REPORT

Interparking Corporation
c/o Carl Walker, Inc.

2198 Gladstone Court, Suite D
Glendale Heights, IL 60139

400 N. La Salle St.

Subsurface Exploration and Geotechnical Engineering Evaluation

Interparking Corporation
c/o Carl Walker, Inc.

Proposed LaSalle/Hubbard
Site Development
Chicago, IL

30852

February 4, 2001
Updated January 25, 2001

STS Consultants, Ltd.
Solutions through Science & Engineering

February 4, 2000
Updated January 25, 2001

Mr. Larry Standlee
Interparking Corporation
c/o Mr. Thomas J. Delaney, P.E., S.E.
Carl Walker, Inc.
2198 Gladstone Court Suite D
Glendale Heights, IL 60139

RE: Subsurface Exploration and Geotechnical Engineering Evaluation for the Proposed LaSalle/Hubbard Site Development in Chicago, Illinois - STS Project No. 30852

Dear Mr. Delaney:

We have finalized subsurface exploration and geotechnical engineering evaluation for the proposed LaSalle/Hubbard development in Chicago, Illinois. This work is based on our proposal to you dated November 8, 1999. This report presents the results of our field and laboratory testing programs and provides recommendations concerning soil and groundwater characteristics as they relate to the proposed construction. Three vane shear test holes were performed in January, 2001 and our original report has been updated with these test results as well as the addition of basement construction and earth retention recommendations.

If there are any questions regarding the information contained in this report or if we may be of further service to you, please do not hesitate to contact us.

Respectfully,

STS CONSULTANTS, LTD.

Andrew J. Ptak

Andrew J. Ptak, P.E.
Project Engineer

ANDREW J. PTAK
062-052031

Clyde N Baker

Clyde N. Baker, P.E., S.E.
Senior Principal Engineer

Attachments

cc: Mr. P. Danos; Chris P. Stefanos Assoc., Inc.; 4532 W. 103rd Street; Oak Lawn, IL 60453
Mr. T. Humes; Solomon Cordwell Buenz and Assoc. Inc.; 625 N. Michigan Av.; Chicago, IL 60611
Mr. T. Black; The Habitat Company; 350 W. Hubbard Street; Chicago, IL 60610

750 Corporate Woods Parkway • Vernon Hills, IL 60061-3153 • (847) 279-2500 • (847) 279-2510 Fax

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SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION
PROPOSED LASALLE & HUBBARD SITE DEVELOPMENT
CHICAGO, ILLINOIS

1.0 PROJECT OVERVIEW

1.1 Project Description

We understand that the existing parking lot located on the southwest corner of LaSalle Street and Hubbard Street in Chicago, Illinois is being considered for development. The proposed development will consist of 50-story residential structure with no basement and a nine to ten story parking garage having a ground level at-grade. Column loads ranging from 1,200 to 2,400 kips are anticipated for the parking garage and 2,200 to 4,000 for the high-rise.

1.2 Scope of Work

The scope of work for this project consisted of performing eleven (11) soil borings over the site. These borings were performed to depths of 100 to 126 below the existing grade. Insitu pressuremeter testing was also performed at three (3) soil boring locations. Laboratory tests were conducted to determine engineering characteristics of the soils encountered at the boring locations, and the geotechnical evaluation of the site was performed based on the data gathered. This report describes the results of our current field exploration and laboratory testing program and contains geotechnical recommendations related to the design and construction of the foundations for the proposed construction.

2.0 EXPLORATION PROCEDURES

2.1 Subsurface Exploration

Eleven (11) soil borings, ranging in depth from 100 to 126 feet below the existing grade, were performed. The soil boring locations were provided by the design team and located in the field by STS and are indicated on the attached boring location diagram. Boring B-3 was located by STS approximately 5 feet outside the proposed building footprint. We consider the location adequate to encompass the soils in this north east area of the proposed high rise. The ground surface elevations at the boring locations were referenced from the top of curb at the southwest corner of LaSalle and Hubbard (reference elevation +13.6 feet City of Chicago Datum (CCD)). The locations of the borings are displayed on Figure 2.

The drilling program was performed on site between January 6th to January 25th. The soil borings were performed by augering methods through the existing fill and then continued with rotary methods. Representative soil samples were obtained in the borings using split-spoon and Shelby tube sampling procedures performed in general conformance with ASTM Standards D-1586 and D-1587. In addition, pressuremeter testing was conducted at three (3) of the boring locations. A summary of this data can be found in the Attachments along copies of the applicable ASTM Standards.

A field log, recording observed soil conditions, groundwater conditions, and drilling procedures was maintained by the drill crew. All soil samples obtained from the drilling operations were sealed immediately in the field and taken to our laboratory for further examination and testing. Observations of water levels encountered in the boring both during and upon completion of the drilling and sampling operations are noted on the representative soil boring logs. The boreholes were backfilled with tremied cement grout after completion of the drilling operations.

2.2 Laboratory Testing Procedures

The laboratory testing program for this project consisted of visual classification and water content testing of all samples and hand penetrometer testing on cohesive samples. In the hand penetrometer test, the unconfined compressive strength of the soil, to a maximum value of 7.0 tons per square foot (tsf) is estimated by measuring the resistance of the soil sample to penetration of a small, spring calibrated cylinder. The results of the laboratory tests are noted on the soil boring logs in the Attachments.

In conjunction with the laboratory testing, the soil samples were examined and visually classified by a geotechnical engineer on the basis of texture and plasticity in accordance with the Unified Soil Classification System. Soil descriptions on the boring logs are in general conformance with this system, and the estimated group symbols according to the system are included in parentheses following the soil descriptions on the boring logs. A brief explanation of the Unified Soil Classification System is included in the Attachments.

The procedures used in preparing the final boring logs from field logs and laboratory test data are described on the sheets entitled "STS Field and Laboratory Procedures", which are included in the Attachments. All soil samples recovered in the borings will be retained at our Vernon Hill, Illinois laboratory for a period of 60 days, after which they will be discarded unless other specific instructions as to their disposition are received.

2.3 Special Testing

In addition to the routine sampling and testing, Menard Pressuremeter tests was performed at Borings B-1, B-5 and B-10.

Pressuremeter results in this hard, very silty clay to clayey silt stratum indicated that the limit pressures, P_l, ranged from 27.5 to 35.9 tons per square foot (tsf) and the elastic modulus, Ed, ranged from 194 to 1161 tsf. The creep pressures, P_f, ranged from 14.0 to 37.0 tsf. A summary of the pressuremeter tests is presented in the Appendix.

In addition, three (3) vane shear test borings (VS#1, VS#2, and VS#3) were performed in January of 2001 from depths ranging from 24 to 49 feet below existing grade. Peak undrained shear strengths ranged from 500 to 1,675 pounds per square foot (psf). A summary of the vane shear testing results is presented in the Appendix.

3.0 EXPLORATION RESULTS

3.1 Site Conditions

The site is located on the southwest corner of the intersection of LaSalle and Hubbard Streets in Chicago, Illinois. The site is currently an at-grade asphalt parking lot.

3.2 Soil Conditions

Based on results of the eleven (11) soil borings completed for this project, the following subsurface profile is presented. A description of each general soil unit has been identified and is described below.

Miscellaneous Fill - Urban fill was encountered at the boring locations to depths ranging from 9.5 to 15 feet at the boring locations. The fill consists of urban fill consisted of sand, gravel, cinders, brick, concrete, and miscellaneous fill containing some organic material. The relative density of the fill was generally loose to medium dense. A strong petroleum odor was noted near the bottom of the fill at boring B-10.

Very Stiff to Stiff Clay - Below the urban fill to a depth of approximately 15 to 20 feet, brown and gray to brown silty clay (CL) with trace amounts of shale was encountered at the boring locations. The consistency of the silty clay was generally from very stiff to stiff.

Soft to Stiff Silty Clay -Below the very stiff clay to a depth of approximately 55 to 60 feet, gray silty clay (CL) with trace amounts of shale was encountered at the boring locations. The consistency of the silty clay was generally from soft to stiff. Peak, undrained shear strengths in this stratum, as measured by insitu vane shear testing, ranged from 500 to 1675 pounds per square foot. A summary of these vane shear results can be found in the Appendix.

Stiff to Very Stiff Silty Clay - Underlying the soft to stiff silty clay, to a depth of approximately 82 to 85 feet, gray silty clay (CL) with trace amounts of shale was encountered at the boring locations. The consistency of the silty clay was generally from stiff to very stiff. Note that a water bearing, granular layer was encountered at the bottom of this layer at borings B-5 , B-6 and B-7.

Hard Silty Clay to Clayey Silt with Occasional Waterbearing Sand and Silt Seams - Underlying the very stiff silty clay, to depths of approximately 102 feet, gray silty clay (CL) to clayey silt (CL-ML) with trace amounts of shale was encountered at all boring locations. The consistency of this stratum was very stiff to very hard. Experience in the downtown area and the measured water contents indicate the soil stratum typically considered "hardpan" in the downtown Chicago area. Occasional waterbearing sand and silt seams, cobbles and boulders are usually present in this stratum. Note that at borings B-3, B-10 and B-11, a water bearing silt (ML) stratum was encountered in this stratum at a depth of approximately 88 feet.

Pressuremeter results in this hard, very silty clay to clayey silt stratum indicated that the limit pressures, P_l, ranged from 27.5 to 35.9 tons per square foot (tsf) and the elastic modulus, Ed, ranged from 194 to 1161 tsf. The creep pressures, P_f, ranged from 14.0 to 37.0 tsf. A summary of the pressuremeter tests is presented in the Appendix.

Extremely Dense Silt with Occasional Waterbearing Sand Seams - Underlying the hardpan, to the top of bedrock at an approximate depth of approximately 124 feet, gray, water bearing silt (ML) to clayey silt (CL-ML) with trace amounts of shale was encountered at all boring locations. The consistency of this stratum was extremely dense.

The geologic profile described above generally represents the conditions encountered in the soil borings performed. Some variations in the descriptions should be expected. A geotechnical engineer grouped the various soil types in the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials shown on the boring logs and profiles are approximate; in-situ, the transition may be gradual. Results of the borings are in general agreement with previous explorations completed by STS Consultants, Ltd. in the immediate vicinity. However, variations from the above general conditions may occur.

3.3 Groundwater Conditions

Groundwater was encountered during our drilling exploration at a depth of approximately 12 to 14 feet during drilling. For foundation design purposes, that water table can be assumed to be at +3 feet (CCD). The nearby Chicago river level typically is at elevations between +0 to +3 feet (CCD).

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Caisson Foundations

For the proposed fifty story building and nine to ten story parking garage, we recommend that the proposed structures be supported on drilled caisson foundations based on the available soil and structural information. For caissons supported on the hard, very silty clay to clayey silt hardpan at approximately 83 feet below existing grade (approximate elevation -67 feet CCD), we recommend a maximum net allowable soil bearing pressure not to exceed 30,000 pounds per square foot (psf). The maximum net allowable soil bearing pressure is that pressure which may be transmitted to the foundation soil in excess of the final minimum surrounding overburden pressure. The bases of the foundations should be enlarged by belling to achieve the required bearing area. Belling should be feasible in the very stiff silty clay soils which overlie the recommended soil bearing layer.

We caution against excavating below a depth of 88 feet (approximate elevation -72 feet CCD) in the areas near Borings B-3, B-10 and B-11 because of potential water blow-in problems due to underlying occasional saturated silt and silty sand strata.

Also note that at Boring B-5, B-6 and B-7, a thin, saturated granular stratum was encountered immediately above the hardpan stratum. The contractor should be prepared with enough casing to penetrate and case through this saturated granular material (if necessary) and bell below the casing. Alternatively, the grout bell technique could be utilized to seal off this layer and permit excavation the next day partially through the grout bell and partially below.

Based on our borings, it appears that these saturated strata are not interconnected and are only expected in isolated caisson excavation instances during excavation.

Based on the estimated bearing pressures, the consistency of the soils encountered and the magnitude of the loads expected, we estimate a maximum settlement in the range of 0.9 to 1.1 inches for belled caisson foundations supported on the hard silty clay or clayey silt hardpan layer described above for a maximum estimated loading of 2,400 to 4,000 kips for the parking garage and high rise, respectively. Differential settlements would be dependent on the adjacent loads but is typically 1/2 to 2/3 of the total settlement. It should be noted that these settlement values are for soil compression only and that elastic compression of the caisson concrete should be added to these values.

To prevent the surface soils from sloughing into the caisson shaft and water inflow from the shallow water table, we recommend that a temporary steel casing be employed at the surface during construction. The top temporary casing should be extended to a minimum of 2 feet into the underlying clay to effect a seal against groundwater.

We recommend that caisson construction begin in the interior of the site to determine if caisson shaft squeeze may be a problem. Soft silty clay deposits having significant moisture contents (>25%) are present from 15 to 30 feet below grade; however, unconfined strengths at these depths indicate a moderate strength of the clay. Based on the results of our insitu vane shear testing, the potential for squeeze of these deposits into the caisson shaft during construction considered low and extended temporary steel casing is not considered necessary.

A minimum caisson shaft diameter of 2 1/2 feet is recommended. The caisson bell should have a base angle of at least 60 degrees (from horizontal) and the bell diameter should not exceed 3 times the shaft diameter. Caisson concrete may be placed by the free fall method into the clean and dry shaft excavations as long as concrete does not hit the sides of the shaft or the rebar cage during placement. Concrete slump should be in the range of 5 to 7 inches.

Because the caisson technician will likely not be lowered into the excavation to observe the base of the caisson excavation directly due to safety concerns, it will be necessary to oversize the bell area by 15% or 1 foot, whichever is smaller. Alternatively, if it proves more economical, a camera could be lowered into the bell after final cleanup to verify that the bell is suitably free of loose material and the oversize eliminated.

We strongly recommend that an experienced soil engineer be present during all phases of caisson construction to observe that the excavations have reached a suitable bearing stratum as recommended in the design.

The caisson design and construction procedures should be reviewed with the contractor selected for this work prior to the start of construction. If you wish, we would be pleased to review the plans and specifications for the foundation work once they are prepared so that we may have the opportunity to comment on the effects of the soil and groundwater conditions on the site.

4.2 Lateral Load Design

For lateral load analysis on the caissons, the following horizontal subgrade resistance profile may be utilized for design.

Lateral Modulus of Subgrade Reaction Profile (K_s)

Depth (ft)	K_s (tsf/ft)*
0 to -12	15
-12 to -15	40
-15 to -55	15
-60 to -82	60
-82 to -102	150

*Assuming a 4 foot diameter caisson shaft is used.

Assuming that the backfill behind the foundation walls and grade beams is comprised of a well-graded sand and gravel (IDOT CA-6 or equivalent), compacted in 9" maximum loose lifts to a minimum of 90 percent of the maximum dry density (modified) as per ASTM D-1557, a friction factor (tan δ) of 0.35 can be utilized along the exterior formed concrete/backfill interface. This assumes a friction angle of 35° and an at-rest earth pressure coefficient (K_o) of 0.5.

