil over fine alluvium to 17.5 feet underlain by till. The fine alluvium is medium dense to very loose and consists of silt with sand, sandy silt, silty clay and sand; the till is medium dense and consists of silty clayey sand with gravel.

Boring SB-4 shows 1.5 feet of topsoil overlying naturally-occurring alluvium. The fine alluvium is medium dense and consists of sandy silt and silt; the coarse alluvium is loose and consists of sand with silt. The boring was terminated upon refusal at 15.6 feet. For purposes of this report we have assumed that refusal occurred on bedrock, boulders or cobbles. Supplemental exploration by means of diamond coring and/or test pits would be needed to define the reason for the auger refusal, and these were beyond our scope of services.

Vault Toilets

We drilled boring SB-5 in the area of the new vault toilets. This boring indicates 1.5 feet of topsoil overlying loose to very loose naturally-occurring alluvium. The fine alluvium consists of loose sandy silt; the coarse alluvium is loose to very loose and consists of sand with varying amounts of silt.

Paved Areas

We drilled borings SB-1 and SB-2 in the pavement areas; SB-2 was located within the abandoned gravel road. These borings indicate 1 foot of topsoil and 1.5 feet of fill, respectively, overlying naturally-occurring alluvium. The fine alluvium (SB-1 only) is medium dense sandy silt. The coarse alluvium consists of mostly loose to very dense sand with varying amounts of gravel and silt.

5.3 Groundwater Levels

We encountered groundwater in all of our borings at depths between 9.2 and 13.0 feet during and after drilling; however, the soils were wet at a depth of about 6½ feet. The coarse alluvium encountered at the site is relatively permeable, and it is our opinion that groundwater level measurements in the borings that terminated in these layers provide a reasonable indication of groundwater conditions on the date of drilling.

It is possible that perched (trapped) ground water could exist in seams of sand or silt above the hydrostatic ground water, even though we did not encounter perched levels in our borings while drilling. Perched water also often exists on top of bedrock surfaces, particularly after periods of precipitation and surficial infiltration. The groundwater levels, both hydrostatic and perched, will vary in elevation seasonally and annually depending on local precipitation, infiltration, and runoff.

6.0 RECOMMENDATIONS

6.1 Discussion

Based on the subsurface conditions found in our borings and on our understanding of the project, it is our opinion that the shelter can be supported on spread footing foundations after proper site preparation. Site preparation should include removing the existing vegetation, topsoil, root clusters, and roots larger than ¾-inch in diameter from the building footprint; surface compaction of soils loosened by the excavation process; placement of new, select compacted fill to bottom of slab elevation; and excavation to bottom of new foundation elevation.

If the shelter is unheated, there will be potential for frost heave under the slab, which could result in cracking and/or vertical movement of the slab. One option to reduce the risk of frost heave would be to excavate the frost-susceptible soils (ML, CL-ML, and SM) to a depth of 6.5 feet and replace them with non-frost susceptible soils. As an alternative to the excavate and replace option, thermal foundation insulation could be placed below the building. The excavate/replace option is discussed in Sections 6.2.1 and 6.2.2, and the insulation option is presented in Section 6.2.4.

The vault toilets can be placed on the naturally-occurring soils, after proper site preparation. Site preparation should include removing the existing vegetation, topsoil, root clusters, and roots larger than ¾-inch in diameter under the vault footprints; further excavation to bottom of vault elevation, and surface compaction of soils loosened by the excavation process.

6.2 Shelter Recommendations

6.2.1 Excavation

All vegetation, topsoil, root clusters, and roots larger than ¾-inch in diameter should be stripped from the planned building footprint. Soils at the bottom of the excavations that are disturbed or loose should be compacted or subcut and replaced.

Based on our borings for the building, we estimate a stripping depth of 6 inches to 1.5 feet (below existing grade) to remove the topsoil. If the building will be unheated and the excavate/replace option is chosen to reduce the risk of frost heave, we estimate a subutting depth of 6.5 feet in the building footprint to remove the frost-susceptible soils. The actual depths of subcutting required will vary away from the boring locations. A geotechnical engineer or technician should perform field observations during construction to determine actual subcutting requirements, which could be deeper or shallower than anticipated from the borings. Also, groundwater may be encountered in the subcut excavation; therefore, the contractor must be prepared to properly dewater the excavation.

