STS CONSULTANTS

CALL THEM ABOUT SOIL.

COPY

STS CONSULTANTS, LTD.

Proposed Commercial Development in Minneapolis, Minnesota

TILL IN CEMENT

Minneapolis Community Development Agency, Minneapolis, Minnesota

STS Project 99358

1401 Central Ave. NE.

FD. Q

- PROP. SEARCH?
- FAX TO ED
JIM. Y.
ATTY.

1. FOOTINGS
2. COLS.
3. FILL

A. 1. EXCAVATE TO LIMESTONE
2. FOOTINGS. 18" to 24" THICK
3. FLOAT SLAB 12" ABOVE FOOTINGS.
4. REPORT SEEMS TO INDICATE
NOT PUTTING SLAB ON GRADE
IF OFFICE, AMEND OR TREAT (CEMENT TREATMENT)
SOIL TO STIFFEN FOR SLAB ON GRADE
(ASSUME 100 lbs/s.f. MAX.)

B. EXC. THEN BACKFILL IS ONE COST
V/S. MATT FOUNDATION - POUR SLAB 18" THICK
ON LIMESTONE.

C. STRUC. FLOOR INSTEAD. - HOVERING OVER GRADE.

THE INFRASTRUCTURE IMPERATIVE

STS CONSULTANTS

STS Consultants, Ltd.
10900 - 73rd Ave. N., Suite 150
Maple Grove, MN 55369-5547
763-315-6300 Phone
763-315-1836 Fax

December 16, 2003

Mr. Steve Maki
Minneapolis Community Development Agency
600 Crown Roller Mill
105 - 5th Avenue South
Minneapolis, MN 55401

Re: Subsurface Exploration and Geotechnical Engineering Analysis for the Proposed Commercial Development in Minneapolis, Minnesota; STS Project 99358

Dear Mr. Maki:

We have performed a subsurface exploration and geotechnical engineering analysis for this project. The attached report contains the logs of three soil borings, an evaluation of the conditions encountered in the borings, and our recommendations for suitable foundation type, allowable soil bearing pressure for footing design, and other geotechnical related design and construction considerations.

In summary, the borings encountered about 2.8 to 3.4 feet of overburden fill soils underlain by limestone bedrock.

We appreciate the opportunity to work with you on this project. If you have any questions about our recommendations, please call us at 763/315-6300.

Sincerely,

STS CONSULTANTS, LTD.

Barry C. Morgan, P.E.
Senior Project Engineer

James H. Overtoom, P.E.
Principal Engineer/Vice President

BCM/dn
Encs.

I HEREBY CERTIFY THAT I AM A PROFESSIONAL ENGINEER REGISTERED UNDER THE LAWS OF THE STATE OF MINNESOTA, AND THAT THIS REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

Signed ______ Barry C. Morgan Registration No. 26433

Date 12/16/03

Table of Contents

1.0 PROJECT OVERVIEW

1.1 Project Description

We understand the proposed project will consist of developing the existing parcel with a slab-on-grade commercial structure with a height up to four stories. A preliminary site plan indicates that the structure will be "L" shaped and situated near the middle of the site. Associated drive and parking areas will also be provided as part of the project. We anticipate typical office traffic in paved areas. Structural loads were not available, however, for the purposes of this report, we assume that maximum continuous wall loads will be on the order of 4 to 6 kips per foot and individual column loads will be on the order of 100 kips each.

Finished floor elevations and a grading plan were also not available. We anticipate that only minor grading with cuts and fills on the order of 1 to 2 feet will be required.

1.2 Project Scope and Purpose

Our services were performed in accordance with the MCDA notice to proceed dated November 21, 2003 and outlined in our confirmation letter dated December 4, 2003.

The purposes of this exploration are to:

- Perform a subsurface exploration and testing program consisting of three soil borings to 2 to 5 feet of auger penetration in bedrock materials.
- Describe the soil and groundwater conditions encountered in our exploration.
- Screen collected samples for volatile organic contaminants.
- Characterize the subsurface conditions with respect to the site geology and the proposed construction.
- Analyze the available subsurface information which is applicable to this project.
- Present recommendations for design of foundations and floor slabs.
- Discuss the construction considerations related to earthwork and foundations.

2.0 EXPLORATION AND TESTING PROCEDURES

2.1 Boring Layout and Soil Sampling Procedures

STS recommended the boring locations and depths. Our field crew staked the borings by measuring from available site features. The approximate boring locations are shown on the Soil Boring Location Diagram in the Appendix. The ground surface elevations indicated on the boring logs were obtained by the drill crew using a level and rod. The elevations are referenced to the top nut of the fire hydrant located at the intersection of Central Avenue and 14th Street.

We drilled the borings with a truck mounted D-50 drill rig operated by a two person crew. The drill crew advanced the borings using continuous flight augers. Detailed descriptions of typical drilling procedures are included in the Appendix. Drilling methods, depths, casing usage, drill rig type, foreman, and other drilling information are indicated on the boring logs.

The drill crew sampled the soil in advance of the auger tip at 2.5 foot intervals of depth to 10 feet and at 5 foot intervals thereafter. The soil samples were obtained using a split-barrel sampler which was driven into the ground during standard penetration tests in accordance with ASTM D-1586, Standard Method of Penetration Test and Split-Barrel Sampling of Soils. An explanation of typical STS drilling and sampling procedures is presented in STS Field and Laboratory Procedures in the Appendix.

Recovered soil samples were described on field logs, containerized, and transported to our laboratory for further examination and testing. The field logs also document sample intervals, test data, observations of drilling resistance, groundwater occurrence and other pertinent conditions.

2.2 Groundwater Measurements and Borehole Abandonment

The drill crew observed the borings for free groundwater while drilling and after completion. These observations and measurements are noted on the lower left corner of the boring logs and represent the groundwater at the time the borings were performed. The crew then backfilled the borings with soil cuttings to comply with Minnesota Department of Health regulations.