The long-term passive pressure coefficient (Kp) recommended for design is 2.0 behind grade beams and foundation walls against compacted granular backfill. Note that these passive pressures have a factor of safety of 1.5 to limit movements to less than 1/2 inch.

4.3 Excavation Support System

We anticipate that an excavation support system will be required to facilitate basement excavation along Hubbard and LaSalle Streets. Interlocking sheetpile walls are typically used downtown for earth retention for one to two level basement excavations. Interlocking sheet piles will minimize groundwater infiltration into the excavation. The excavation support system should be designed for lateral earth pressures, hydrostatic pressures, traffic loads, and surcharge loads within a 1:1 (H:V) zone from the base of the excavation. In order to minimize lateral movements of the system, we recommend that the system be adequately braced and streets be underpinned as needed. The retention system should be designed by an Illinois Registered Structural Engineer. For permanent wall design, we recommend an at-rest lateral earth pressure of 45 psf per foot of wall depth and 85 psf per foot of wall depth to be used for calculations above and below the water table, respectively.

To minimize groundwater infiltration into the excavation and to help prevent groundwater from entering the basement area, we recommend that the sheeting be socketed at least two feet into the underlying silty clay below. This should cut off the majority of any perched groundwater infiltration and therefore should provide relatively dry working conditions and a relatively dry basement. However, deeper embedment depths may be required based on the structural design.

For areas where open-cut excavation are used, we recommend that cut slopes be no steeper than 1.5 Horizontal to 1.0 Vertical above the water table.

4.4 Basement Construction

The basement floor slab subgrade will be situated on the natural, gray, soft to stiff, silty clay (CL) observed at depths of 11 to 14 feet below existing grade. The slab subgrade should be undercut by a minimum of 18 inches to permit placement of a 10 inch working mat of crushed concrete or CA-6 crushed stone compacted to a minimum of 90% of the maximum dry density obtained in accordance with ASTM D-1557 modified Proctor method. An 8 inch drainage layer of CA-7 grade stone should be placed over the working mat and drain lines placed on 50 foot centers connected to a sump pit and pump system to carry off any small seepage coming through the clay. We recommend that an STS geotechnical engineer or qualified representative observe the basement slab excavation of subgrade soils and compaction of structural fill.

For the drained case, there are two approaches to the basement wall design consisting of either waterproofing and designing for maximum exterior water table pressure, or external perimeter drainage and only damp-proofing of the wall.

A perimeter drainage system should be used which would consist of a perforated or porous wall drain tile installed outside the basement. The drain tile should be surrounded with a minimum of 6 inches of granular filter material which is compatible with the size of the openings in the drain lines and surrounding soils. The drain tile should outlet into a sump pit equipped with an automatic pump to remove collected water.

The zone adjacent to the basement walls should be backfilled with a minimum 2 feet wide zone of free draining granular material (less than 3% by weight passing the No. 200 sieve) to prevent the buildup of hydrostatic pressure behind the wall. Above this free-draining material, a 2 feet thick clay fill should be compacted at the surface to prevent surface water infiltration. The clay fill should be compacted to a minimum of 90% of the maximum dry density obtained in accordance with ASTM D-1557 modified Proctor method.

Assuming that a perimeter drainage system has been utilized, we recommend that basement walls be designed for a lateral earth pressure of 45 psf per foot depth of wall.

If the proposed perimeter basement walls will be constructed directly against the excavation support system so that an external perimeter drainage is not practical, the walls should be designed to resist the full lateral earth pressures, external water pressure traffic loads, and surcharge loads lying within a 1:1 (H:V) zone from the base of the foundation wall. Basement walls should be damp proofed above the maximum assumed water table and waterproofed below.

The proposed elevator pit slab that is well below the drainage system should be waterproofed and designed to resist the maximum hydrostatic uplift pressure up to the level of the slab drainage layer.

Slab reinforcement and joint spacing should be carefully considered to control random cracking due to slab shrinkage. Slabs should be isolated from the foundations to allow differential movements to take place between the slab and walls.

4.5 Slab-on-Grade and New Pavement Areas

For slab-on-grade and pavement areas of the site, after removal of any surficial vegetation and topsoil or pavement surface, we recommend that the subgrade be proof-rolled with a loaded semi-trailer or a heavy piece of construction equipment to delineate an soft, yielding areas. These soft, yielding areas (if any) should be removed and replaced with structural fill to the depth encountered or a maximum additional depth of 1.5 feet.

New fill for slab-on-grade should be an approved, inorganic material. This material should be free of organic matter, topsoil, high moisture content clay and debris. New fill should be placed in maximum 9-inch-thick loose lifts and compacted to a minimum of 90 percent of maximum dry density as determined by ASTM Specification D1557, Modified Proctor method. Where pavement areas are to be utilized by truck traffic or in slab-on-grade areas which will support loads in excess of 500 psf, heavy concentrated loads or masonry partition walls, the fill should be compacted to a minimum of 95% of the dry density referenced above. Periodic density testing should be performed on any fill in order to document that density requirements have been met.

Floor slabs should be isolated from foundations to permit relative displacement without cracking. Slabs should also be provided with adequate reinforcing and jointing to control minor slab cracking.

4.6 Excavation of Existing Foundations

We recommend that an attempt be made to obtain drawings of any existing structures previously onsite to determine conflicts that may occur between existing buried foundations and new proposed foundations and caisson excavations.

4.7 Construction Considerations

All excavation sides should be constructed such that they provide a safe, stable excavation. OSHA regulations regarding excavations should be followed. Care should be exercised when excavating adjacent to existing structures to prevent loss of support.

All soils which become softened or loosened at the base of subgrade areas should be carefully recompacted or removed prior to placement fill material. No structural fill should be placed in areas of ponded water or frozen soil.

It is recommended that all foundation subgrade soils be observed by an experienced geotechnical engineer or his field representative prior to placement of concrete n order to confirm that the soil conditions are consistent with the design assumptions and recommendations contained in this report. Periodic density testing should be performed on any fill in order to document that density requirements have been met.

4.8 General Qualifications

General Qualifications applicable to subsurface exploration, earthwork, construction, and the recommendations contained in this report are a part of this report and are attached.

APPENDIX

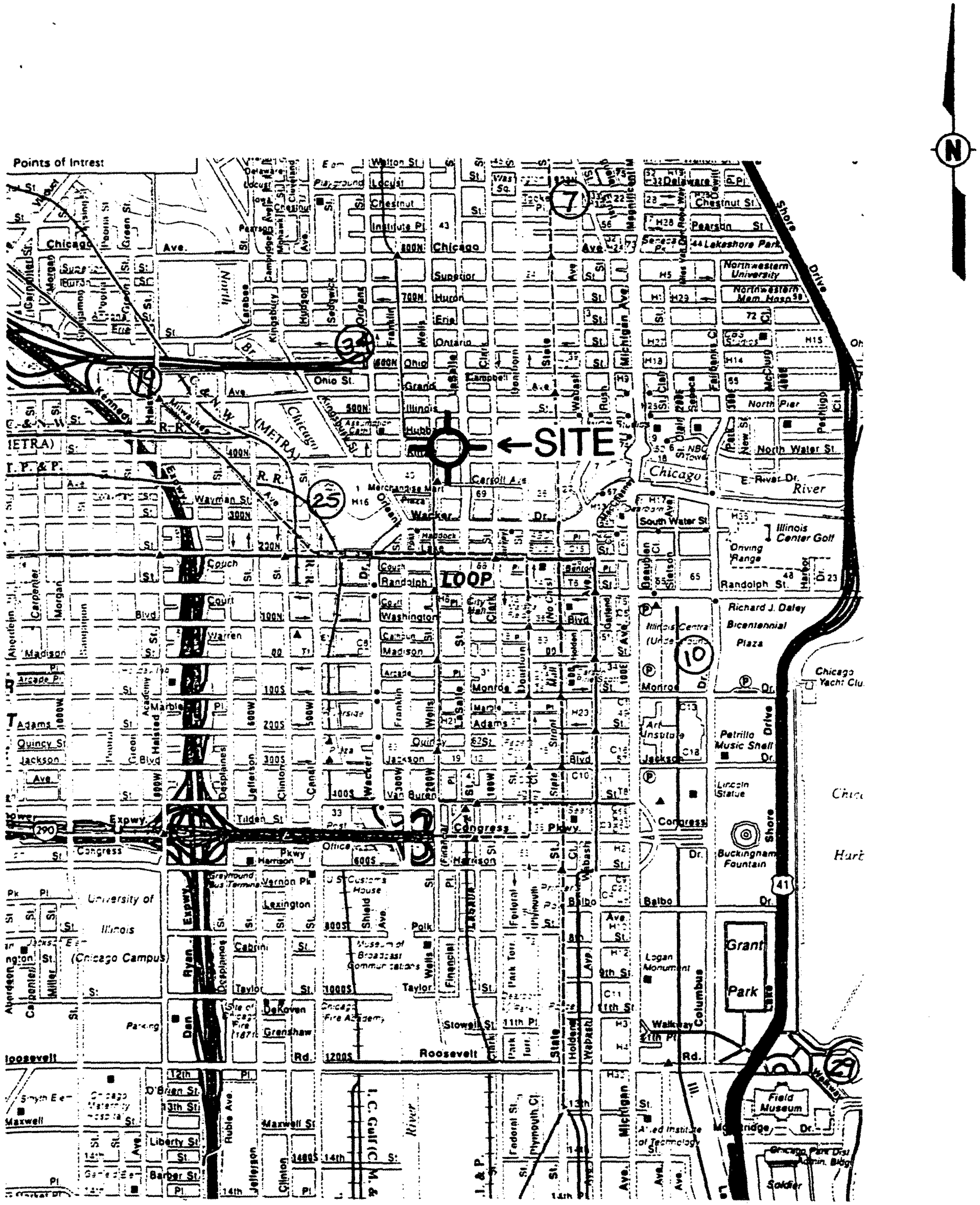
STS CONSULTANTS, LTD.

The following is a suggested standard clause for unanticipated subsurface conditions:

"The owner has had a subsurface exploration performed by a foundation consultant, the results of which are contained in the consultant's report. The consultant's report presents his conclusions on the subsurface conditions based on his interpretation of the data obtained in the exploration. The contractor acknowledges that he has reviewed the consultant's report and any addenda thereto, and that his bid for earthwork operations is based on the subsurface conditions, as described in that report. It is recognized that a subsurface exploration may not disclose all conditions as they actually exist and further, conditions may change, particularly groundwater conditions, between the time of subsurface exploration and the time of earthwork operations. In recognition of these facts, this clause is entered in the contract to provide a means of equitable additional compensation for the contractor if adverse unanticipated conditions are encountered and to provide a means of rebate to the owner if the conditions are more favorable than anticipated.

At any time during earthwork, paving and foundation construction operations that the contractor encounters conditions that are different than those anticipated by the foundation consultant's report, he shall immediately (within 24 hours) bring this fact to the owner's attention. If the owner's representative on the construction site observes subsurface conditions which are different than those anticipated by the foundation consultant's report, he shall immediately (within 24 hours) bring this fact to the contractor's attention. Once a fact of unanticipated conditions has been brought to the attention of either the owner or the contractor, and the consultant has concurred, immediate negotiations will be undertaken between the owner and the contractor to arrive at a change in contract price for additional work or reduction in work because of the unanticipated conditions. The contractor agrees that the following unit prices would apply for additional or reduced work under the contract. For changed conditions for which unit prices are not provided, the additional work shall be paid for on a time and material basis."

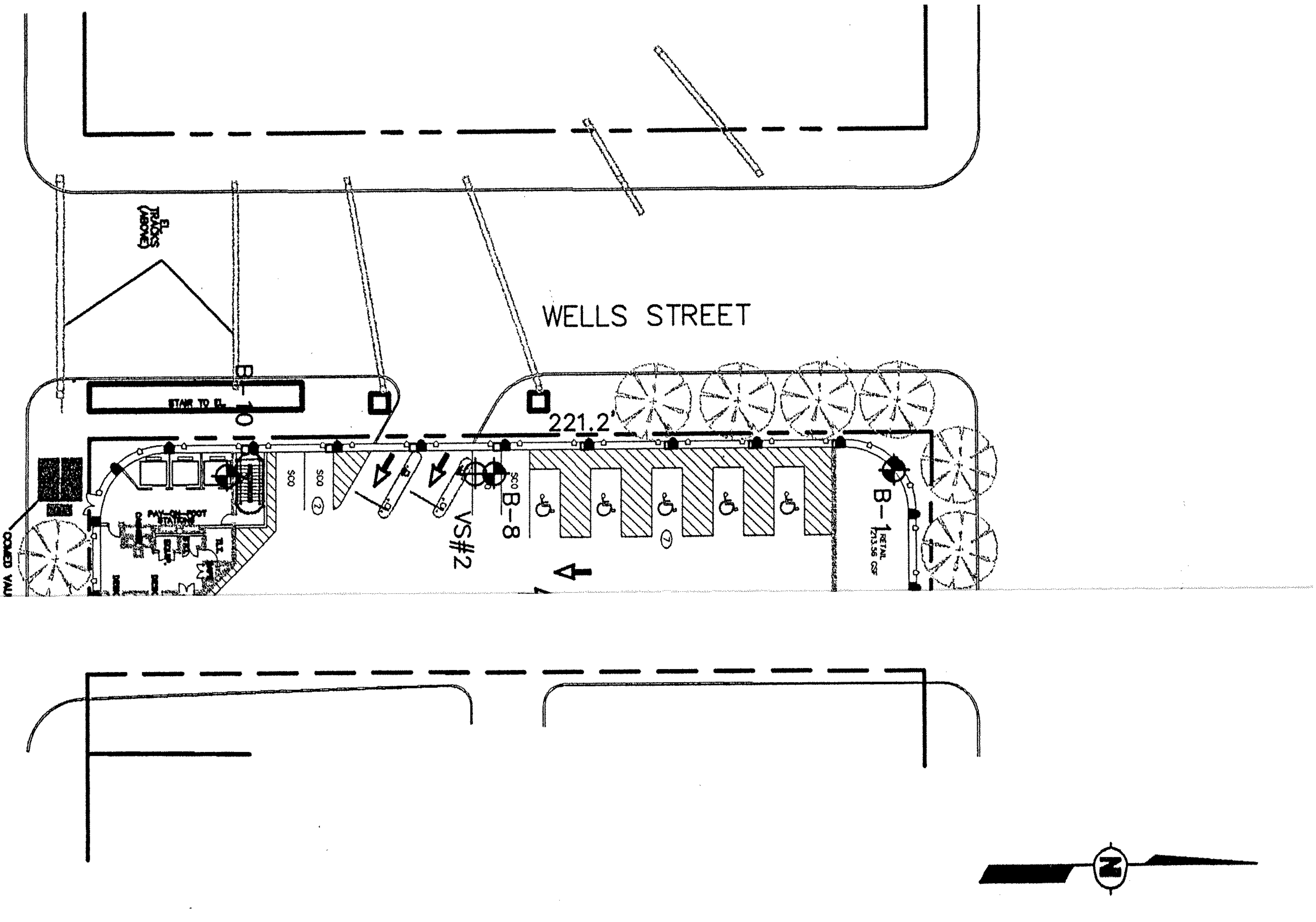
Another example of a changed conditions clause can be found in paper No. 4035 by Robert F. Borg, published in ASCE Construction Division Journal, No. CO2, September 1964, page 37.