Due to the wet, loose soils at bottom of foundation elevation, we recommend excavating an additional 1 foot below bottom of footing to allow for a crushed rock working base. Because the subcutting will extend below the foundation base, the excavation bottom and resultant compacted fill system must be oversized laterally beyond the planned outside edges of the foundations to properly support the lateral loads exerted by that foundation. This engineered fill lateral extension should at least be equal to the vertical depth of fill needed to attain foundation grade at that location (i.e., 1:1 lateral oversize).

6.2.2 Building Fill/Compaction

New fill required to raise the grade under the building should be select granular non-frost susceptible soil meeting the gradation of Mn/DOT 3149.2B2, modified to less than 5% passing the No. 200 sieve. If the contractor wishes to propose a different gradation of material, he should submit a sample to AET at least three weeks before the start of construction for gradation testing and assessment by a geotechnical engineer.

The crushed rock below the footings should meet the Mn/DOT 3138.2B gradation requirements.

The fill should be placed in loose lifts about 6 to 8 inches thick, with each lift mechanically compacted to at least 95% of the maximum Modified Proctor dry density (ASTM: D 1557). Please refer to the attached standard sheet entitled "Excavation and Refilling for Structural Support" for general information regarding placing fill for buildings.

6.2.3 Spread Footing Foundation System

After the site has been prepared as described above, the structure may be supported on conventional spread footings bearing on the crushed rock placed over a suitable subgrade. We recommend that continuous strip footings have a minimum width of 20 inches and that column pads have a minimum dimension of 3 feet, even if the resulting contact pressure is less than our recommended allowable bearing pressure.

We recommend that perimeter foundations for an unheated building bear at least 7 feet below final exterior grade for protection from frost penetration; for a heated building, perimeter foundations should bear at least 5 feet below final exterior grade. We recommend that the footings bearing on the crushed rock be designed for a maximum net allowable soil bearing pressure of 2,000 pounds per square foot. It is our judgment this design pressure will provide a factor of safety of 3 against bearing capacity failure. We estimate that total settlement under this loading would be ¾ inch or less, with differential settlements less than half this amount, if the bearing soils are not soft, wet, disturbed, or frozen before or after construction.

6.2.4 Floor Slab Subgrade

We recommend that interior backfill in footing trenches be granular soil meeting the requirements in Section 6.2.2 of this report, placed in loose lifts no thicker than 4 inches, with each lift mechanically compacted to at least 93% of the maximum Modified Proctor dry density. The fill on both the inside and outside of the foundation walls should be kept at the same level during placement and compaction to prevent an unbalanced force from developing that may damage the foundation wall during construction. Based on a subgrade prepared in this manner, the structural engineer may use a modulus of subgrade reaction of 200 pounds per cubic inch to design the slab.

The floor slab on-grade should have construction joints and control joints at spacing recommended by the American Concrete Institute and the Portland Cement Association to limit (but not eliminate) excessive slab cracking and curling.

If the building will be unheated and the excavate/replace option is not chosen, we recommend placing thermal foundation insulation beneath the entire slab footprint and vertically along the inside foundation walls. The insulation below the slab would be placed horizontally over the prepared subgrade. The insulation should be extruded polystyrene with a minimum 5-inch thickness. The insulation should be placed in two layers with staggered joints over a smooth, compacted surface that is flat. Dow Styrofoam HI-60 would be suitable foundation insulation.

6.3 Vault Toilet Recommendations

All topsoil should be stripped from the planned vault toilet footprints, after which excavations should be made to bottom of vault elevation. Where tree stumps or root clusters are removed, holes will be created. If these holes extend below the bottom of the vault excavation they should be further subcut to the base of the holes and backfilled with compacted granular soils. We anticipate naturally-occurring loose silty sand at the bottom of vault slab elevations. The soils at the bottom of excavations should be densified in place. After the sites have been prepared as described, the structures may be supported on naturally-occurring loose silty sand.