2.3 Laboratory Testing Procedures

The penetration test split-spoon samples were visually examined by a geotechnical engineer to estimate the distribution of grain sizes, plasticity, consistency, moisture condition, color, presence of lenses and seams, and apparent geologic origin. The engineer classified the soils according to type using the STS Classification System, which is closely based on the Unified Soil Classification System. A chart describing the STS Classification System is included in the Appendix. An explanation of typical laboratory procedures is presented in the Appendix.

Three samples were selected and tested to determine the organic content of the soils. The test was performed in general accordance with ASTM D-2974. The results are indicated on the boring logs.

The soil samples were screened in the laboratory using a photoionization detector (PID) meter to evaluate the presence of volatile organic compounds. The results are shown on the boring logs.

2.4 Boring Log Procedures and Qualifications

The results of the field and laboratory observations and tests are printed on final boring logs included in the Appendix. Similar soils were grouped into the strata shown on the boring logs, and the appropriate estimated USCS classification symbols were also added. Note that the stratification depth lines between soil types on the logs are estimated based on the available data. In-situ, the transition between soil types may be distinct or gradual in either the horizontal or vertical directions. The soil conditions have been established at our specific test hole locations only. Variations in the soil stratigraphy may occur between and around the borings, the nature and extent of which would not become evident until exposed by construction excavation. These variations must be properly assessed when utilizing the information presented on the boring logs. Additional comments on boring log preparation and qualifications are contained in an Appendix sheet entitled STS Standard Boring Log Procedures.

Descriptions of bedrock materials are based on the drillers observations during drilling and observation of disturbed samples in the laboratory. Rock cores may indicate other bedrock types.

3.0 EXPLORATION RESULTS

3.1 Site and Geology

The proposed site is located in the northeast quadrant at the intersection of Central Avenue and 14th Street in Minneapolis, Minnesota. The site is bound by a railway on the north. The site is currently undeveloped and existing grades at the site are relatively level.

STS has provided Phase I and II ESA services on this site. Our previous work was performed for Hennepin County (STS Project 98408-XB, reports dated October 4, 2001 and July 1, 2002). This previous work identified that the site was once occupied by a sheet metal factory.

There is no information indicating that old foundations and/or utilities for the old facility were removed as part of the demolition. The drillers observed what appeared to be a buried concrete slab in boring 3.

Bedrock geology maps indicate that the upper bedrock materials consist of limestone materials of the Platteville formation.

3.2 Soil Conditions

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification on the boring logs represents the approximate location of changes in soil types; in-situ; the transitions may be gradual. Based on the results of the borings, the subsurface conditions at the site can be generalized as follows:

Fill and possible fill soils were encountered to depths of about 2.8 to 3.4 feet in each boring. The fill consisted of fine sand and/or clayey sand soils with varying portions of organics, gravel, and debris.

These materials were underlain by limestone bedrock. The bedrock surface was encountered at depths of about 2.8 to 3.4 feet and penetrated to depths of about 6.5 to 9.5 feet where practical auger refusal occurred.

3.3 Groundwater Conditions

The drill crew did not indicate groundwater in the borings while drilling or upon completion.

Fluctuations in the groundwater level can occur and the possibility of these fluctuations should be considered in developing the project.

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Discussion

Based on the observations of the soils encountered in the borings, the organic content and review of information from previous explorations, the organic fill soils are not considered suitable for the support of floor slabs, due to the organic materials and debris. The non-organic fill soils, B-1, appear suitable for reuse as structural fill. Debris should be removed before using as structural fill. The fill and possible fill soils are not the most well suited soils for support of pavements, but if the owner is willing to accept some risk in placing pavements on the soils, the soils could remain in place for support of pavements. Thorough observation during construction can reduce and minimize the risk. However, due to the potential for soft or loose zones present in the fill, complete removal of the fill would be required to completely minimize the risk associated with placing pavements on the fill.

Foundations are expected to bear on bedrock materials. Based on the drilling characteristics of the bedrock materials, we expect excavation in bedrock, if any, to be difficult and will likely require the use of rippers attached to large dozers, pneumatic breakers, or other rock excavation techniques.

As-built information obtained from the City of Minneapolis for the sanitary sewer in Central Avenue indicated shallow depth to bedrock.

The discussions in this report relate only to geotechnical issues. Please refer to STS's reports dated October 4, 2001 and July 1, 2002 (STS Project 98408-XB) for environmental concerns related to the excavation and disposal of the on-site soils.

4.2 Site Preparation

Site preparation should begin by removing any vegetation, topsoil, or other loose, soft or otherwise unsuitable materials from the construction area. Fill materials should be completely removed in the proposed building area. In parking areas, after stripping and prior to fill placement in fill areas, the surface should be compacted to the requirements specified herein. In cut areas, once the design subgrade has been achieved, the surface should be compacted as specified herein.

Fill materials placed in building areas and areas to be paved should consist of materials approved by the geotechnical engineer and be free of organic matter, frozen materials and debris.

Fill & compaction costs.

Structural fill should be placed in lifts of 9 inches or less in loose thickness. We recommend that all structural fill placed beneath footings and floor slabs be compacted to 100% of the materials maximum Standard Proctor dry density, ASTM D-698. The top 3 feet of material below pavement sections should also meet this compaction criteria. Below this 3 foot depth, fill in pavement areas should be compacted to a minimum of 95% of the materials Standard Proctor maximum dry density. Compaction of the fill should be performed in accordance with STS Earthwork Guidelines in the Appendix.

Upon completion of fill, care should be taken to minimize disturbance of subgrade and maintain proper subgrade moisture contents. Should the subgrade soils become desiccated or saturated, the affected soils should be reworked prior to footing or floor slab placement.