STS Consultants Ltd.
Consulting Engineers

SITE LOCATION MAP
LaSALLE/HUBBARD DEVELOPMENT
SWC LaSALLE & HUBBARD STREETS
CHICAGO, ILLINOIS

DRAWN BY	KKB	2-1-0
CHECKED BY	AJP	2-1-0
APPROVED BY	CNB	2-1-0
CADFILE	SCALE NTS	
STS PROJECT NO. 30852	FIGURE NO. 1	



LEGEND

SOIL BORING

VANE SHEAR BORING

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NO.
30852-A

STS PROJECT FILE
G1-SBLD.dwg

SCALE
1"=40'±

FIGURE NO.
2

SOIL BORING LOCATION DIAGRAM
LaSALLE/HUBBARD DEVELOPMENT
SWC LaSALLE & HUBBARD STREETS
CHICAGO, ILLINOIS

DRAWN BY	KKB	DATE	1-5-01
CHECKED BY	AJP	DATE	1-5-01
APPROVED BY	CNB	DATE	1-5-01
CADFILE	X:\PROJECTS\30852\A\ G1-SBLD.dwg 01/05/01		

STS Consultants Ltd.

OWNER
Interparking

PROJECT NAME
LaSalle/Hubbard Development

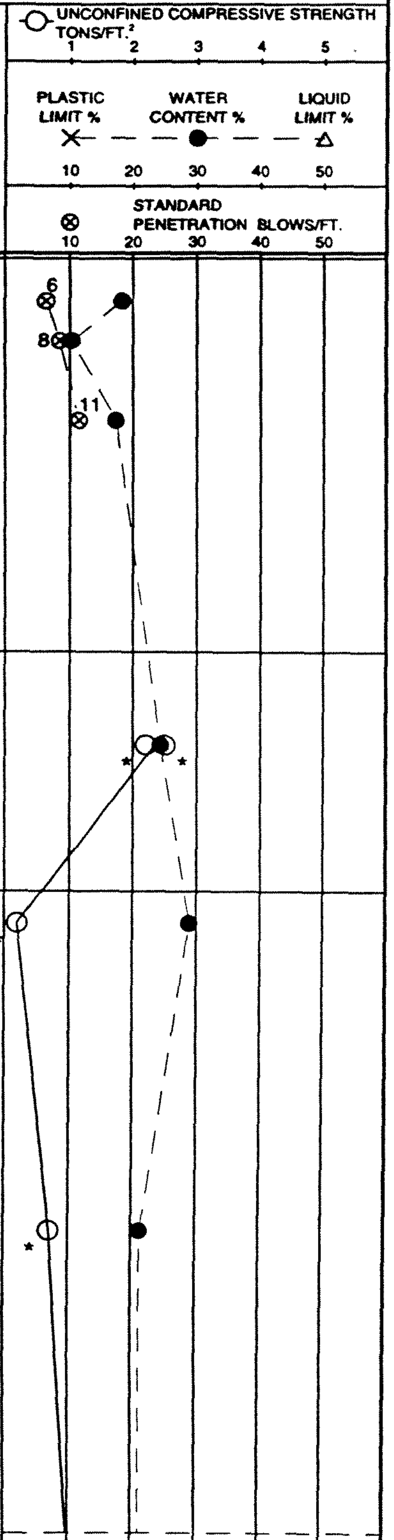
LOG OF BORING NUMBER **B-1**

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.3 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
			PA			Asphalt (2")	
		1	SS			Urban fill: Cinders, brick, sand, gravel, crushed concrete, wood and slag.	
		2	SS				
5.0			PA				
		3	SS				
			PA			Steel obstruction encountered at 7.5 ft. Boring offset 5 ft. east. Concrete obstructions encountered from 7.5-12.5 ft.	
10.0			RB				
						Silty clay, trace gravel and sand - brownish gray - very stiff (CL)	
15.0		4	ST				
			RB				
20.0		5	ST			Silty clay, trace gravel, sand and shale - gray - stiff to soft (CL)	
25.0			RB				
30.0		6	ST				
35.0			RB				
40.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 1 OF 3

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OWNER
Interparking

LOG OF BORING NUMBER **B-1**

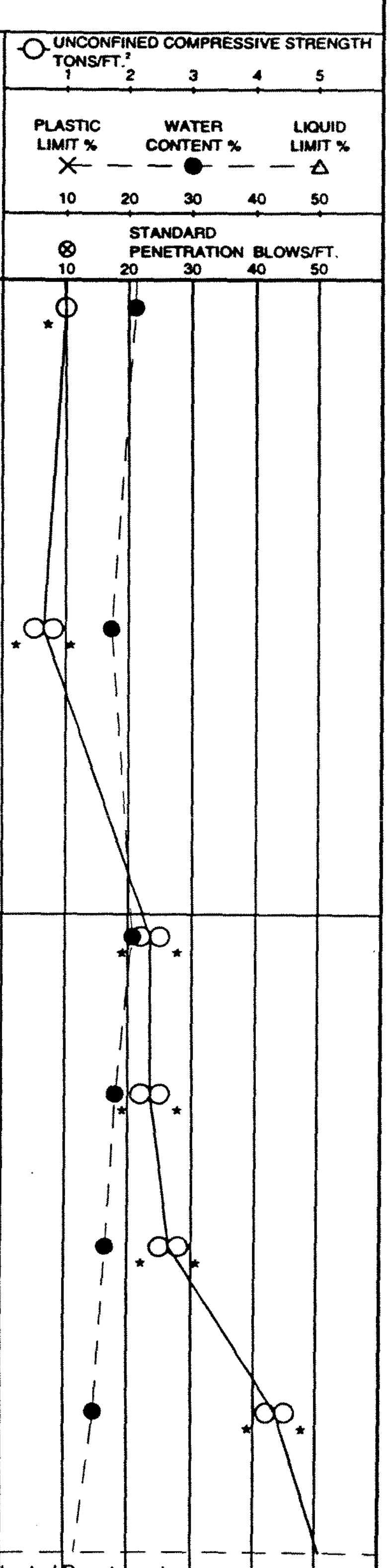
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.3 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		7	ST			*Silty clay, trace gravel, sand and shale - gray - stiff to soft (CL)*	
45.0			RB				
50.0							
		8	ST				
55.0			RB				
60.0							
		9	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to stiff (CL)	
			RB				
65.0							
		10	ST				
			RB				
70.0							
		11	ST				
			RB				
75.0							
		12	ST				123
			RB				
80.0							



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* Calibrated Penetrometer

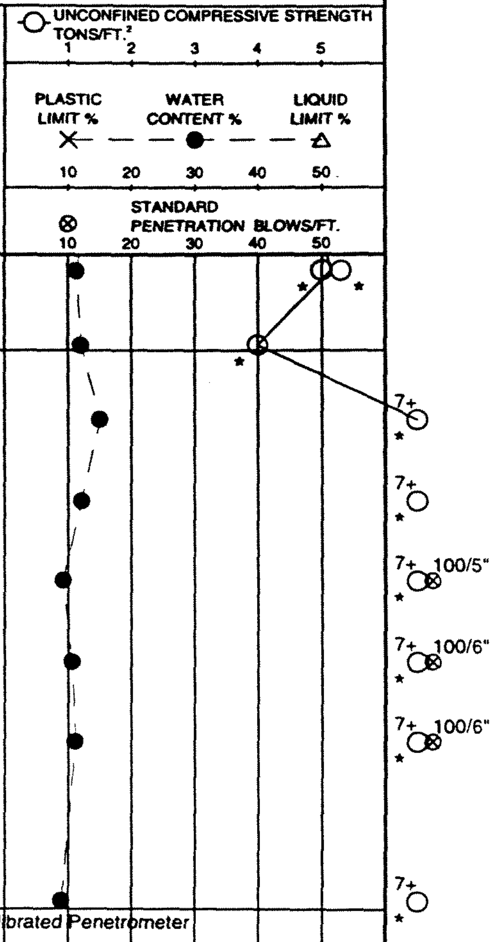
The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

STS JOB NO. 30852

STS Consultants Ltd.

OWNER **Interparking**	LOG OF BORING NUMBER **B-1**
PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER
SITE LOCATION **SWC LaSalle & Hubbard Streets; Chicago, IL**	

DEPTH(FT) ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +15.3 CCD (Continued)	UNIT DRY WT. LBS./FT.³
	13	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to stiff (CL)	
		RB				
	14	ST				
		RB			Very silty clay, trace gravel, sand and shale - gray - hard (CL) Pressuremeter Test at 82.5-85 ft.	
85.0	15	ST				
		RB				
	16	ST				
		RB			Pressuremeter Test at 87.5-90 ft.	
90.0	17	SS*				
		RB				
	18	SS*			Pressuremeter Test at 92.5-95 ft.	
		RB				
95.0	19	SS*				
		RB				
100.0	20	ST				
100.5					End of Boring Borehole grouted upon completion. Casing used: 20 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



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

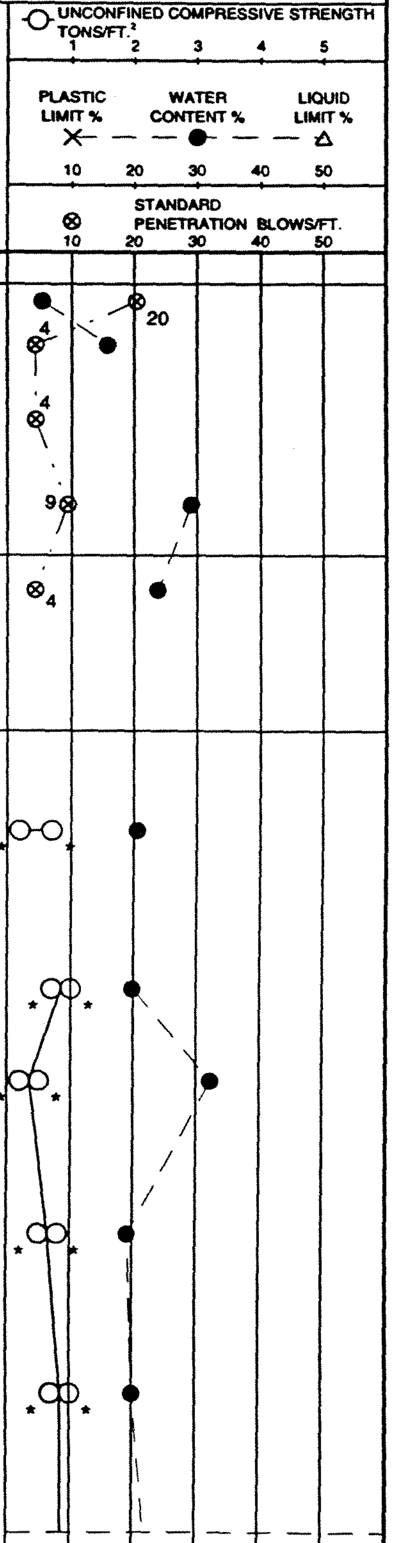
WL 21.0 ft. BCR' 21.0 ft. ACR	BORING STARTED 1/13/00	STS OFFICE Chicago Area - 01	
WL	BORING COMPLETED 1/13/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER	**Interparking**
PROJECT NAME	**LaSalle/Hubbard Development**
LOG OF BORING NUMBER	**B-2**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +14.1 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			PA			Asphalt (3") and base course (9")	
		1	SS			Miscellaneous urban fill: Brick, cinders, and, gravel, wood, crushed concrete and slag.	
		2	SS				
5.0			PA				
		3	SS				
			PA				
		4	SS				
10.0			PA			Sandy silt to silty sand, trace clay - brownish gray - loose - saturated (ML to SM)	
		5	SS				
			RB				
15.0		.	ST			Silty clay, trace gravel, sand and shale - gray - soft to medium (CL)	
			RB				
		6	ST				
20.0			RB				
		.	ST				
			RB				
		7	ST				
25.0			RB				
		8	ST				
			RB				
30.0		9	ST				
			RB				
35.0		10	ST				83
			RB				
40.0							



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* Calibrated Penetrometer

The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.	STS JOB NO. 30852	SHEET NO. 1 OF 3

BORING_LOG 30852.GPJ STS.GDT 1/26/00

STS Consultants Ltd.