6.4 Pavement Recommendations

6.4.1 Site Preparation

We drilled two borings for the drive lanes and parking lots. We recommend that the surficial topsoil be removed from pavement areas. After the topsoil has been removed, the areas should be further subcut to the bottom of the select granular subbase elevation. The exposed soils should then be compacted in-place with a heavy smooth wheel vibratory roller.

6.4.2 Pavement Thickness

We recommend the following pavement section for the drive lanes and parking lot to be used by vehicles with a GVW of 9 tons:

Pavement Component	**Recommended Bituminous Pavement Section**
Mn/DOT SPWEB240C (wear course)	1.5 inches
Mn/DOT 2357 Tack Coat	Yes
Mn/DOT SPWEB240C (base course)	2.0 inches
Mn/DOT 3138 Class 5 Aggregate Base	6 inches
Mn/DOT 3149.2B2, modified <7%, Select Granular Subbase	18 inches
Mn/DOT Section 3733 Type V, non-woven geotextile fabric	Yes
Subgrade Preparation	Per this report

Please note that these are the <u>minimum</u> thicknesses for each pavement component, not the averages. This should be noted in the project specifications and on the drawings.

6.4.3 Pavement Construction

The geotextile separation fabric should be placed on the exposed, compacted subgrade. The Select Granular subbase should be placed over the geotextile fabric in loose lifts no thicker than 6 inches and mechanically compacted to at least 97% of the maximum Modified Proctor dry density. The Class 5 aggregate base should be placed over this subbase in loose lifts no thicker than 6 inches and mechanically compacted to at least 97% of the maximum Modified Proctor dry density. After the aggregate base course has been placed and compacted, the contractor must maintain the base course in a suitable condition for paving. If the base course becomes saturated after testing, it may be unsuitable for paving and may require correction before the pavement is placed.

The bituminous pavement should be placed according to the provisions of Mn/DOT specification 2360 Plant Mixed Asphalt Pavement. The bituminous base course should be compacted to at least 91.0% of the maximum theoretical density (Gmm); the bituminous wear course should be compacted to at least 92.0%. Before placing the wear course, the surface of the bituminous base course should be cleaned of all dust and debris. A tack coat should be applied between each lift of bituminous pavement in accordance with Mn/DOT 2357.

6.4.5 Pavement Maintenance

Regardless of the subgrade preparation and pavement design, the owner should expect that cracks will appear in the bituminous pavement within 1 to 3 years after construction due to thermal expansion and contraction, and due to the loss of volatiles from the bituminous cement. These cracks cannot be avoided; they should be cleaned annually and filled with a hot bituminous sealant. Within three to five years after construction, cracks and depressions may appear in heavily traveled areas, such as drive aisles. Such areas should be cut out and repaired expeditiously to extend the pavement life. Periodically during the pavement life, the engineer responsible for maintenance of the facility should determine the need to apply a seal coat of hot bituminous and rock chips.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Excavation Difficulties

7.1.1 Groundwater

We encountered groundwater in all of our borings at depths between 9.2 and 13.0 feet below the ground surface. The contractor may encounter hydrostatic groundwater in the excavations for the shelter footings.

To allow observation of the excavation bases and to reduce the potential for soil disturbance or softening by standing water, we recommend that all water be pumped out of excavations prior to placement of compacted fill, concrete, or bituminous. The contractor should <u>not</u> excavate in standing water, or place select fill, concrete, or bituminous into standing water in an attempt to displace these materials. This technique can result in trapping softened soils under the buildings, causing excess post-construction settlement even if the softened zone is only a few inches thick.

7.2 Excavation Sidesloping

The excavations for this project must have side 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 could induce side slope erosion which could require slope maintenance. The decision on excavating safe slopes for this project should be made by the excavator's "competent person." AET will not accept any liability or responsibility for excavation safety on this project.