Procedures to reduce subgrade deterioration and for subgrade improvement when locally unsuitable soils are encountered are discussed in sheets entitled STS Subgrade Stabilization Guideline and STS Subgrade Protection Guideline in the Appendix.

4.3 Foundation Recommendations

Based on the results of the borings, it appears the building may be supported on conventional, relatively shallow spread footings bearing on limestone bedrock materials. Perimeter footings bearing on bedrock should be based at a depth of at least 2.5 feet below outside finished grade to provide adequate embedment and for frost protection, and should be at least 2 feet wide. Individual interior column footings should be based at least 20 inches below the top of the floor slab, and should be at least 3.5 feet wide.

Interior footings should bear on structural fill, bedrock materials, or on structural fill extending to bedrock. Design of foundations will likely be controlled by the minimum width of footings. Footings bearing on properly placed structural fill extending to bedrock or on bedrock materials could be proportioned using a net allowable bearing pressure of 3,000 psf. If all foundations extend to and bear on the bedrock materials, an allowable bearing pressure up to 10,000 psf could be used.

The recommended soil bearing pressure provides a theoretical factor of safety against shear or bearing capacity failure in excess of 3. Total and differential settlements corresponding to this loading should be less than 1 inch and 1/2 inch, respectively, provided the bearing soils are not frozen or disturbed at the time of footing installation.

Footing excavations should be protected from excessive wetting or drying. If water enters an excavation, it should be removed along with any disturbed or softened soil.

4.4 Ground Supported Floor Slab

Based on the recommendations presented herein, floor slabs will be supported on new structural fill. If portions of the new floor slabs are to have a non-breathable covering, such as vinyl tile or linoleum, or if there is to be a room with wood flooring, we recommend that a vapor barrier should be installed below those portions of the slab. If a vapor barrier is used, it should be installed in accordance with the recommendations given in the ACI Manual of Concrete Practice, Part 2, Section 302.2.4.1.

4.5 Exterior Pavement Areas

The recommendations in this section assume the existing fill will remain in place for support of pavements. Site preparation of pavement areas should consist of stripping topsoil or soil containing excessive vegetation and roots. The subgrade should then be thoroughly rolled and surface compacted to at least 100% of the maximum Standard Proctor dry density, ASTM D-698. Prior to paving and placement of the gravel sub-base, the subgrade should be proof rolled in the presence of the geotechnical engineer to evaluate the subgrade stability. Proof rolling should be performed with a loaded tandem-axle dump truck. Proof rolling will help aid in identifying soft or loose zones that may be present in the fill soils. Fill required to reach design subgrade elevation should be similarly compacted.

For a 15-year design life, in moderate traffic of trucks and smaller vehicles, our recommended pavement thickness design.

	Thickness - inches	
Material	**Light Duty**	**Heavy Duty**
Hot-mix bituminous wearing course	1.5	2.0
Hot-mix bituminous binder course	1.5	2.0
Aggregate base course, MnDOT Class 5 100% crushed rock or recycled concrete	6	8

4.6 Utility Installations

Excavations for site utilities (water, storm and sanitary) will encounter bedrock materials. As previously stated, excavation of the bedrock will be difficult and will likely require pneumatic breakers or similar equipment.

As an option to bedrock excavation, the use of insulation could be considered. The utility to be insulated could be installed in a shallow trench just below the bedrock surface and backfilled to just above the top of the pipe. At this point, 10 inches of high density insulation could be installed and then backfilled to desired subgrades. The insulation should extend horizontally a minimum of 4 feet beyond the outside edge of the pipe. Depending upon the amount of fill cover above the insulation, the use of alternative construction equipment may be required to minimize damage to the insulation.

4.7 Construction Considerations

Good surface drainage should be maintained throughout the work, so that the site is not vulnerable to ponding after or during a rainfall. The excavation for footings and utilities, should not encounter groundwater intrusion. However if water does enter excavations, it should be promptly removed prior to further construction activities. Under no circumstances should fill or concrete be placed into standing water. Trenches for underground utility lines serving the building addition are also expected to be dry.

4.8 Winter Construction

Only unfrozen fill should be used. Placement of fill and/or foundation concrete must not be permitted on frozen soil, and the bearing soils under footings or under the floor slab should not be allowed to freeze after concrete is placed. Excessive post-construction settlement could occur as the frozen soils thaw.

4.9 Construction Safety

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P "Excavations and Trenches". This document states that excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the job specifications.

The responsibility to provide safe working conditions on this site, for earthwork, building construction, or any associated operations is solely that of the contractor. This responsibility is not borne in any manner by STS Consultants, Ltd.

4.10 Field Observation and Testing

We recommend that the earthwork and footing installations for this project be observed and tested by a geotechnical engineer or qualified engineering technician to determine if the soil and groundwater conditions encountered are consistent with those anticipated based on our exploration. Foundation subgrades should be tested to check for adequate bearing conditions. Subgrades for slabs, pavement and new structural fill should be test rolled and unsuitable areas improved. Fill placement and compaction should be monitored and tested to determine that the resulting fill conforms to specified density, strength or compressibility requirements. Structural materials should also be tested for conformance to specifications. STS would be pleased to provide the necessary field observation, monitoring and testing services during construction.

4.11 General Qualifications

This report has been prepared in accordance with generally accepted geotechnical engineering practices to aid in the evaluation of this site and to assist the owner and the architect and/or engineer in the design of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to the geotechnical characteristics. In the event that any changes in the design or location of the facilities described in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified as necessary in writing by the geotechnical engineer. As a check, we recommend that we be authorized to review the project plans and specifications to confirm that the recommendations contained in this report have been interpreted in accordance with our intent. Without this review, we will not be responsible for the misinterpretation of our data, our analysis, and/or our recommendations, or how these are incorporated into the final design.