OWNER
Interparking

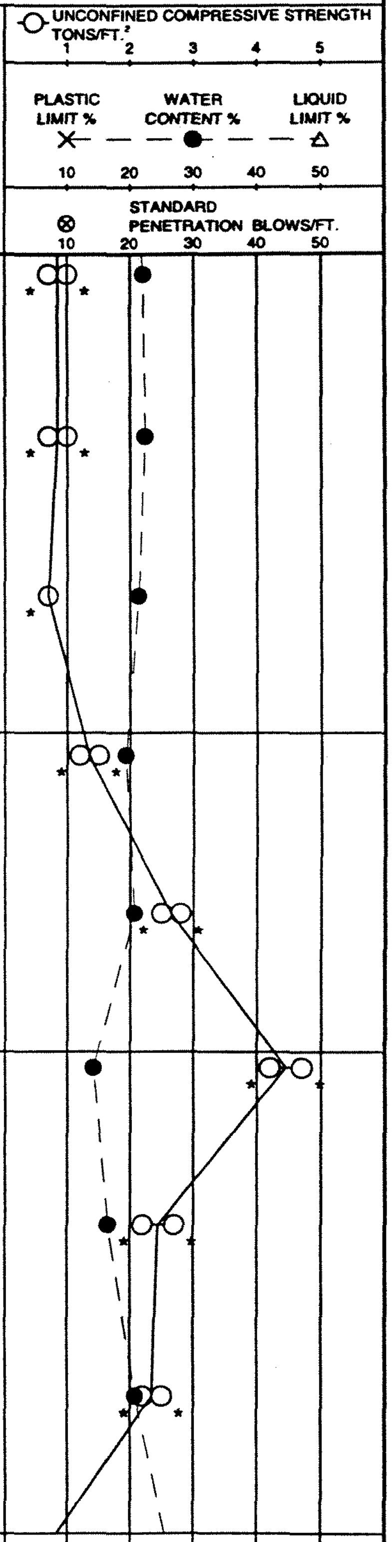
LOG OF BORING NUMBER **B-2**

PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

DEPTH(FT) ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +14.1 CCD (Continued)	UNIT DRY WT. LBS./FT.³
	11	ST			Silty clay, trace gravel, sand and shale - gray - soft to medium (CL)	
		RB				
45.0	12	ST				
		RB				
50.0	13	ST				
		RB				
55.0	14	ST			Silty clay, trace gravel, sand and shale - gray - stiff to very stiff (CL)	
		RB				
60.0	15	ST				
		RB				
65.0	16	ST			Silty clay, trace gravel, sand and shale - gray - hard to very stiff (CL)	128
		RB				
70.0	17	ST				
		RB				
75.0	18	ST				
		RB				
80.0					. . . continued	



* Calibrated Penetrometer

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

STS JOB NO. 30852

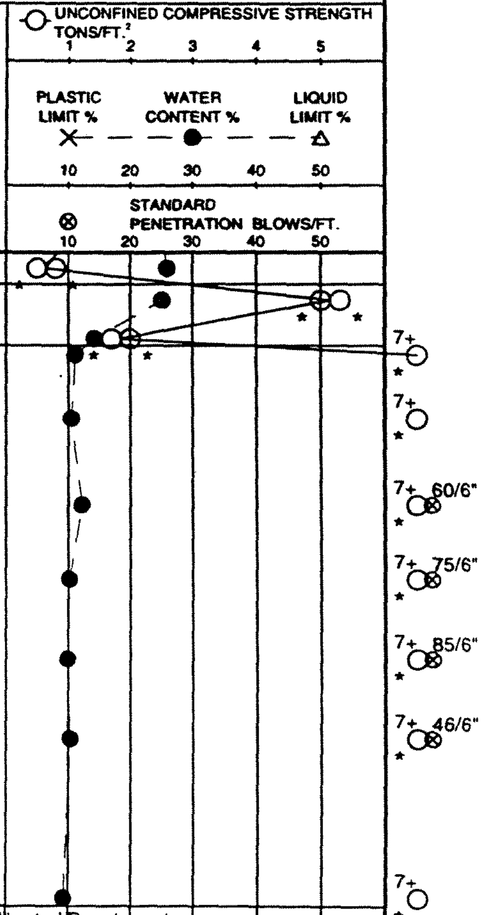
SHEET NO. 2 OF 3

STS Consultants Ltd.

OWNER **Interparking**	LOG OF BORING NUMBER **B-2**
PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +14.1 CCD (Continued)	UNIT DRY WT. LBS./FT.³
		19	ST			Silty clay, trace sand and shale - gray - medium (CH)	
		19A	ST			Clayey silt to silt, trace gravel and sand - gray - hard - moist (CL-ML to ML)	
			RB				
		20	ST				
		20A	ST			Very silty clay, trace gravel, sand and shale - gray - hard (CL to CL-ML)	
			RB				
85.0		21	ST				
			RB				
		22	SS				
			RB				
90.0		23	SS*				
			RB				
		24	SS*				
			RB				
95.0		25	SS				
			RB				
100.0		26	ST				
100.5						End of Boring Borehole grouted upon completion. Casing used: 20 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



* Calibrated Penetrometer

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

WL 7.0 ft. WD	BORING STARTED 1/10/00	STS OFFICE Chicago Area - 01	
WL 22.0 ft. BCR; 22.0 ft. ACR	BORING COMPLETED 1/10/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

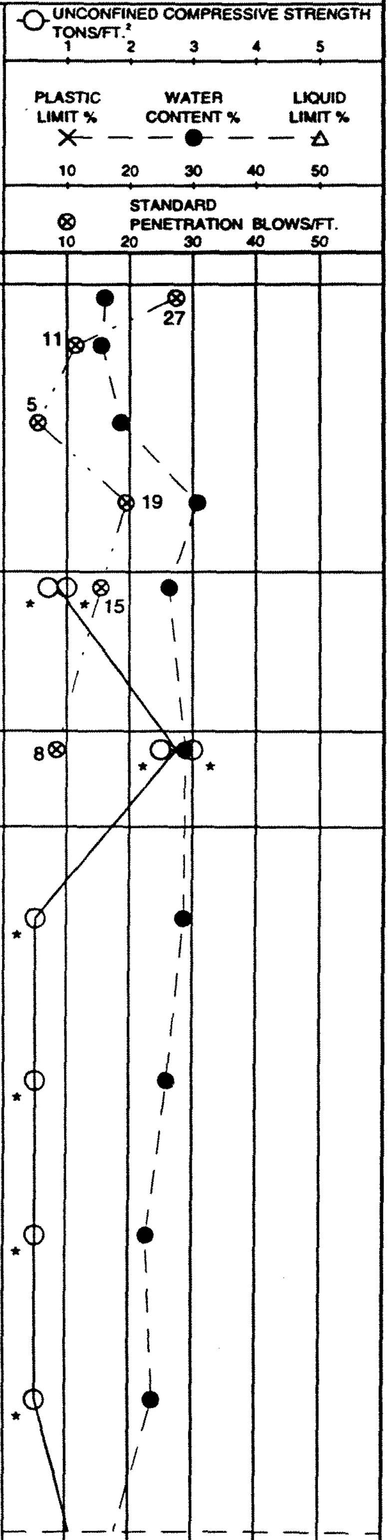
BORING_LOG 30852.GPJ STS.GDT 1/26/00

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-3**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +14.2 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			PA			Asphalt (3") and base course (9")	
		1	SS			Miscellaneous urban fill: Brick, cinders, sand, gravel, wood, crushed concrete and slag.	
		2	SS				
5.0			PA				
		3	SS				
			PA				
		4	SS				
10.0			PA				
		5	SS			Fill: Silty clay, little brick and organics - brownish gray and black (CL)	
			PA				
15.0							
		6	SS			Silty clay, trace gravel and sand - grayish brown - very stiff (CL)	
			RB			Silty clay, trace gravel, sand and shale - gray - medium to stiff (CL)	
20.0							
		7	ST				
			RB				
25.0							
		8	ST				
			RB				
30.0							
		9	ST				
			RB				
35.0							
		10	ST				
			RB				
40.0							



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* Calibrated Penetrometer

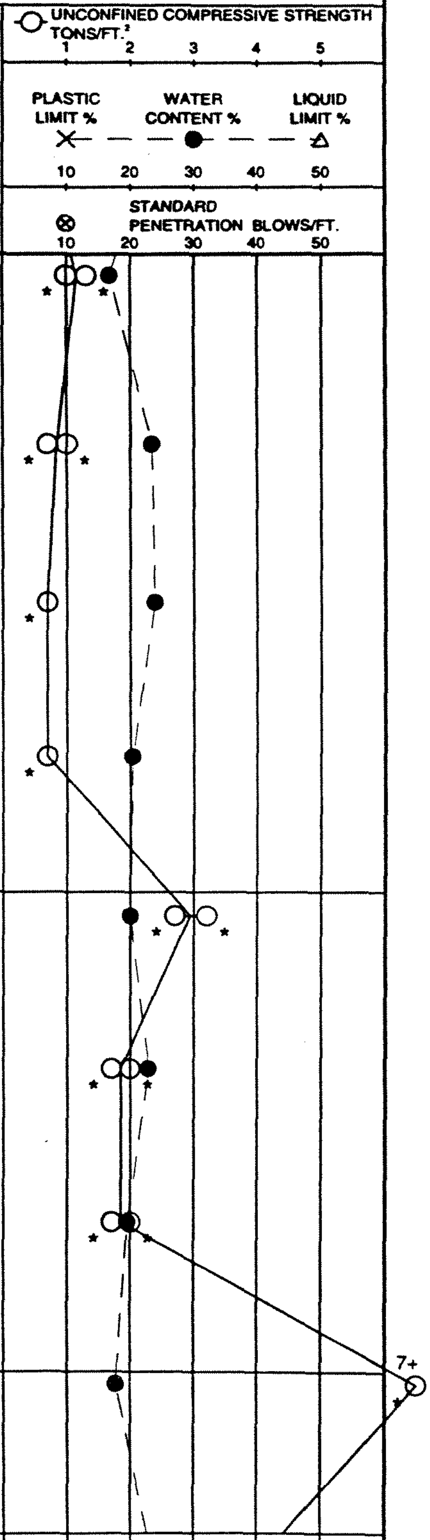
The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

STS JOB NO.	SHEET NO.	OF
30852	1	3

STS Consultants Ltd.	OWNER **Interparking**
LOG OF BORING NUMBER	**B-3**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +14.2 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		11	ST			Silty clay, trace gravel, sand and shale - gray - medium to stiff (CL)	
45.0			RB				
		12	ST				110
50.0			RB				
		13	ST				
55.0			RB				
		14	ST				113
60.0			RB				
		15	ST			Silty clay, trace gravel, sand and shale - gray - stiff to very stiff (CL)	
65.0			RB				
		16	ST				
70.0			RB				
		17	ST				
75.0			RB				
		18	ST			Silty clay, trace gravel, sand and shale - gray - hard (CL)	
80.0			RB				



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* Calibrated Penetrometer

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

STS JOB NO.	SHEET NO.	OF
30852	2	3

BORING_LOG 30852.GPJ STS.GDT 1/26/00

STS Consultants Ltd.

OWNER
Interparking

PROJECT NAME
LaSalle/Hubbard Development

LOG OF BORING NUMBER **B-3**

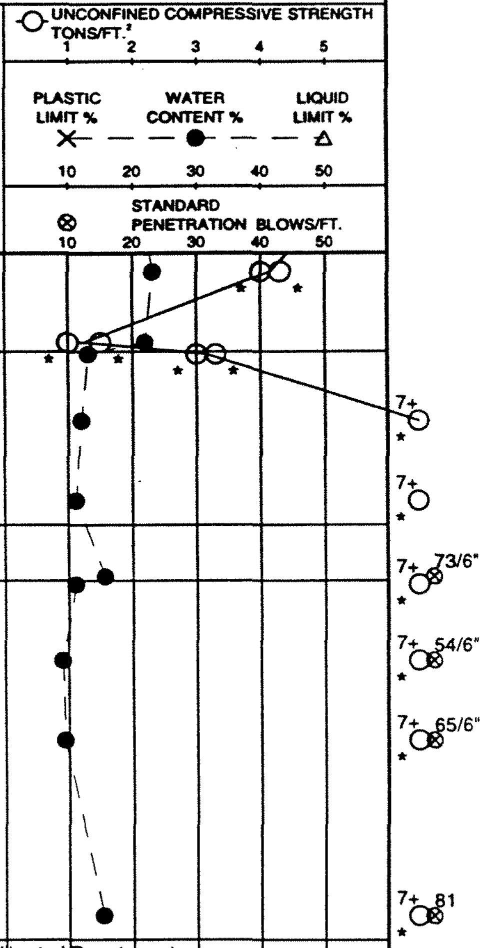
ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +14.2 CCD (Continued)

DEPTH(FT) / ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
	19	ST			Clayey silt - gray - hard to stiff - wet (CL-ML to ML)	
		RB				
	20	ST				
	20A	ST			Silty clay, trace gravel, sand and shale - gray - hard (CL)	
		RB				
85.0	21	ST				
		RB				
	22	ST				
		RB			Sandy silt, trace gravel - gray - extremely dense - saturated (ML)	
90.0	23	SS*				
	23A	SS			Very silty clay, trace gravel, sand and shale - gray - hard (CL to CL-ML)	
		RB				
	24	SS*				
		RB				
95.0	25	SS*				
		RB				
100.0	26	SS				
101.5						

End of Boring
Borehole grouted upon completion.
Casing used: 20 ft. of 4 in.
Automatic-Mobile Hammer used for Standard Penetration Tests.
SS* = SPT value based on first 6 in.



* Calibrated Penetrometer

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

WL 12.0 ft. WD
WL 24.0 ft. BCR; 24.0 ft. ACR
WL

BORING STARTED 1/6/00
BORING COMPLETED 1/6/00
RIG/FOREMAN Mobile B-61/Baker

STS OFFICE **Chicago Area - 01**
ENTERED BY KKB
SHEET NO. 3 OF 3
APP'D BY AJP
STS JOB NO. 30852

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-4**

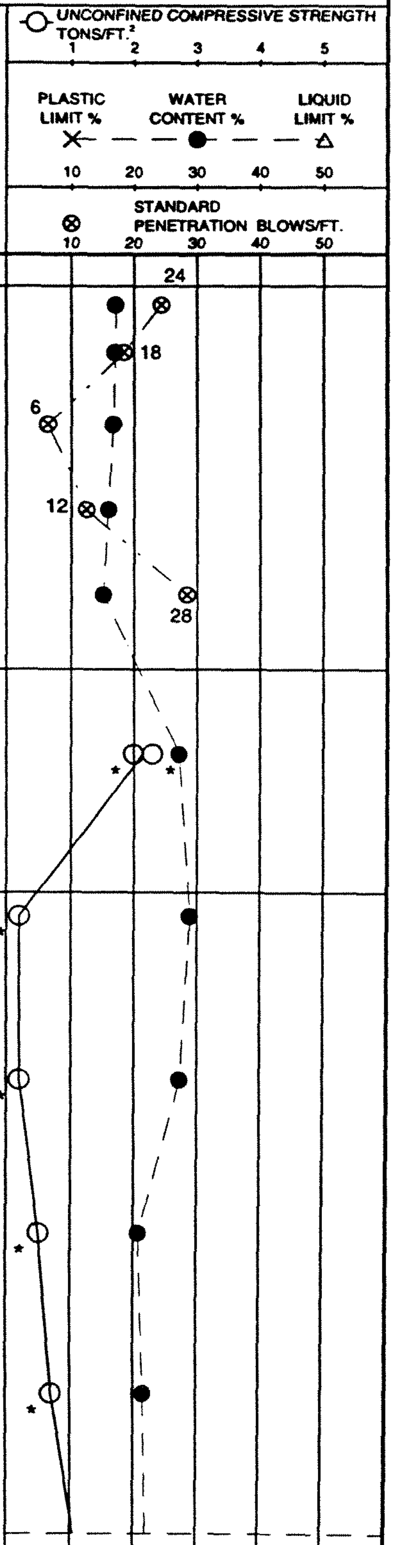
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.6 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			PA	Asphalt (2-3") and base course (10")	
		1	SS	Urban fill: Cinders, brick, sand, gravel, crushed concrete and slag	
		2	SS		
5.0			PA		
		3	SS		
			PA		
		4	SS		
10.0			PA		
		5	SS		
15.0			PA	Silty clay, trace gravel and sand - brownish gray - very stiff (CL)	
		6	ST		
20.0			RB		
		7	ST	Silty clay, trace gravel, sand and shale - gray - soft to stiff (CL)	
25.0			RB		
		8	ST		
30.0			RB		
		9	ST		
35.0			RB		
		10	ST		
40.0			RB		



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 1 OF 3

STS Consultants Ltd.