7.3 Soil Disturbance

The soils found at the site are susceptible to disturbance by construction equipment and workers' foot traffic, and should be protected until a final observation can be made immediately prior to placing concrete/bituminous. The responsibility to avoid disturbing the soils by choosing proper equipment and methods lies solely with the contractor.

7.4 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our boring locations. The soils found in our borings vary; we recommend that the base soils be observed and tested by an experienced material technician or a geotechnical engineer. The fill materials should be tested for gradation and Proctor values, and field density tests should be performed as the fill is placed and compacted.

8.0 GENERAL QUALIFICATIONS

This report has been prepared based on the soil and groundwater conditions found in our borings, and on the project design as described in the Introduction of this report. If there are any changes in size, location, finished floor elevation, structural loads, use or nature of the structures from those outlined in the Introduction of this report, or if our understanding of the project is incomplete or incorrect, it is necessary that you contact us so we can review our recommendations to determine if they remain applicable. If we are not given the opportunity to review any changes in the building designs, then the recommendations in this report will not be valid.

We determined the soil and ground water conditions at five locations for the project. The subsurface conditions we describe and discuss in this report are pertinent only at the borings and under the environment of our field exploration. Variations in the subsurface soils were found, and it is likely that additional variations exist that cannot be determined from our borings or our site observations. These variations would not become apparent until excavation is started. No warranty, express or implied, is presented in this report with respect to the soil and ground water conditions on this site.

9.0 ASTM STANDARDS

When we refer to an ASTM Standard in this report, we mean that our services were performed in general accordance with that standard. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

10.0 STANDARD OF CARE

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

Standard Data Sheets

AET Project No. 07-05637

Excavation and Refilling for Structural Support

EXCAVATION AND REFILLING FOR STRUCTURAL SUPPORT

EXCAVATION

Excavations for structural support at soil boring locations should be taken to depths recommended in the geotechnical report. Since conditions can vary, recommended excavation depths between and beyond the boring locations should be evaluated by geotechnical field personnel. If ground water is present, the excavation should be dewatered to avoid the risk of unobservable poor soils being left in-place. Excavation base soils may become disturbed due to construction traffic, ground water or other reasons. Such soils should be subcut to underlying undisturbed soils. Where the excavation base slopes steeper than 4:1, the excavation bottom should be benched across the slope parallel to the excavation contour.

Soil stresses under footings spread out with depth. Therefore, the excavation bottom and subsequent fill system should be laterally oversized beyond footing edges to support the footing stresses. A lateral oversize equal to the depth of fill below the footing (i.e., 1:1 oversize) is usually recommended. The lateral oversize is usually increased to 1.5:1 where compressible organic soils are exposed on the excavation sides. Variations in oversize requirements may be recommended in the geotechnical report or can be evaluated by the geotechnical field personnel.

Unless the excavation is retained, the backslopes should be maintained in accordance with OSHA Regulations (Standards - 29 CFR), Part 1926, Subpart P, "Excavations" (found on www.osha.gov). Even with the required OSHA sloping, ground water can induce sideslope raveling or running which could require that flatter slopes or other approaches be used.

FILLING

Filling should proceed only after the excavation bottom has been approved by the geotechnical engineer/technician. Approved fill material should be uniformly compacted in thin lifts to the compaction levels specified in the geotechnical report. The lift thickness should be thin enough to achieve specified compaction through the full lift thickness with the compaction equipment utilized. Typical thicknesses are 6" to 9" for clays and 12" to 18" for sands. Fine grained soils are moisture sensitive and are often wet (water content exceeds the "optimum moisture content" defined by a Proctor test). In this case, the soils should be scarified and dried to achieve a water content suitable for compaction. This drying process can be time consuming, labor intensive, and requires favorable weather.

Select fill material may be needed where the excavation bottom is sensitive to disturbance or where standing water is present. Sands (SP) which are medium to coarse grained are preferred, and can be compacted in thicker lift thicknesses than finer grained soils.

Filling operations for structural support should be closely monitored for fill type and compaction by a geotechnical technician. Monitoring should be on a full-time basis in cases where vertical fill placement is rapid; during freezing weather conditions; where ground water is present; or where sensitive bottom conditions are present.