The analysis and recommendations submitted in this report are based on the data obtained from the soil borings performed at the locations indicated on the location diagram and from the information discussed in this report. This report does not reflect any variations which may occur between the borings. In the performance of subsurface explorations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations and that seasonal and annual fluctuations in groundwater levels will likely occur. The nature and extent of variations may not become evident until the course of construction. If variations then appear evident, it will be necessary for a re-evaluation of the recommendations contained in this report after performing on-site observations during the construction period and noting the characteristics of the variations.

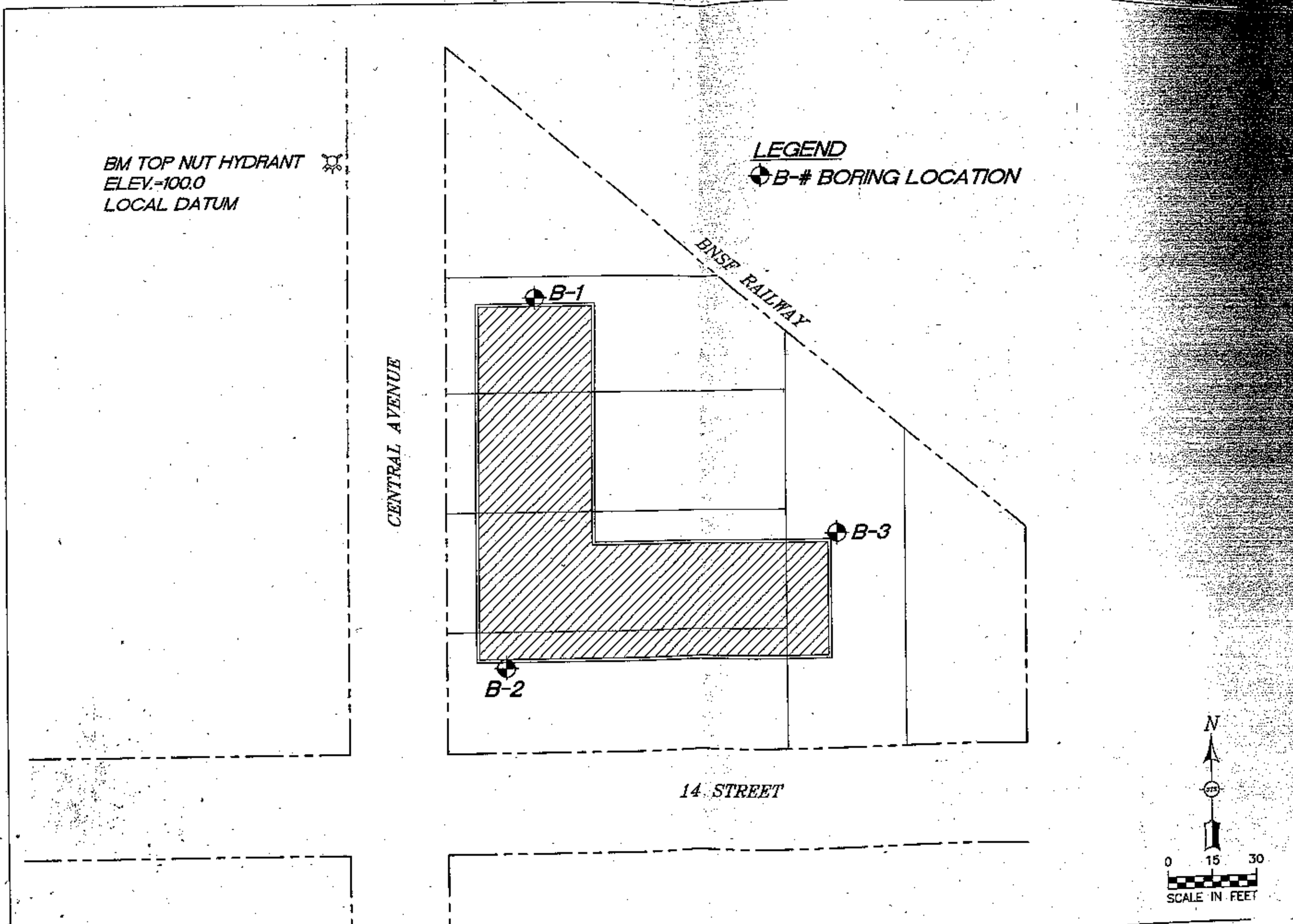
The geotechnical engineer of record is the professional engineer who authored the geotechnical report. It is recommended that all construction operations dealing with earthwork and foundations be observed by the geotechnical engineer of record or the geotechnical engineer's appointed representative to confirm that the design requirements are fulfilled in the actual construction. For some projects, this may be required by the governing building code.

5.0 STANDARD OF CARE

The recommendations and opinions contained in this report are based on our professional judgment. The soil testing and geotechnical engineering services performed for this project have been conducted in a manner consistent with that level of skill and care ordinarily exercised by other members of the profession currently practicing in this area under similar budgetary and time constraints. No other warranty, express or implied, is made.

APPENDIX

1. Boring Location Diagram
2. Boring Logs
3. STS General Notes
4. STS Soil Classification System
5. STS Field and Laboratory Procedures
   - Subsurface Exploration Field Procedures
   - Field Sampling Procedures
   - Laboratory Procedures
6. STS Standard Boring Log Procedures
7. STS Subgrade Protection Guideline
8. STS Subgrade Stabilization Guideline
9. STS Earthwork Guideline



SOIL LOCATION DIAGRAM
PROPOSED OFFICE BUILDING
1401 CENTRAL AVENUE NE
MINNEAPOLIS, MINNESOTA
FOR MODA

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO.	99358
STS PROJECT FILE	G99358-01.DWG
SCALE	AS SHOWN
FIGURE NO.	1

STS Consultants Ltd.