OWNER **Interparking**

PROJECT NAME **LaSalle/Hubbard Development**

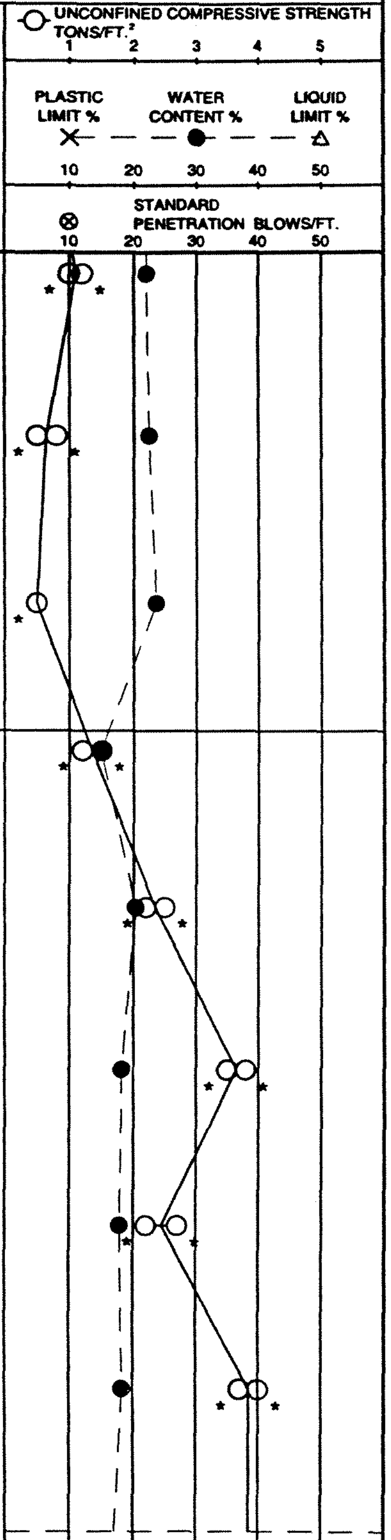
LOG OF BORING NUMBER **B-4**

ARCHITECT-ENGINEER

SITE LOCATION **SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +15.6 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		11	ST	Silty clay, trace gravel, sand and shale - gray - soft to stiff (CL)	114
			RB		
45.0		12	ST		
			RB		
50.0		13	ST		
			RB		
55.0		14	ST	Silty clay, trace gravel, sand and shale - gray - stiff to very stiff (CL)	
			RB		
60.0		15	ST		
			RB		
65.0		16	ST		
			RB		
70.0		17	ST		
			RB		
75.0		18	ST		
			RB		
80.0					



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 2 OF 3

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-4**

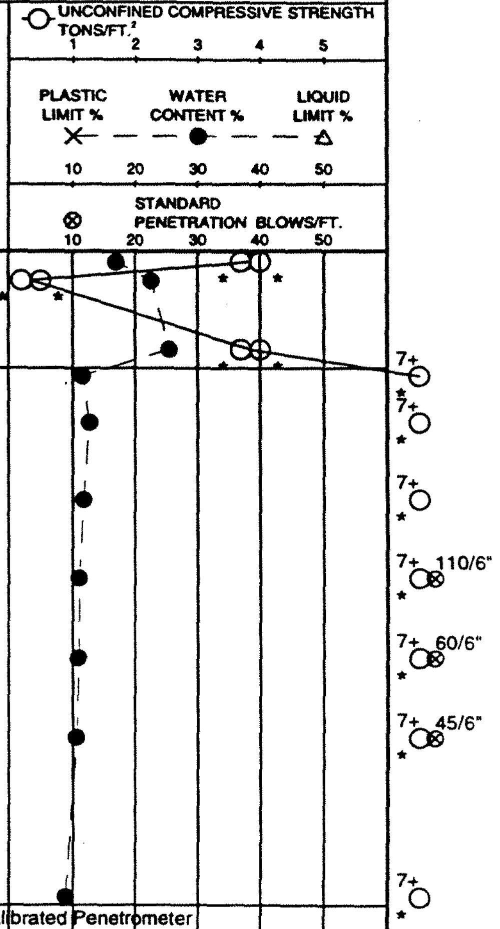
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.6 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		19	ST			Silty clay, trace gravel, sand and shale - gray - stiff to very stiff (CL)	
		19A	ST			Sample 19 - disturbed sample.	
			RB				
		20	ST				
		20A	ST			Very silty clay - gray - hard (CL)	
85.0			RB				
		21	ST				
			RB				
		22	ST				
90.0			RB				
		23	SS*				
			RB			Boulder obstruction encountered 91-91.5' and 96.5-97'.	
		24	SS*				
95.0			RB				
		25	SS*				
			RB				
100.0		26	ST				
100.5						End of Boring Borehole grouted upon completion. Casing used: 16 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



* Calibrated Penetrometer

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

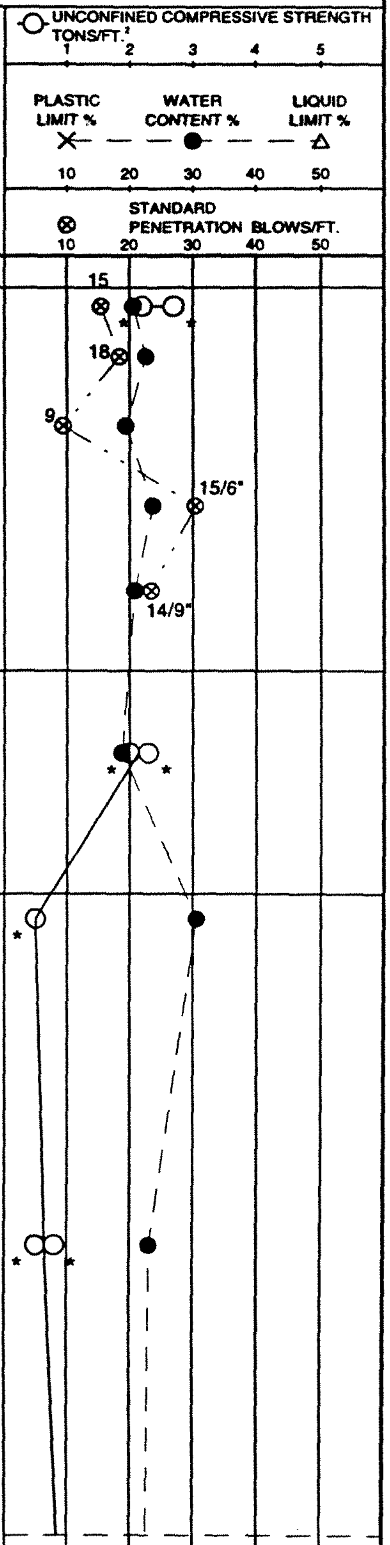
WL 13.0 ft. WD	BORING STARTED 1/18/00	STS OFFICE Chicago Area - 01	
WL 20.0 ft. BCR; 20.0 ft. ACR	BORING COMPLETED 1/19/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER	Interparking
PROJECT NAME	LaSalle/Hubbard Development
LOG OF BORING NUMBER	B-5
ARCHITECT-ENGINEER	
SITE LOCATION	SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +14.1 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			PA	Asphalt (3 in.) and base course (9 in.)	
		1	SS	Miscellaneous urban fill: Brick, cinders, sand, gravel, clay, wood, crushed concrete and slag.	
		2	SS		
5.0			PA		
		3	SS		
			PA		
		4	SS		
10.0			PA		
		5	SS		
			PA	Silty clay, trace gravel and sand - brownish gray - very stiff (CL)	
15.0		6	ST		113
			RB		
20.0		7	ST	Silty clay, trace gravel, sand and shale - gray - medium to stiff (CL)	
25.0			RB		
30.0		8	ST		98
35.0			RB		
40.0				. . . continued	



* Calibrated Penetrometer

BORING_LOG 30852.GPJ STS.GDT 1/26/00

STS JOB NO.	30852
SHEET NO.	1 OF 4

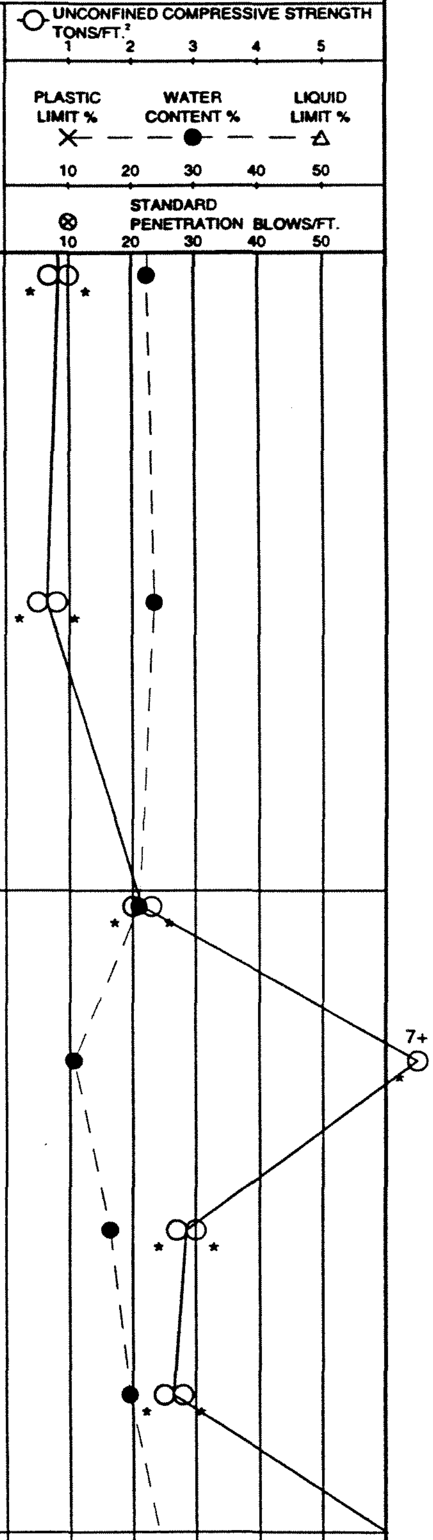
STS Consultants Ltd.

OWNER **Interparking**	LOG OF BORING NUMBER **B-5**
PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +14.1 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		9	ST			*Silty clay, trace gravel, sand and shale - gray - medium to stiff (CL)*	
45.0			RB				
50.0		10	ST				
55.0			RB				
60.0		11	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)	
			RB				
65.0		12	ST				
			RB				
70.0		13	ST				
			RB				
75.0		14	ST				
			RB				
80.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

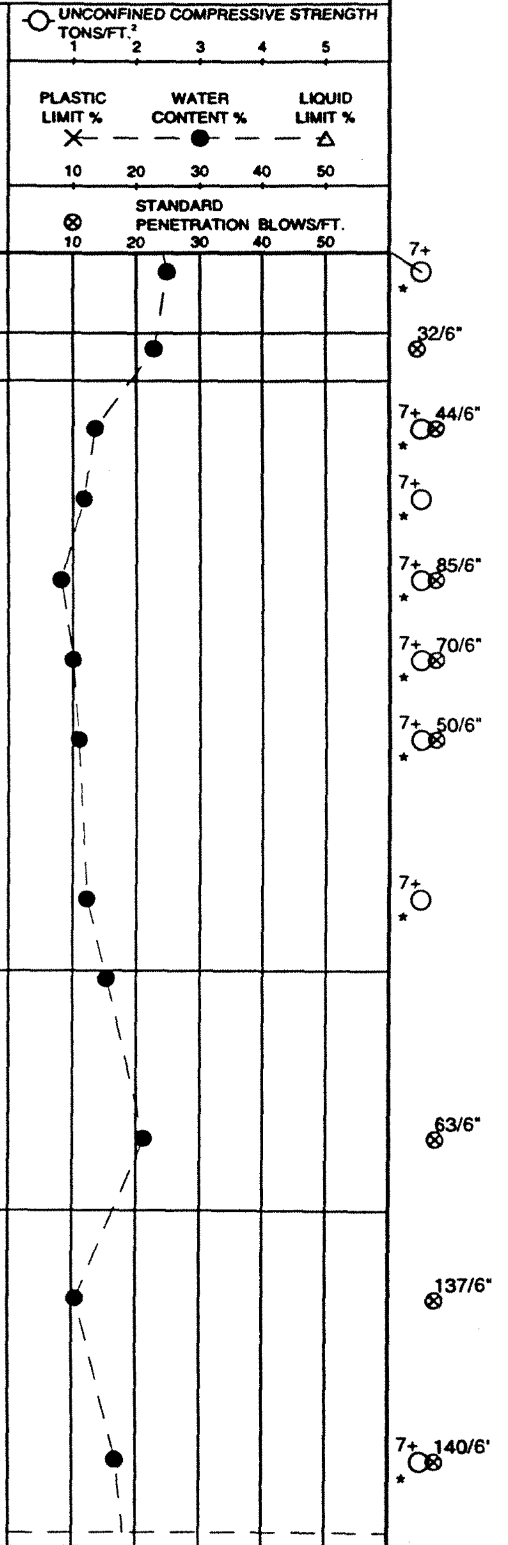
SHEET NO. 2 OF 4

STS Consultants Ltd.

OWNER	**Interparking**
PROJECT NAME	**LaSalle/Hubbard Development**
LOG OF BORING NUMBER	**B-5**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +14.1 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
		15	ST	Silty clay to clayey silt, trace gravel, sand and shale - gray - hard (CL to CL-ML)
			RB	
		16	SS	Silty fine to coarse sand, trace clay and gravel - gray - very dense - saturated
85.0			RB	Very silty clay, trace gravel, sand and shale - gray - hard (CL to CL-ML)
		17	SS	Pressuremeter Test at 82.5-85 ft.
			RB	
		18	ST	
			RB	Pressuremeter Test at 87.5-90 ft.
90.0		19	SS*	
			RB	
		20	SS*	Pressuremeter Test at 92.5-95 ft.
			RB	
95.0		21	SS*	
			RB	
100.0		22	ST	
			RB	Pressuremeter Test at 100-102.5 ft.
		23	ST	Silt, trace fine to medium sand - gray - extremely dense - saturated (ML)
105.0			PA	
		24	SS*	
110.0			RB	Clayey silt, trace gravel, sand and shale - gray - extremely dense - saturated (CL-ML to ML)
		25	SS*	
115.0			RB	
		26	SS*	
120.0				



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 3 OF 4

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-5**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

○ 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 SURFACE ELEVATION +14.1 CCD (Continued)	UNIT DRY WT. LBS./FT.³	
			RB			Clayey silt, trace gravel, sand and shale - gray - extremely dense - *saturated* (CL-ML to ML)		
		27	SS*					7+ * ○⊗ 110/6"
125.0			RB			Probable weathered limestone bedrock.		
126.5								

End of Boring
Borehole grouted upon completion.
Casing used: 20 ft. of 4 in.
Automatic-Mobile Hammer used for Standard Penetration Tests.
SS* = SPT value based on first 6 in.