EXCAVATION/REFILLING DURING FREEZING TEMPERATURES

Soils that freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density loss depends on the soil type and moisture condition; and is most pronounced in clays and silts. Foundations, slabs, and other improvements should be protected from frost intrusion during freezing weather. For earthwork during freezing weather, the areas to be filled should be stripped of frozen soil, snow and ice prior to new fill placement. In addition, new fill should not be allowed to freeze during or after placement. For this reason, it may be preferable to do earthwork operations in small plan areas so grade can be quickly attained instead of large areas where much frost stripping may be needed.

Appendix A

AET Project No. 07-05637

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Boring Locations Figure (provided by Mn/DNR)
Subsurface Boring Logs

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by performing five standard penetration test borings on March 21, 2013. The locations of the borings appear on the figure provided by the Mn/DNR 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 newest 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 log.

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 log 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 log 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 log are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring log.

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

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

A.4 WATER LEVEL MEASUREMENTS

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

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

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests
Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Atterberg Limits Tests
Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

A.5.4 Particle Size Analysis of Soils (with hydrometer)
Conducted per AET Procedure 01-LAB-050, which is performed in general accordance with ASTM: D422 and AASHTO: T88.

A.5.5 Unconfined Compressive Strength of Cohesive Soil
Conducted per AET Procedure 01-LAB-080, which is performed in general accordance with ASTM: D2166 and AASHTO: T208.

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
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nominal diameter in inches
CC:	Crew Chief (initials)
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In split-spoon (see notes) and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
REV:	Revert drilling fluid
SS:	Standard split-spoon sampler (steel; 1d" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level measured in borehole prior to abandonment
▽:	Interim water level measurement or estimated water level based 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, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

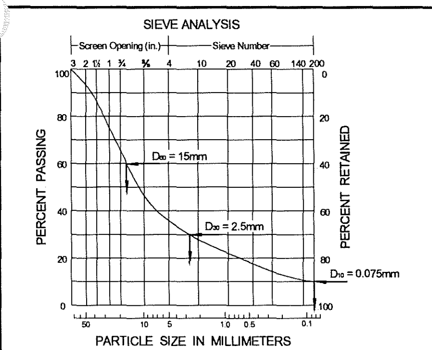
The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete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

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

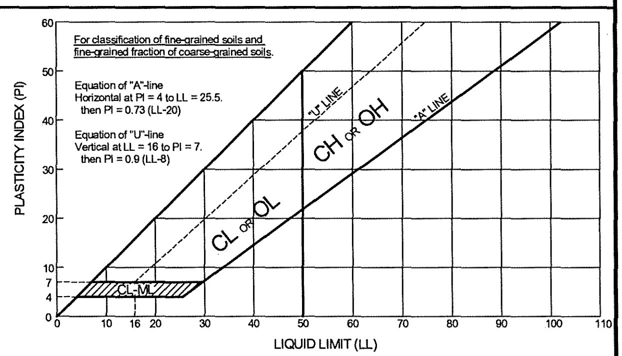
UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: 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 $1 > Cc > 3$[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	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	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	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	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]



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



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, 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.