OWNER	LOG OF BORING NUMBER
Minneapolis Community Development Agency	1
PROJECT NAME	ARCHITECT-ENGINEER
Commercial Development	

SITE LOCATION
Central Ave. & 14th St., Minneapolis, MN

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	STANDARD PENETRATION BLOWS/FT.
						SURFACE ELEVATION +100.0 Project Datum		
						Possible FILL: Fine sand, trace gravel - brown - moist - (SP)		
		1	SS					17
2.5			PA					
		2	SS			3.1		72/7"
						Weathered limestone bedrock		
5.0		3	AS					
7.5								
8.1						8.1		

Auger refusal at 8.1 ft.
Note: PID reading of 0 on all samples.

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 12/5/03	STS OFFICE	Minneapolis Area - 06
WL	BORING COMPLETED 12/5/03	ENTERED BY DN	SHEET NO. 1 OF 1
WL	RIG/FOREMAN Diedrich D-50/TM	APP'D BY BCM	STS JOB NO. 99358

BORING_LOG 699358.GPJ STS.GDT 12/10/03

STS Consultants Ltd.

OWNER: **Minneapolis Community Development Agency**

LOG OF BORING NUMBER: **2**

PROJECT NAME: **Commercial Development**

ARCHITECT-ENGINEER:

SITE LOCATION: **Central Ave. & 14th St., Minneapolis, MN**

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5)

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50)

STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50)

SURFACE ELEVATION +99.0 Project Datum

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³	STANDARD PENETRATION BLOWS/FT.
						FILL: Clayey sand, little organics, trace gravel and debris - dark brown - (SC/OL)		
		1	SS			Organic content 5.1% - sample 1		22
			PA					
2.5		2	SS			2.8 Organic content 5.3% - sample 2		50/3"
			PA			Weathered limestone bedrock		
		3	SS					69
5.0		4	SS					60/4"
		5	AS					
6.5						6.5		
						Auger refusal at 6.5 ft. Note: PID reading of 0 on all samples.		

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 12/5/03	STS OFFICE	Minneapolis Area - 06
WL	BORING COMPLETED 12/5/03	ENTERED BY DN	SHEET NO. 1 OF 1
WL	RIG/FOREMAN Diedrich D-50/TM	APP'D BY BCM	STS JOB NO. 99358

BORING_LOG 699358.GPJ STS.GDT 12/17/03

STS Consultants Ltd.

OWNER	LOG OF BORING NUMBER
Minneapolis Community Development Agency	3
PROJECT NAME	ARCHITECT-ENGINEER
Commercial Development	

SITE LOCATION
Central Ave. & 14th St., Minneapolis, MN

SURFACE ELEVATION +100.5 Project Datum

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	STANDARD PENETRATION BLOWS/FT.
	1	SS	FILL: Clayey sand, little organics, trace gravel and debris - dark brown - (SC/OL)	18
			Organic content 4.1% - sample 1	
2.5		PA		
	2	SS		20
3.4			Concrete slab (drillers note)	
3.8		PA	Weathered limestone bedrock	
5.0				
7.5	3	AS		
9.5				

Auger refusal at 9.5 ft.
Note: PID reading of 0 on all samples.

Column headings: ELEVATION (FT); SAMPLE DISTANCE; RECOVERY; UNIT DRY WT. LBS./FT.³; UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50); STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50)

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

WL Dry	BORING STARTED 12/5/03	STS OFFICE	Minneapolis Area - 06
WL	BORING COMPLETED 12/5/03	ENTERED BY DN	SHEET NO. 1 OF 1
WL	RIG/FOREMAN Diedrich D-50/TM	APP'D BY BCM	STS JOB NO. 99358

BORING_LOG 699358.GPJ STS.GDT 12/17/03

STS General Notes

STS CONSULTANTS

DRILLING & SAMPLING SYMBOLS:

SS : Split Spoon - 1-3/8" I.D. 2" O.D.
Unless otherwise noted
ST : Shelby Tube-2" O.D.
Unless otherwise noted
PA : Power Auger
DB : Diamond Bit-NX, BX, AX
AS : Auger Sample
JS : Jar Sample
VS : Vane Shear
OS : Osterberg Sampler
HS : Hollow Stem Auger
WS : Wash Sample
FT : Fish Tail
RB : Rock Bit
BS : Bulk Sample
PM : Pressuremeter Test
GS : Giddings Sampler

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler, except where otherwise noted.

WATER LEVEL MEASUREMENT SYMBOLS:

WL : Water Level
WS : While Sampling
WD : While Drilling
AB : After Boring
WCI : Wet Cave In
DCI : Dry Cave In
BCR : Before Casing Removal
ACR : After Casing Removal

Water levels indicated on the boring logs are the levels measured in the boring at the time indicated. In pervious soils, the indicated elevations are considered reliable groundwater levels. In impervious soils, the accurate determination of groundwater elevations may not be possible, even after several days of observations; additional evidence of groundwater elevations must be sought.

GRADATION DESCRIPTION AND TERMINOLOGY:

Coarse grained or granular soils have more than 50% of their dry weight retained on a #200 sieve; they are described as boulders, cobbles, gravel or sand. Fine grained soils have less than 50% of their dry weight retained on a #200 sieve; they are described as clay or clayey silt if they are cohesive and silt if they are non-cohesive. In addition to gradation, granular soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their strength or consistency and their plasticity.