* Calibrated Penetrometer

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

WL 14.0 ft. WD	BORING STARTED 1/6/00	STS OFFICE Chicago Area - 01	
WL 20.0 ft. BCR; 20.0 ft. ACR	BORING COMPLETED 1/7/00	ENTERED BY KKB	SHEET NO. 4 OF 4
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-6**

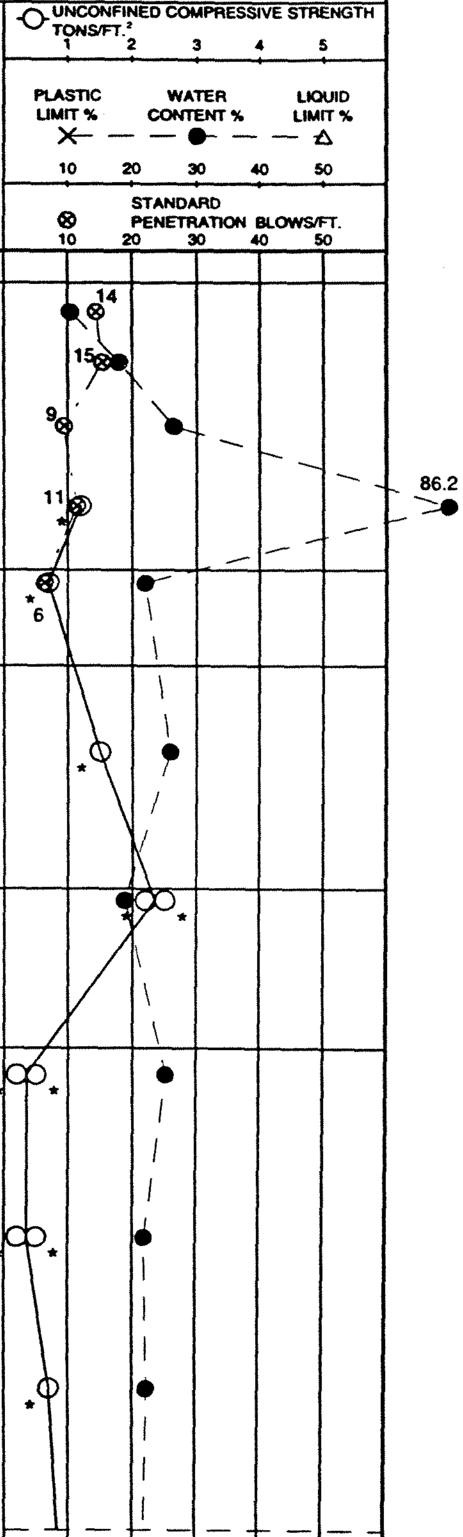
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.2 CCD

DEPTH(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL
		PA	Asphalt (3") and base course (9")
	1	SS	Miscellaneous urban fill: Brick, cinders, sand, gravel, wood, crushed concrete and slag.
	2	SS	
5.0		PA	
	3	SS	
		PA	
	4	SS	
10.0		PA	
	5	SS	Clayey silt, trace sand - gray - medium - saturated (CL-ML)
		RB	Silty clay - brownish gray - stiff (CL)
15.0	6	ST	
		RB	
20.0	7	ST	Clayey, sandy silt - gray - very stiff - moist (CL-ML)
		RB	
25.0	8	ST	Silty clay, trace gravel, sand and shale - gray - soft to medium (CL)
		RB	
30.0	9	ST	
		RB	
35.0	10	ST	
		RB	
40.0			



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 1 OF 4

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-6**

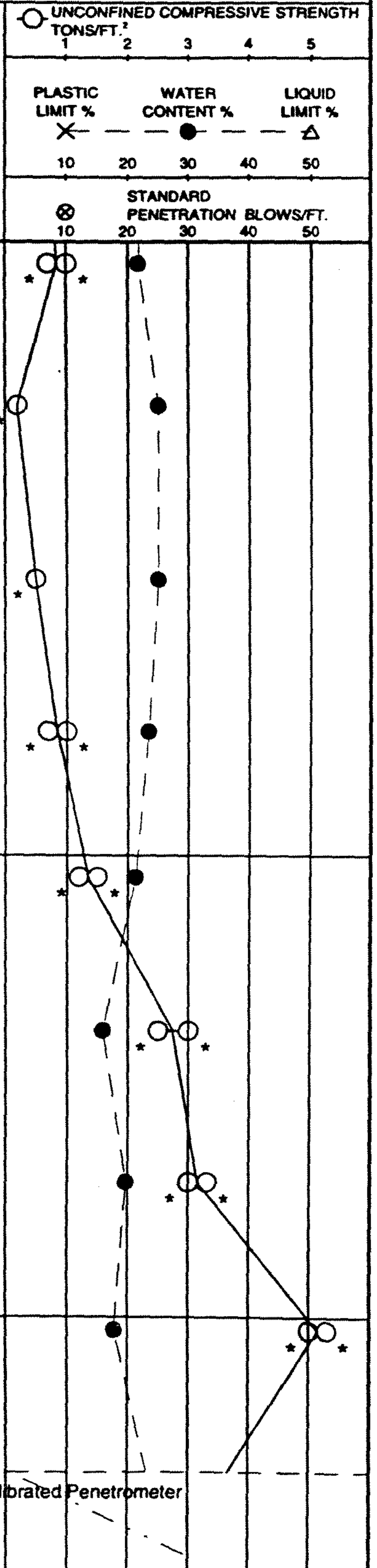
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.2 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		11	ST			Silty clay, trace gravel, sand and shale - gray - soft to medium (CL)	
			RB				
45.0		12	ST				
			RB				
50.0		13	ST				107
			RB				
55.0		14	ST				
			RB				
60.0		15	ST			Silty clay, trace gravel, sand and shale - gray - stiff to very stiff (CL)	
			RB				
65.0		16	ST				
			RB				
70.0		17	ST				120
			RB				
75.0		18	ST			Silty clay, trace gravel, sand and shale - gray - hard to very stiff (CL)	
			RB				
80.0							



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* Calibrated Penetrometer

BORING_LOG 30852.GPJ STS.GDT 1/26/00

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

STS JOB NO. 30852

SHEET NO. 2 OF 4

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-6**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +15.2 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		19	ST			Silty clay, trace gravel, sand and shale - gray - hard to very stiff (CL)	
			RB				
		20	SS*			Silt and fine to medium sand - gray - dense - saturated (ML)	
		20A	SS				
		20B	SS			Very silty clay, trace gravel, sand and shale - gray - hard (CL to CL-ML)	
85.0			RB				
		21	ST				
			RB				
		22	ST				
			RB				
90.0		23	SS*				
			RB				
		24	SS*				
			RB				
95.0		25	SS				
			RB				
100.0		26	ST				
			RB			Clayey silt to silt, trace limestone gravel - gray - extremely dense - saturated (ML)	
105.0		27	SS*				
			RB				
110.0		28	SS*				
			RB				
115.0		29	SS*				
			RB				
120.0							

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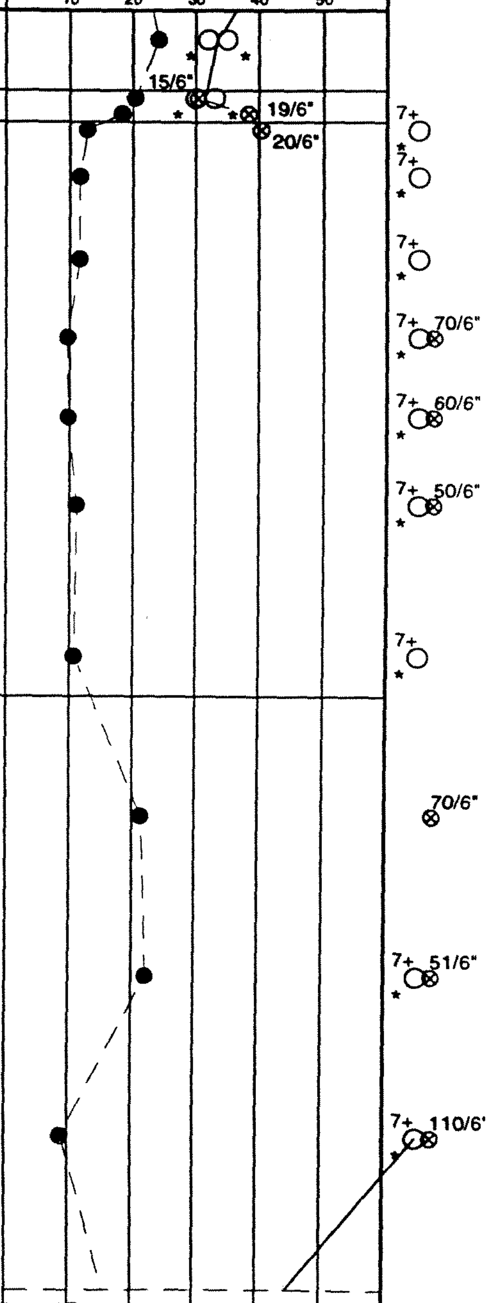
○ UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

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

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50



* Calibrated Penetrometer

BORING_LOG 30852.GPJ STS.GDT 1/26/00

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

STS JOB NO.	SHEET NO.	OF
30852	3	4

STS Consultants Ltd.

OWNER **Interparking**	LOG OF BORING NUMBER **B-6**
PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER

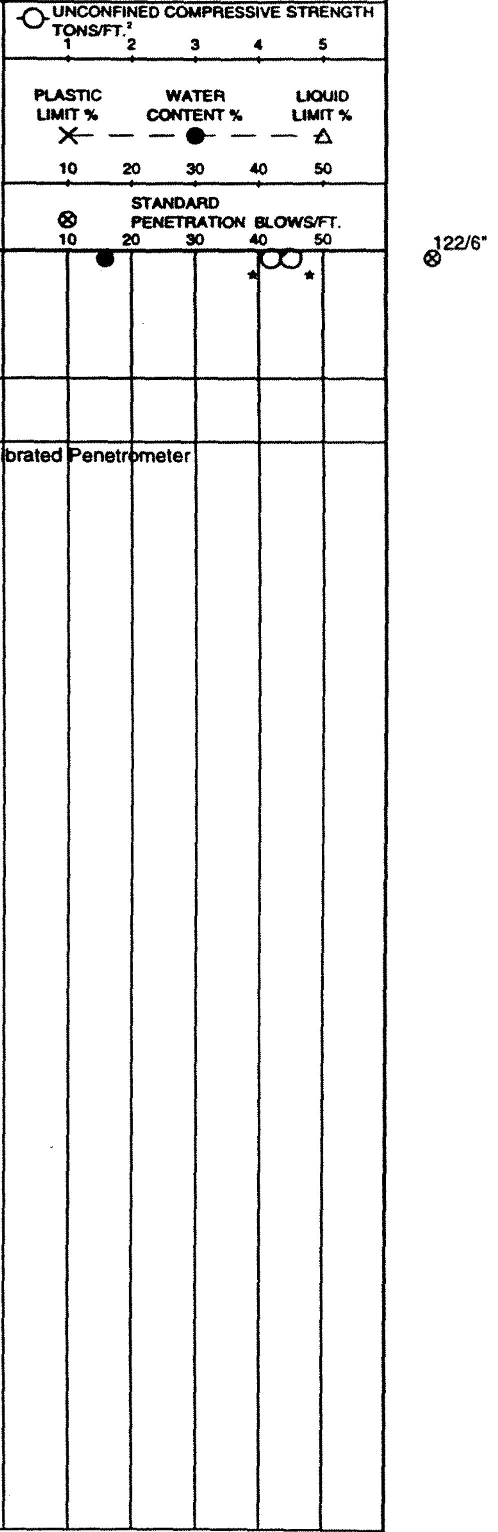
SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

DESCRIPTION OF MATERIAL

SURFACE ELEVATION +15.2 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		30	SS*	I	I	Clayey silt to silt, trace limestone gravel - gray - extremely dense - saturated (ML)	
			RB				
125.0			RB			Probable weathered limestone bedrock.	
126.0						End of Boring Borehole grouted upon completion. Casing used: 15 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests.	

* Calibrated Penetrometer



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

WL 10.0 ft. WS	BORING STARTED 1/11/00	STS OFFICE **Chicago Area - 01**	
WL 19.5 ft. BCR; 19.5 ft. ACR	BORING COMPLETED 1/11/00	ENTERED BY KKB	SHEET NO. 4 OF 4
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-7**

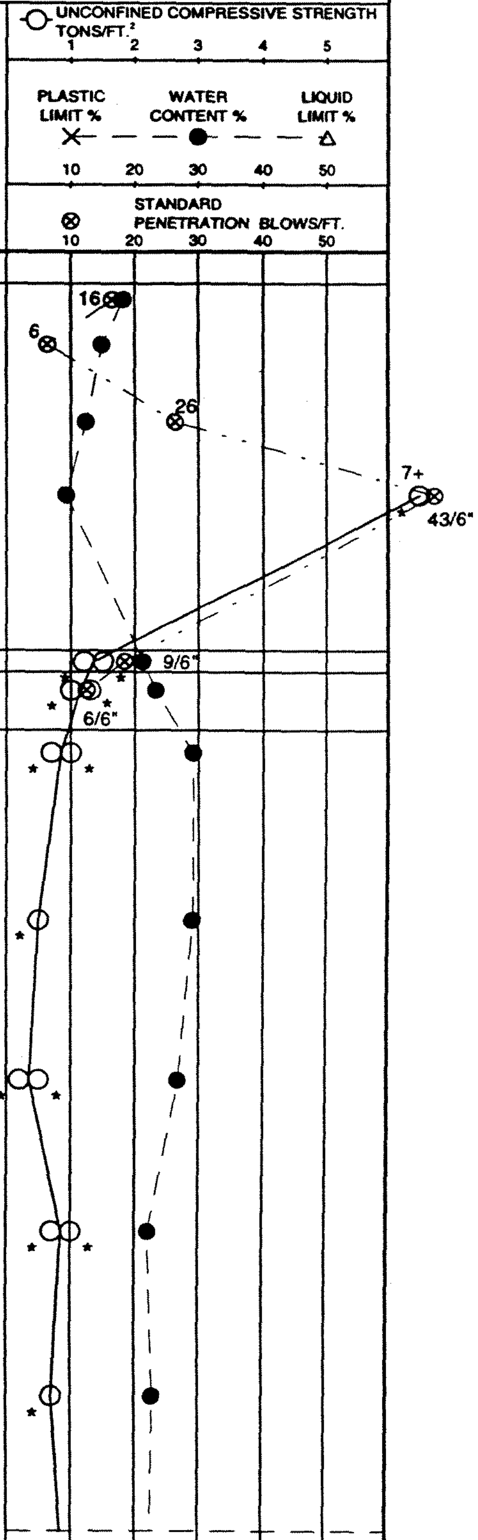
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +14.7 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
			PA			Asphalt (3") and base course (9")	
		1	SS			Miscellaneous urban fill: Brick, cinders, sand, gravel, wood, crushed concrete and slag	
		2	SS				
5.0			PA			Concrete obstructions encountered at 4.5-5 ', 6.5-7' and 8-13'.	
		3	SS			Boring offset 6' west and boring continued.	
			PA				
		4	SS*				
10.0			PA				
		5	SS			Clayey silt, trace gravel and sand - brownish gray - stiff - wet	
		5A	SS			Possible steel beam encountered at 13 ft.	
			RB			Silty clay, trace gravel and sand - brownish gray - stiff (CL)	
15.0		6	ST			Silty clay, trace gravel, sand and shale - gray - medium (CL)	
			RB				
20.0		7	ST				101
			RB				
25.0		8	ST				
			RB				
30.0		9	ST				
			RB				
35.0		10	ST				
			RB				
40.0							