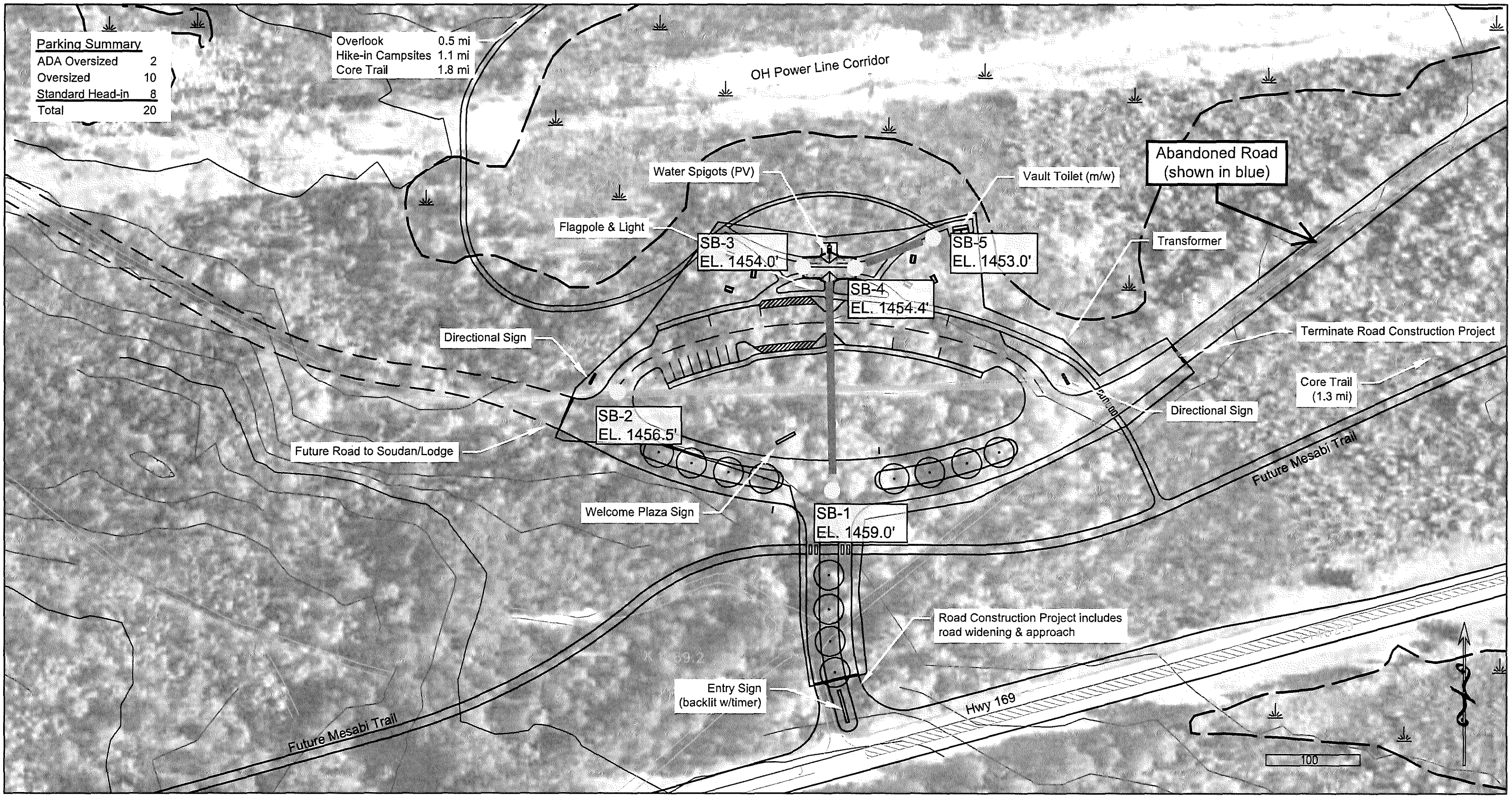
Fiber Content of Peat

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

Organic/Roots 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 soil properties. *Slightly organic* used for borderline cases.

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.



CONCEPT:
January 23, 2013

Minnesota DEPARTMENT OF NATURAL RESOURCES

DNR Division of Parks and Trails

LAKE VERMILION STATE PARK

Figure of Approximate Boring Locations
(provided by Mn/DNR)
Lake Vemilion State Park Welcome Plaza
AET Project No. 07-05637

Operation Services
Safety
Facilities
Materials
Equipment
Field Operations
Information Management

SHEET: L1

TITLE: Welcome Center Site Plan

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **07-05637** LOG OF BORING NO. **SB-1 (p. 1 of 1)**