Major Component of Sample	Size Range
Boulders	Over 8 in. (200 mm)
Cobbles	8 inches to 3 inches (200 mm to 75 mm)
Gravel	3 inches to #4 sieve (75 mm to 4.76 mm)
Sand	#4 to #200 sieve (4.76 mm to 0.074 mm)
Silt	Passing #200 sieve (0.074 mm to 0.005 mm)
Clay	Smaller than 0.005 mm

Description of Other Components Present in Sample	Percent Dry Weight
Trace	1-9
Little	10-19
Some	20-34
And	35-50

CONSISTENCY OF COHESIVE SOILS:

Unconfined Compressive Strength, Qu, tsf	Consistency
<0.25	Very Soft
0.25 - 0.49	Soft
0.50 - 0.99	Medium (firm)
1.00 - 1.99	Stiff
2.00 - 3.99	Very Stiff
4.00 - 8.00	Hard
>8.00	Very Hard

RELATIVE DENSITY OF GRANULAR SOILS:

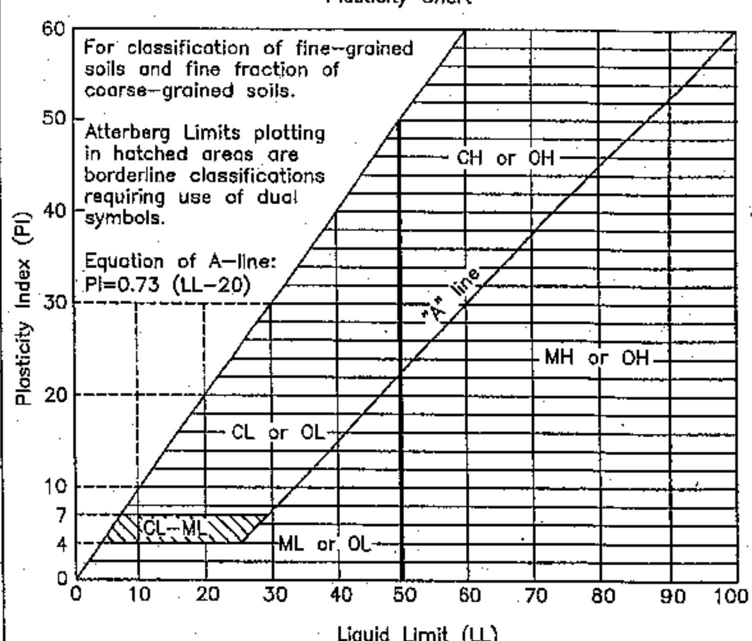
N-Blows per foot	Relative Density
0 - 3	Very Loose
4 - 9	Loose
10 - 29	Medium Dense
30 - 49	Dense
50 - 80	Very Dense
>80	Extremely Dense

STS Soil Classification System[1]

STS Consultants

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is ***larger*** than No. 200 sieve size)	Gravel (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW	Well-graded, gravel, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent . . . . . GW, GP, SW, SP; More than 12 percent . . . . . GM, GC, SM, SC; 5 to 12 percent . . . . . Borderline cases *requiring* dual symbols[3]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 & 3	
			GP	Poorly graded gravel, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravel, gravel-sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are ***borderline*** cases requiring use of dual symbols
			GC	Clayey gravel, gravel-sand-clay mixtures		Atterberg limits above "A" line or PI greater than 7	
	Sand (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sand (Little or no fines)	SW	Well-graded sand, gravelly sand, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 & 3	
			SP	Poorly graded sand, gravelly sand, little or no fines		Not meeting all gradation requirements for SW	
		Sand with fines (Appreciable amount of fines)	SM	Silty sand, sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are ***borderline*** cases requiring use of dual symbols
			SC	Clayey sand, sand-clay mixtures		Atterberg limits above "A" line or PI greater than 7	
Fine-grained soils (More than half of material is ***smaller*** than No. 200 sieve size)	Silt and clay (Liquid limit less than 50)		ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or clayey silt with slight plasticity	Plasticity Chart[2] (see below)		
			CL	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay, silty clay, lean clay			
			OL	Organic silt and organic silty clay of low plasticity			
	Silt and clay (Liquid limit greater than 50)		MH	Inorganic silt, micaceous or diatomaceous fine sandy or silty soils, elastic silt			
			CH	Inorganic clay of high plasticity, fat clay			
			OH	Organic clay of medium to high plasticity, organic silt			
	Highly organic soils		PT	Peat and other highly organic soil			

Plasticity Chart[2]



1) See STS General Notes for component gradation terminology, consistency of cohesive soils and relative density of granular soils.

2) Reference: Unified Soil Classification System

3) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

Y:\UEPL\ STS SOIL CLASSIFICATION SYSTEM.dwg

SUBSURFACE EXPLORATION FIELD PROCEDURES

Hand-Auger Drilling (HA)

In this procedure, a sampling device is driven into the soil by repeated blows of a sledge hammer or a drop hammer. When the sampler is driven to the desired sample depth, the soil sample is retrieved. The hole is then advanced by manually turning the hand auger until the next sampling depth increment is reached. The hand auger drilling between sampling intervals also helps to clean and enlarge the borehole in preparation for obtaining the next sample.

Power Auger Drilling (PA)

In this type of drilling procedure, continuous flight augers are used to advance the boreholes. They are turned and hydraulically advanced by a truck, trailer or track-mounted unit as site accessibility dictates. In auger drilling, casing and drilling mud are not required to maintain open boreholes.

Hollow Stem Auger Drilling (HS)

In this drilling procedure, continuous flight augers having open stems are used to advance the boreholes. The open stem allows the sampling tool to be used without removing the augers from the borehole. Hollow stem augers thus provide support to the sides of the borehole during the sampling operations.

Rotary Drilling (RB)

In employing rotary drilling methods, various cutting bits are used to advance the boreholes. In this process, surface casing and/or drilling fluids are used to maintain open boreholes.

Diamond Core Drilling (DB)

Diamond core drilling is used to sample cemented formations. In this procedure, a double tube (or triple tube) core barrel with a diamond bit cuts an annular space around a cylindrical prism of the material sampled. The sample is retrieved by a catcher just above the bit. Samples recovered by this procedure are placed in sturdy containers in sequential order.