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* Calibrated Penetrometer

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

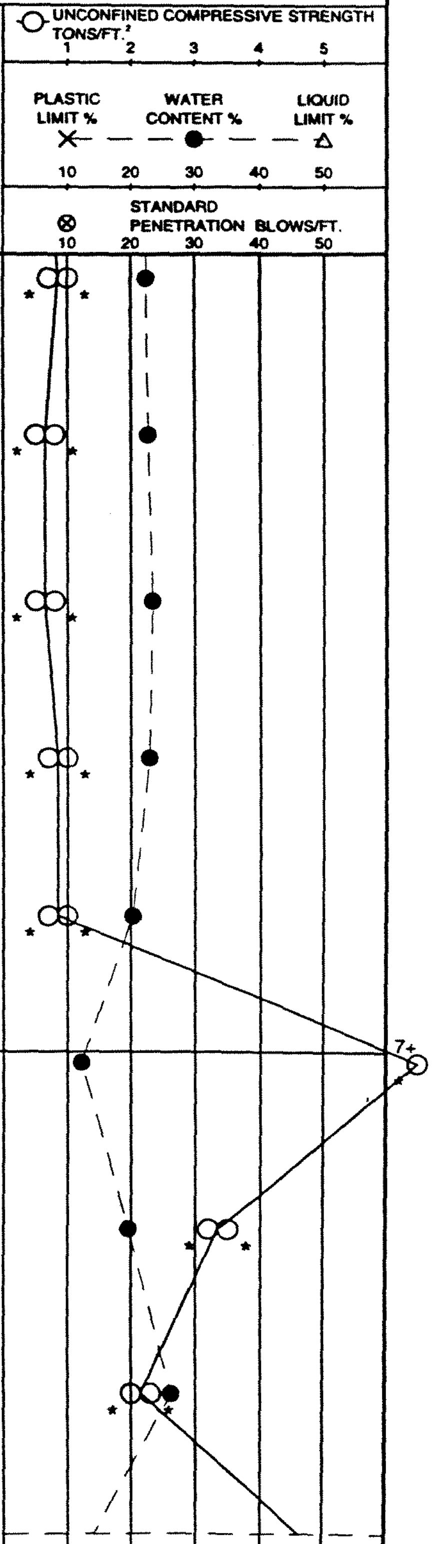
STS JOB NO. 30852

STS Consultants Ltd.

OWNER	**Interparking**
PROJECT NAME	**LaSalle/Hubbard Development**
LOG OF BORING NUMBER	**B-7**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +14.7 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		11	ST			Silty clay, trace gravel, sand and shale - gray - medium (CL)	
			RB				
45.0		12	ST				
			RB				
50.0		13	ST				
			RB				
55.0		14	ST				
			RB				
60.0		15	ST				
			RB				
65.0		16	ST			Very silty clay, trace gravel, sand and shale - gray - hard to very stiff (CL-ML to CL)	
			RB				
70.0		17	ST				
			RB				
75.0		18	ST				
			RB				
80.0							



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* Calibrated Penetrometer

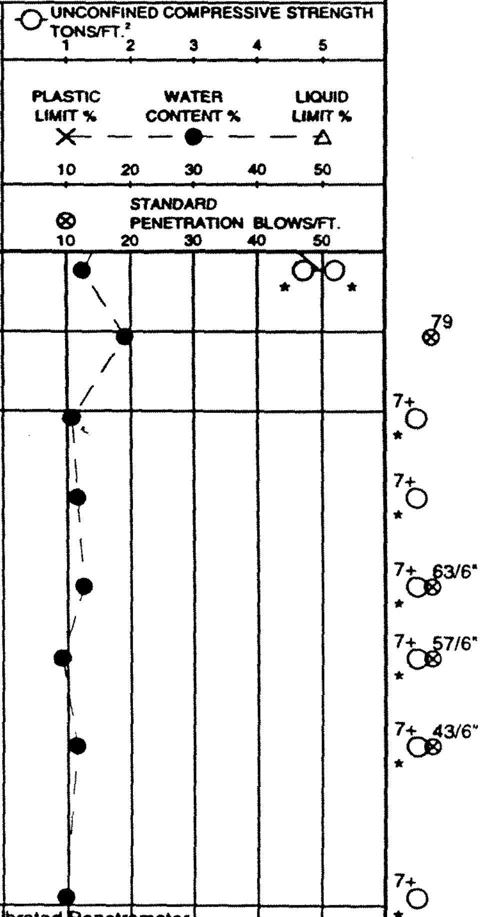
The stratification lines represent the approximate boundary lines between soil types: in situ, the transition may be gradual.

STS JOB NO. 30852

SHEET NO. 2 OF 3

STS Consultants Ltd.	OWNER **Interparking**	LOG OF BORING NUMBER **B-7**	
	PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER	
SITE LOCATION **SWC LaSalle & Hubbard Streets; Chicago, IL**			

DEPTH(FT) · ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION +14.7 CCD (Continued)	UNIT DRY WT. LBS./FT.³
	19	ST			Very silty clay, trace gravel, sand and shale - gray - hard to very stiff (CL-ML to CL)	132
		RB				
	20	SS			Silty sand to sandy silt, trace gravel - gray - very dense - saturated (SM to ML)	
85.0		RB				
	21	ST			Very silty clay, trace gravel, sand and shale - gray - hard (CL to CL-ML)	
		RB				
	22	ST				
		RB				
90.0						
	23	SS				
		RB				
	24	SS*				
		RB				
95.0						
	25	SS				
		RB				
100.0						
	26	ST				
100.5					End of Boring Borehole grouted upon completion. Casing used: 16 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



* Calibrated Penetrometer

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

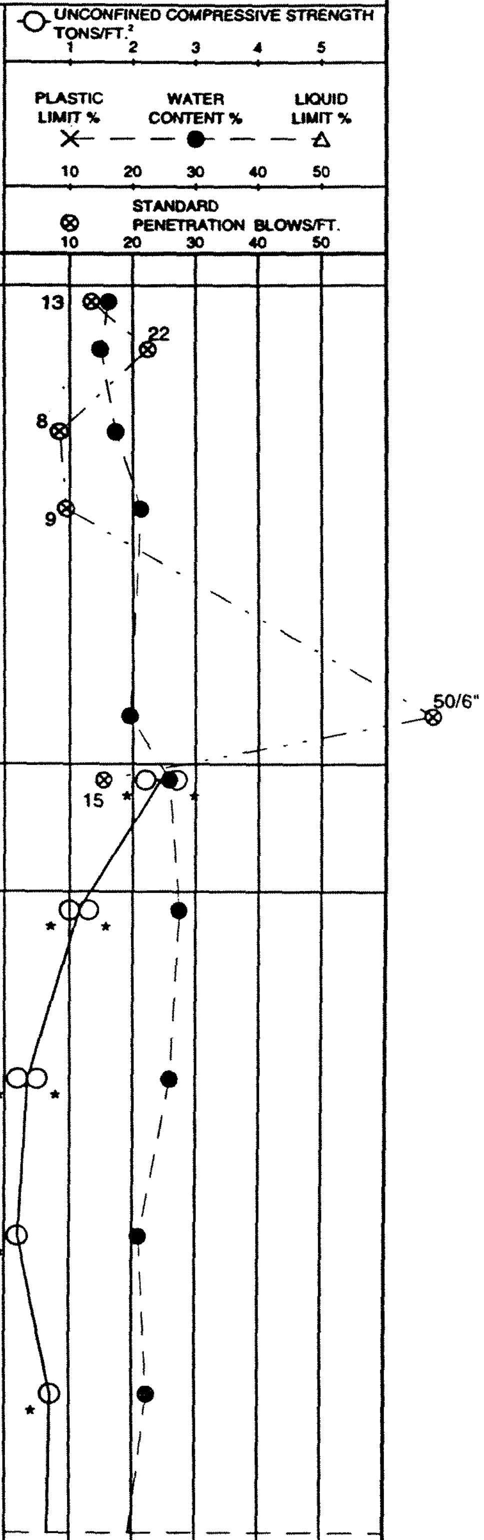
WL 12.5 ft.	BORING STARTED 1/12/00	STS OFFICE Chicago Area - 01	
WL 18.0 ft. BCR; 18.0 ft. ACR	BORING COMPLETED 1/12/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-8**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +16.2 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
			PA			Asphalt (2-3") and base course (10")	
		1	SS			*Urban fill:* Brick, cinders, sand, gravel and slag	
		2	SS				
5.0			PA				
		3	SS				
			PA				
		4	SS				
10.0			PA			Concrete obstruction encountered at 13-13.5' and 15-16'.	
15.0		5	SS				
			PA				
		6	SS			Silty clay, trace gravel, sand and shale - very stiff to stiff (CL)	
			RB				
20.0		7	ST			Silty clay, trace gravel and shale - gray - stiff to soft (CL)	
			RB				
25.0		8	ST				103
			RB				
30.0		9	ST				
			RB				
35.0		10	ST				
			RB				
40.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 1 OF 3

BORING_LOG 30852.GPJ STS.GDT 1/31/00

STS Consultants Ltd.

OWNER **Interparking**

LOG OF BORING NUMBER **B-8**

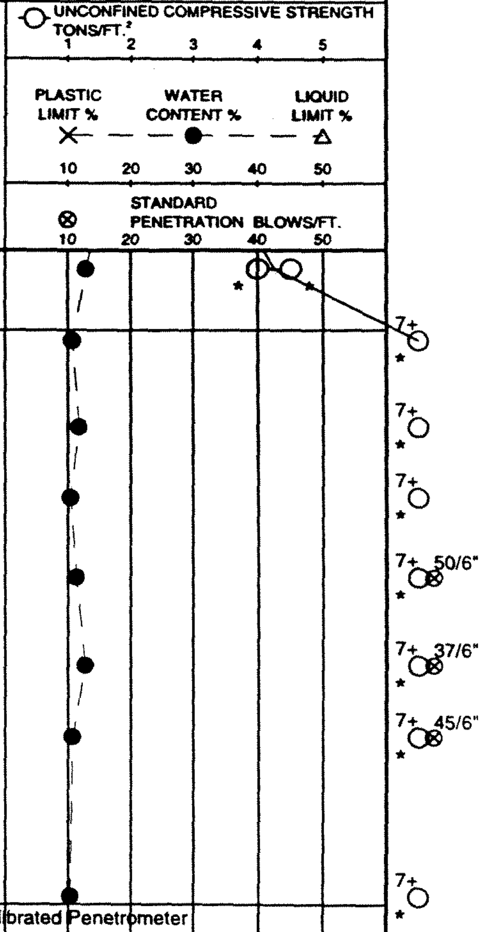
PROJECT NAME **LaSalle/Hubbard Development**

ARCHITECT-ENGINEER

SITE LOCATION **SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +16.2 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		19	ST	Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)	
			RB		
		20	ST	Very silty clay, trace gravel, sand and shale - gray - hard (CL)	
			RB		
85.0		21	ST		
			RB		
		22	ST		
			RB		
90.0		23	SS*	Boulder obstruction encountered at 89.5-90 ft.	
			RB		
		24	SS		
			RB		
95.0		25	SS*		
			RB		
100.0		26	ST		
100.5				End of Boring Borehole grouted upon completion. Casing used: 20 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



* Calibrated Penetrometer

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WL 16.0 ft. WD	BORING STARTED 1/17/00	STS OFFICE Chicago Area - 01	
WL 27.0 ft. BCR; 27.0 ft. ACR	BORING COMPLETED 1/18/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

STS Consultants Ltd.

OWNER
Interparking

PROJECT NAME
LaSalle/Hubbard Development

LOG OF BORING NUMBER **B-9**

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

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

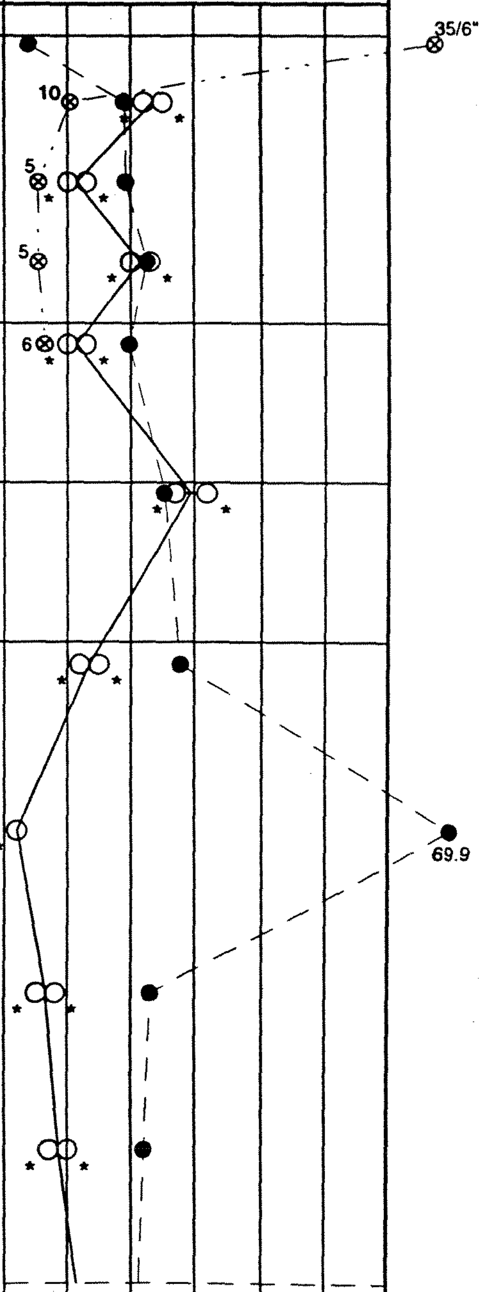
PLASTIC LIMIT % ✕ — WATER CONTENT % ● — LIQUID LIMIT % △ 10 20 30 40 50