PROJECT: **Lake Vermilion State Park Welcome Plaza; Near Soudan, Minnesota**

SURFACE ELEVATION: **1459.0**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DD	LL	PL	%-#200
0–1	TOPSOIL, organic silt with sand and roots, dark brown, frozen (OL)	TOPSOIL		F/M	SU						
1–8	SANDY SILT, brown to light brown, frozen to about 1.5 feet, medium dense, lenses of silty sand below about 4 feet (ML)	FINE ALLUVIUM	19	M	SS	12					
			24	M	SS	13					
			12	M	SS	15					
8–14	SAND, fine to medium grained, dark brown to brown, moist to wet, medium dense (SP)	COARSE ALLUVIUM	18	W	SS	11					
			12	W	SS	12					
14–19	SAND WITH SILT, fine to medium grained, grayish brown to dark gray, wet, loose (SP-SM)		7	W	SS	13					
			8	W	SS	11					
19–21	SAND, fine to medium grained, dark gray, wet, loose (SP)		7	W	SS	10					
21	**END OF BORING AT 21.0 FEET** *Boring backfilled with auger cuttings*										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-19½'	**3.25" HSA**	**3/21/13**	**5:20**	**21.0**	**19.5**	**18.0**	**--**	**13.0**

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

BORING COMPLETED: **3/21/13**

DR: **LA** LG: **TD** Rig: **51**

06/06

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **07-05637** LOG OF BORING NO. **SB-2 (p. 1 of 1)**

PROJECT: **Lake Vermilion State Park Welcome Plaza; Near Soudan, Minnesota**

SURFACE ELEVATION: **1456.5**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DD	LL	PL	%-#200
0–2	FILL, silty sand, a little gravel, with roots above about 0.2 feet, dark brown, frozen	FILL		F	SU						
2–4	SAND WITH SILT AND GRAVEL, fine to medium grained, brown, moist, dense (SP-SM)	COARSE ALLUVIUM	45	M	SS	8					
4–6.5	SANDY SILT, brown, moist, medium dense, lenses of light brown silt (ML)		30	M	SS	6					
6.5–7.7	SAND, fine grained, grayish brown, wet, loose (SP)		7	W	SS	12					
7.7–12.8	SILTY SAND, fine grained, brown, moist with wet lenses, loose (SM)		10	M/W	SS	12					
			12	W	SS	11					
12.8–15.2	SAND, fine to medium grained, brown and reddish brown, wet (SP)		39	W	SS	8					
15.2–19.7	SAND WITH SILT AND GRAVEL, brown, wet, medium dense (SP-SM)		24	W	SS	8					
19.7–20.7	SAND WITH SILT AND GRAVEL, fine to coarse grained, brown, wet (SP-SM)		5/0.5 35/0.5 50/0.2	M	SS	6					

END OF BORING AT 20.7 FEET
Boring backfilled with auger cuttings

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-19½'	**3.25" HSA**	**3/21/13**	**4:10**	**20.7**	**19.5**	**19.0**	**--**	**10.0**

BORING COMPLETED: **3/21/13**

DR: **LA** LG: **TD** Rig: **51**

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

06/06

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

Offset 4 feet southwest

AET JOB NO: **07-05637** LOG OF BORING NO. **SB-3 (p. 1 of 1)**

PROJECT: **Lake Vermilion State Park Welcome Plaza; Near Soudan, Minnesota**

SURFACE ELEVATION: **1454.0**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DD	LL	PL	%-#200
0–1	TOPSOIL, organic silt with roots, dark brown, frozen (OL)	TOPSOIL									
1–2	SILT WITH SAND, light brown, moist (ML)	FINE ALLUVIUM		F	SU						
2–5.4	SANDY SILT, light brown and grayish brown mottled, moist, medium dense (ML)		20	M	SS	11					
			12	M	SS	14					
5.4–6.5	SILTY CLAY WITH SAND, gray and orangish brown mottled (CL-ML)										
6.5–14	SILTY SAND, fine grained, grayish brown, wet, loose (SM)		7	W	SS	11					
			7	W	SS	11					
			6	W	SS	10					
14–17.5	SAND, fine to medium grained, dark gray, wet, very loose (SP)		4	W	SS	10					
17.5–21	SILTY CLAYEY SAND WITH GRAVEL, brown, wet, medium dense (SC-SM)	TILL	19	W	SS	10					
			20	W	SS	9					
21	**END OF BORING AT 21.0 FEET** *Boring backfilled with auger cuttings*										