FIELD SAMPLING PROCEDURES

Auger Sampling (AS)

In this procedure, soil samples are collected from cuttings off of the auger flights as they are removed from the ground. Such samples provide a general indication of subsurface conditions; however, they do not provide undisturbed samples, nor do they provide samples from discrete depths.

Split-Barrel Sampling (SS) - (ASTM Standard D-1586-99)

In the split-barrel sampling procedure, a 2-inch O.D. split barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches. The value of the Standard Penetration Resistance is obtained by counting the number of blows of the hammer over the final 12 inches of driving. This value provides a qualitative indication of the in-place relative density of cohesionless soils. The indication is qualitative only, however, since many factors can significantly affect the Standard Penetration Resistance Value, and direct correlation of results obtained by drill crews using different rigs, drilling procedures, and hammer-rod-spoon assemblies should not be made. A portion of the recovered sample is placed in a sample jar and returned to the laboratory for further analysis and testing.

Shelby Tube Sampling Procedure (ST) - ASTM Standard D-1587-94

In the Shelby tube sampling procedure, a thin-walled steel seamless tube with a sharp cutting edge is pushed hydraulically into the soil and a relatively undisturbed sample is obtained. This procedure is generally employed in cohesive soils. The tubes are identified, sealed and carefully handled in the field to avoid excessive disturbance and are returned to the laboratory for extrusion and further analysis and testing.

Giddings Sampler (GS)

This type of sampling device consists of 5-foot sections of thin-wall tubing which are capable of retrieving continuous columns of soil in 5-foot maximum increments. Because of a continuous slot in the sampling tubes, the sampler allows field determination of stratification boundaries and containerization of soil samples from any sampling depth within the 5-foot interval.

LABORATORY PROCEDURES

Water Content (Wc)

The water content of a soil is the ratio of the weight of water in a given soil mass to the weight of the dry soil. Water content is generally expressed as a percentage.

Hand Penetrometer (Qp)

In the hand penetrometer test, the unconfined compressive strength of a soil is determined, to a maximum value of 4.5 tons per square foot (tsf) or 7.0 tsf depending on the testing device utilized, by measuring the resistance of the soil sample to penetration by a small, spring-calibrated cylinder. The hand penetrometer test has been carefully correlated with unconfined compressive strength tests, and thereby provides a useful and a relatively simple testing procedure in which soil strength can be quickly and easily estimated.

Unconfined Compression Tests (Qu)

In the unconfined compression strength test, an undisturbed prism of soil is loaded axially until failure or until 20% strain has been reached, whichever occurs first.

Dry Density (Yd)

The dry density is a measure of the amount of solids in a unit volume of soil. Use of this value is often made when measuring the degree of compaction of a soil.

Classification of Samples

In conjunction with the sample testing program, all soil samples are examined in our laboratory and visually classified on the basis of their texture and plasticity in accordance with the STS Soil Classification System which is described on a separate sheet. The soil descriptions on the boring logs are derived from this system as well as the component gradation terminology, consistency of cohesive soils and relative density of granular soils as described on a separate sheet entitled "STS General Notes". The estimated group symbols included in parentheses following the soil descriptions on the boring logs are in general conformance with the Unified Soil Classification System (USCS) which serves as the basis of the STS Soil Classification System.

STS STANDARD BORING LOG PROCEDURES

In the process of obtaining and testing samples and preparing this report, standard procedures are followed regarding field logs, laboratory data sheets and samples.

Field logs are prepared during performance of the drilling and sampling operations and are intended to essentially portray field occurrences, sampling locations and procedures.

Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory by experienced geotechnical engineers, and as such, differences between the field logs and the final logs may exist. The engineer preparing the report reviews the field logs, laboratory test data and classifications, and using judgment and experience in interpreting this data, may make further changes. It is common practice in the geotechnical engineering profession not to include field logs and laboratory data sheets in engineering reports, because they do not represent the engineer's final opinions as to appropriate descriptions for conditions encountered in the exploration and testing work. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for sixty days and are then discarded unless special disposition is requested by our client. Samples retained over a long period of time, even in sealed jars, are subject to moisture loss which changes the apparent strength of cohesive soil, generally increasing the strength from what was originally encountered in the field. Since they are then no longer representative of the moisture conditions initially encountered, observers of these samples should recognize this factor.

Care should be exercised to minimize disturbance and degradation of subgrade soils for foundations, slabs-on-grade, pavements and areas to be filled. Water should not be allowed to pond on the surface of exposed subgrade soils, as this could cause a softening of the subgrade, particularly when subjected to construction traffic. Disturbed or softened subgrade soils should be removed to a suitable undisturbed subgrade prior to fill or concrete placement.

Wet subgrade conditions may result from precipitation, runoff and groundwater seepage through excavation walls and bottom. Precipitation risk can be minimized by scheduling construction for drier seasons. The subgrade should be sloped to drainage ditches and sumps to minimize water accumulations. Runoff from adjacent areas should be eliminated by use of berms and ditches to channel water away. Groundwater seepage may be minimized by use of dewatering systems such as wells and/or groundwater isolation systems such as cutoff walls or trenches. Dewatering wells and/or groundwater isolation systems are recommended where upward seepage is likely to cause the subgrade to loosen and become "quick" or where lateral seepage may erode the face soil or cause "piping" of fines from the soil matrix as exhibited by muddy or silt laden water.