DEPTH:	DRILLING METHOD
0-19½'	3.25" HSA

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
3/21/13	2:00	21.0	19.5	21.0	--	9.2

BORING COMPLETED: **3/21/13**

DR: **LA** LG: **TD** Rig: **51**

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

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

Offset 4 feet west

AET JOB NO: **07-05637** LOG OF BORING NO. **SB-4 (p. 1 of 1)**

PROJECT: **Lake Vermilion State Park Welcome Plaza; Near Soudan, Minnesota**

SURFACE ELEVATION: **1454.4**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DD	LL	PL	%-#200
0–1	TOPSOIL, organic silt with roots, dark brown, frozen to about 0.5 feet (OL)	TOPSOIL		F/M	SU						
1.5–7	SANDY SILT, light brown and orangish brown mottled, moist, medium dense (ML)	FINE ALLUVIUM	12	M	SS	13					
			13	M	SS	15					
7–9.5	SAND WITH SILT, fine grained, dark grayish brown to dark gray, wet, loose (SP-SM)	COARSE ALLUVIUM	6	W	SS	14					
9.5–10	SILT, dark gray, wet (ML)	FINE ALLUVIUM									
10–11.5	SAND WITH SILT, fine grained, dark gray, wet (SM)	COARSE ALLUVIUM	8	W	SS	12					
11.5–15	SANDY SILT, dark gray, wet, medium dense (ML)	FINE ALLUVIUM	11	W	SS	3					
15–15.6	WEATHERED BOULDER OR BEDROCK, dark gray	BOULDER OR BEDROCK	4/0.5 39/0.5 50/0.2	W	SS	8					
	REFUSAL TO AUGER AT 15.6 FEET *Boring backfilled with auger cuttings*										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS						
0-16'	**3.25" HSA**	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
		3/21/13	**12:50**	**15.7**	**16.0**	**16.0**	**--**	**12.0**

BORING COMPLETED: **3/21/13**

DR: **LA** LG: **TD** Rig: **51**

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

06/06

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **07-05637** LOG OF BORING NO. **SB-5 (p. 1 of 1)**

PROJECT: **Lake Vermilion State Park Welcome Plaza; Near Soudan, Minnesota**

DEPTH IN FEET	SURFACE ELEVATION: 1453.0 MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	WC	DD	LL	PL	%-#200
0–1	TOPSOIL, organic sandy silt with roots, dark brown, frozen to about 1 foot (OL)	TOPSOIL		F	SU						
1–4	SANDY SILT, grayish brown and orangish brown mottled, moist, loose (ML)	FINE ALLUVIUM	9	M	SS	13					
4–6.5	SILTY SAND, fine to medium grained, dark grayish brown, moist with wet lenses, loose (SM)	COARSE ALLUVIUM	8	M/W	SS	10					
6.5–11	SILTY SAND, fine grained, dark gray, wet, very loose (SM)		4	W	SS	12					
			4	M	SS	13					
11–14.5	SAND WITH SILT, fine grained, dark gray, wet, very loose (SP-SM)		4	W	SS	12					
14.5–16	SAND, fine grained, dark gray, wet, loose (SP)		5	W	SS	3					
16–19	SANDY SILT, dark gray, wet, loose (ML)	FINE ALLUVIUM	5	W	SS	12					
19–21	SILTY SAND, fine grained, dark gray, wet, loose (SM)	COARSE ALLUVIUM	6	W	SS	12					
21	**END OF BORING AT 21.0 FEET** *Boring backfilled with auger cuttings*										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
0-19½'	**3.25" HSA**	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		3/21/13	**11:15**	**21.0**	**19.5**	**19.5**	**--**	**11.0**	
BORING COMPLETED: **3/21/13**									
DR: **LA** LG: **TD** Rig: **51**									

06/06

Appendix B

AET Project No. 07-05637

Geotechnical Report Limitations and Guidelines for Use

Geotechnical Report Limitations and Guidelines for Use
AET Project No. 07-05637

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.