If moisture or disturbance sensitive subgrade soils and wet conditions are expected and construction of facilities bearing on the subgrade will not promptly protect the subgrade soils, then consideration should be given to protecting the subgrade by promptly placing appropriate combinations of a geotextile, a gravel base course and a lean concrete mud mat over the prepared and approved subgrade. Geotextiles should be considered for use to separate the subgrade and gravel where subgrade soils are at risk of migrating into the gravel base course. A suitably designed gravel base course should help surcharge the subgrade and act as a drainage layer for removing water accumulations. A lean concrete or flowable fill mud mat with a thickness of several inches or more may be placed directly on the subgrade if upward seepage does not exist. If base drainage is needed, a lean concrete or flowable fill mud mat may be placed over a gravel base course. A mud mat will help to isolate water, provide surcharge against loosening and will provide a stable surface which is resistant to disturbance from construction traffic. Sump and pump systems or dewatering wells should be used to remove any accumulating water or water pressure in the gravel base course.

In any areas where unsuitable conditions develop despite protection measures, subgrade stabilization should be performed as described in a separate sheet entitled "STS Subgrade Stabilization Guideline".

Subgrade stabilization may be required if zones of unsuitable soil are encountered upon excavating to the subgrade level or if subgrade degradation occurs from construction traffic, moisture accumulations, freeze-thaw cycles or other causes. Care should always be used to minimize disturbance and degradation of subgrade soils below foundations, slabs-on-grade, pavements and fill areas. Water should not be allowed to pond on the surface of exposed subgrade soils, as this could cause a softening of the subgrade, particularly when subjected to construction traffic. Detrimental groundwater seepage should not be allowed to soften or loosen the subgrade.

Unsuitable subgrade soils that are encountered or subgrade soils that become disturbed or softened after exposure should be improved prior to concrete or new material placement. The unsuitable soils should either be properly compacted in place (if feasible based on material type, moisture content and thickness), or over-excavations should extend through the unsuitable soils to remove them to an underlying competent soil stratum.

If improvement by over-excavating is performed, footing walls can be extended deeper and supported at the level where suitable soil is encountered. Alternatively, the over-excavations can be backfilled to the design level using either a suitable compacted structural fill material or a flowable cementitious fill.

If the over-excavations are backfilled using structural soil fill, the over-excavations should extend a minimum of 1 foot horizontally from each edge of the footing for each foot of fill required below the footing base. The structural soil fill should be placed, compacted and tested in accordance with a separate document entitled STS Earthwork Guideline. Generally, a well-graded granular material is more suitable for stabilization work than cohesive soils. If an open-graded granular material is planned as the backfill and the new subgrade or surrounding soils contain zones of cohesionless fine sands or silts which may migrate into the open-graded backfill, then an appropriately designed geotextile should be utilized to separate the stabilization material from the subgrade and surrounding trench soils. Failure to provide such separation may cause lost ground from surrounding soils and detrimental settlements.

Horizontal over-excavation is unnecessary if footing walls are extended to the lower suitable subgrade level or if flowable fill is used to backfill the over-excavated area. Flowable fill should have a sufficient Portland cement and/or fly ash content to achieve 28 day unconfined compressive strengths in the range of 50 to 200 pounds per square inch (psi).

Fill or backfill required on the project should consist of a non-frozen, non-organic granular material, aggregate or natural soil that is free of debris and particles larger than 25 percent of the loose lift thickness. The natural water content of cohesive fill soil at the time of compaction should generally be within -2 to +3 percent of the optimum water content as determined by the Standard Proctor test (ASTM D-698). Difficulty in obtaining the desired degree of compaction is expected for soil that is too dry or too wet. The water content should be adjusted by sprinkling if too dry or by scarifying and aerating if too wet. Blending with an additive such as fly ash or drier soil may also help produce an acceptable water content.

Fill or backfill which is relatively uniform should be used on the project. Non-uniform materials or mixing two or more materials will reduce the degree of certainty in the test results and will tend to cause variable compressibility of the fill.

Fill or backfill should be placed on a firm, checked subgrade in horizontal lifts with a loose thickness not greater than 12 inches for granular material and 9 inches for cohesive soil. It should then be compacted with equipment that is suited to the soil type and compaction requirements. Normally, vibratory roller or plate compactors are better suited for granular soils, while a sheepsfoot or other "kneading" type of compactors are more effective in cohesive soils. Lighter, hand-propelled compactors should generally be utilized to compact backfill within 5 feet of structures unless the structure is designed to resist expected lateral pressures from use of heavier compactors. When using lighter, hand-propelled compactors, a maximum loose lift thickness of 8 inches should be used for granular material and 6 inches for cohesive soil.

Unless stated otherwise in the report text, fill or backfill that supports foundations, floor slabs that are loaded in excess of 400 psf, and roadway pavement that is subjected to concentrated automobile or truck traffic should be compacted to a dry density of 95% or more of the maximum dry density determined by Standard Proctor tests (ASTM D-698) on representative samples of the fill material. Fill or backfill that supports lightly loaded floor slabs, sidewalks or pavement that is subjected to dispersed automobile traffic should be compacted to a dry density of 90% or more of the maximum dry density determined by Standard Proctor tests on representative samples of the fill material. Compaction tests may be considered satisfactory if the average of five consecutive tests on similarly compacted material exceeds the required compaction and no individual test is more than 2% below the required percentage of compaction.

Proper compaction is generally difficult to achieve near the edge of a slope or embankment fill due to lack of confinement. For this reason, we recommend that the compacted fill or backfill zone extend horizontally beyond the edge of foundations a minimum of 1 foot at the subgrade level and then with depth at a minimum slope of 1 horizontal to 1 vertical.

Fill material acceptability, subgrade preparation and testing for suitability, fill placement and fill compaction should be monitored continuously or at least regularly by a qualified soils technician whom reports to the geotechnical engineer for the project. Compaction density for structural fill should be tested at a minimum frequency of once per 5000 ft^2 of fill area or once per 200 yd^3 of compacted material placed unless stated otherwise in our report. In non-structural fill areas, testing frequencies may be reduced in half.