⊗ STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

UNIT DRY WT. LBS./FT.^{3}

SURFACE ELEVATION +15.6 CCD

DEPTH(FT) ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL
		PA			Asphalt (2-3") and 10" base course
	1	SS			Fill: Sandy clay, little crushed concrete, slag and cinders - gray - very stiff to stiff (CL)
		PA			
	2	SS			
5.0		PA			
	3	SS			
		PA			
	4	SS			
10.0		PA			
	5	SS			Silty clay to clayey silt, little roots - gray (CL-ML)
		RB			
15.0	6	ST			Silty clay, trace gravel and sand - brownish gray - very stiff (CL)
		RB			
20.0	7	ST			Silty clay, trace gravel, sand and shale - gray - stiff to soft (CL)
		RB			
25.0	8	ST			
		RB			
30.0	9	ST			
		RB			
35.0	10	ST			
		RB			
40.0					



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* Calibrated Penetrometer

BORING_LOG 30852.GPJ STS.GDT 2/1/00

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

STS JOB NO. 30852

SHEET NO. 1 OF 3

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-9**

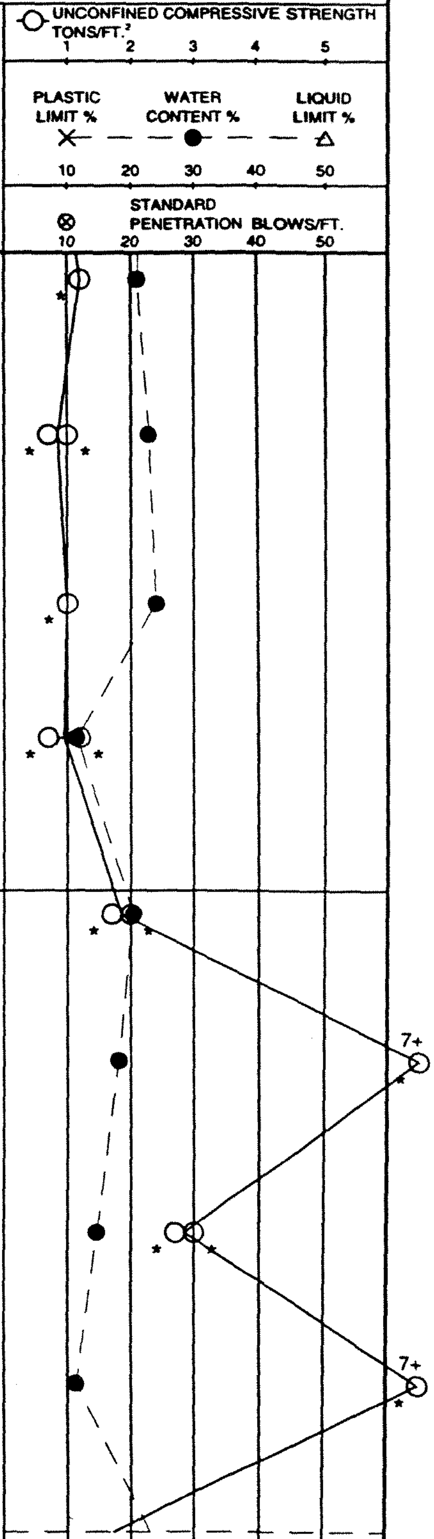
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.6 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		11	ST			Silty clay, trace gravel, sand and shale - gray - stiff to soft (CL)	
			RB				
45.0		12	ST				
			RB				
50.0		13	ST				
			RB				
55.0		14	ST			Sample 14 - disturbed sample.	
			RB				
60.0		15	ST			Silty clay, trace gravel, sand and shale - hard to stiff (CL)	
			RB				
65.0		17	ST				
			RB				
70.0		17	ST				
			RB				
75.0		18	ST				
			RB				
80.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 2 OF 3

STS Consultants Ltd.

OWNER
Interparking

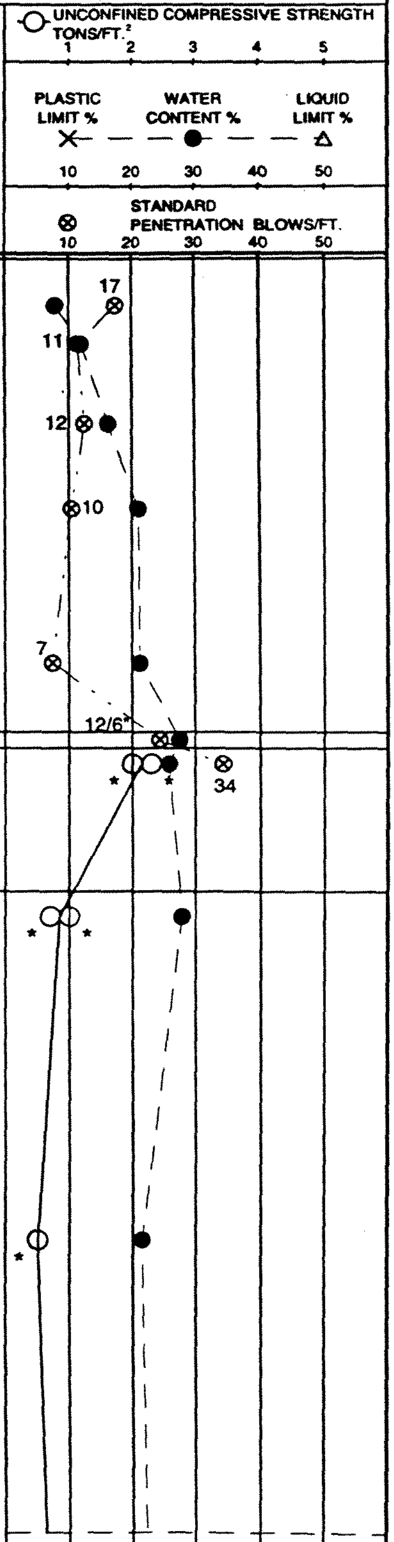
LOG OF BORING NUMBER **B-10**

PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						SURFACE ELEVATION +16.3 CCD	
			PA			Asphalt (2")	
		1	SS			Urban fill: Cinders, brick, crushed concrete, sand and gravel	
		2	SS				
5.0			PA				
		3	SS				
			PA				
		4	SS				
10.0			PA				
		5	SS			Driller's observation: Strong petroleum odor noted in Sample 5.	
15.0			PA				
		6	SS*			Silty sand - brown - medium dense - saturated (SP to SM)	
		6A	SS			Silty clay, trace gravel, sand and shale - brownish gray - very stiff (CL)	
			RB				
20.0		7	ST			Silty clay, trace shale - gray - medium (CL)	
25.0			RB				
30.0		8	ST				
35.0			RB				
40.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 1 OF 4

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-10**

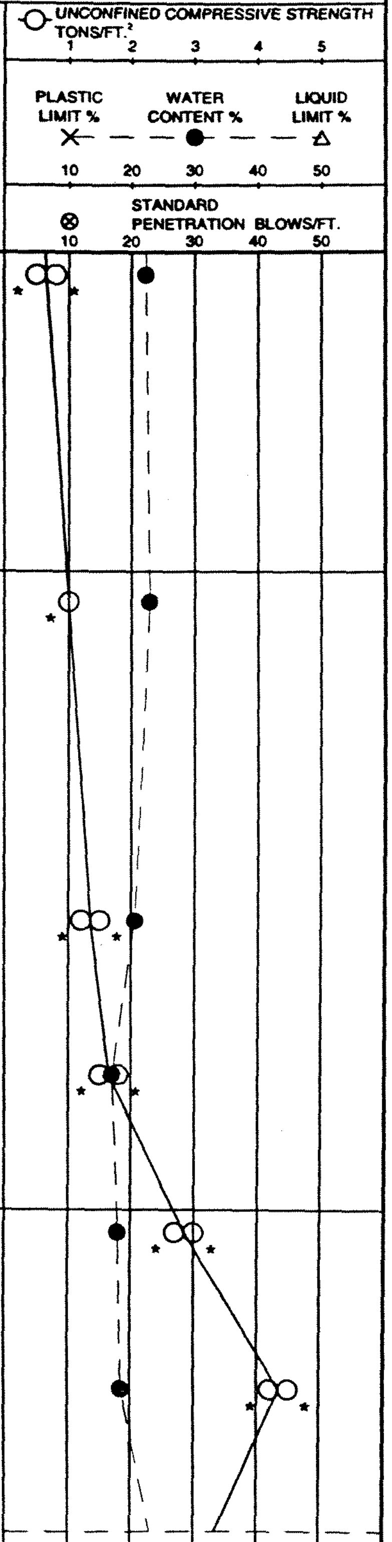
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +16.3 CCD (Continued)

DEPTH(FT) · ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
	9	ST			Silty clay, trace shale - gray - medium (CL)	
45.0		RB				
50.0	10	ST			Silty clay, trace gravel, sand and shale - gray - stiff (CL)	
55.0		RB				
60.0	11	ST				117
		RB				
65.0	12	ST				
		RB				
70.0	13	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)	
		RB				
75.0	14	ST				
		RB				
80.0						



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* Calibrated Penetrometer

BORING_LOG 30852.GPJ STS.GDT 1/31/00

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

STS JOB NO. 30852

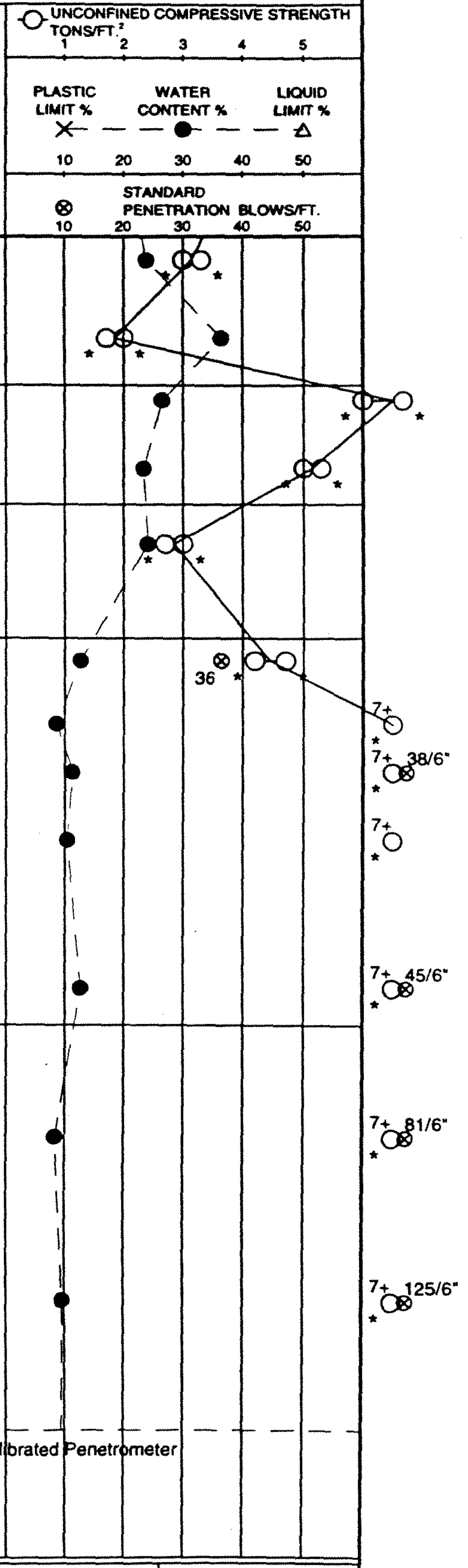
SHEET NO. 2 OF 4

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-10**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +16.3 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		15	ST			Silty clay, trace gravel, sand and shale - gray - very stiff to hard (CL)	
			RB				
		16	ST				
85.0			RB				
		17	ST			Very silty clay to clayey silt, trace gravel, sand and shale - gray - hard (CL to CL-ML)	
			RB			Saturated silt seams noted in Sample 18.	
		18	ST			Pressuremeter Test at 85-87.5 ft.	
90.0			RB			Driller's observation: Sand and gravel (likely saturated).	
		19	ST			Drilling fluid loss=60% from 90-93'.	
			RB			Note: Borehole was caving in when trying to run pressuremeter test. No PMT could be performed at 90-92.5 ft.	
95.0		20	SS			Silty clay to clayey silt, trace gravel, sand and shale - gray - hard (CL to CL-ML) Pressuremeter Test at 93.5-96 ft.	
			RB				
		21	ST				
			RB				
		22	ST			Pressuremeter Test at 97.5-100 ft.	
100.0			RB				
		23	ST				
			RB			Boulder obstruction encountered from 102-102.75'.	
105.0		24	SS*				
			RB			Clayey silt to silt, trace gravel, sand and shale - gray - hard - wet (CL-ML to ML) Drilling fluid loss=20% from 107.5 to EOB. Boulder obstruction encountered from 107-107.5', 111-111.5', 114-115', 116.5-117' and 122-122.5'.	
110.0		25	SS*				
			RB				
115.0							
		26	SS*				
			RB				
120.0							



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* Calibrated Penetrometer

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

STS JOB NO. 30852

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-10**

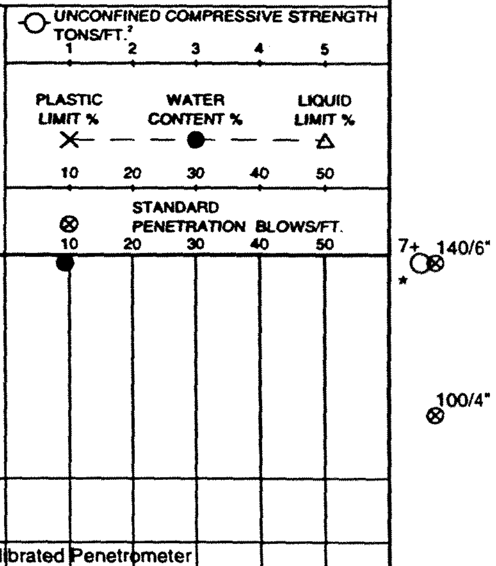
PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +16.3 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		27	SS*			Clayey silt to silt, trace gravel, sand and shale - gray - hard - wet (CL-ML to ML)	
			RB			Drilling fluid loss=20% from 107.5 to EOB. Boulder obstruction encountered from 107-107.5', 111-111.5', 114-115', 116.5-117' and 122-122.5'.	
125.0			SS*				
			RB			Driller's observation: Probable weathered limestone bedrock.	
129.0						End of Boring Borehole grouted upon completion. Casing used: 20 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in. or less.	* Calibrated Penetrometer



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

WL 14.5 ft. WS	BORING STARTED 1/14/00	STS OFFICE Chicago Area - 01
WL 22.0 ft. BCR; 22.0 ft. ACR	BORING COMPLETED 1/17/00	ENTERED BY KKB SHEET NO. 4 OF 4
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP STS JOB NO. 30852

STS Consultants Ltd.

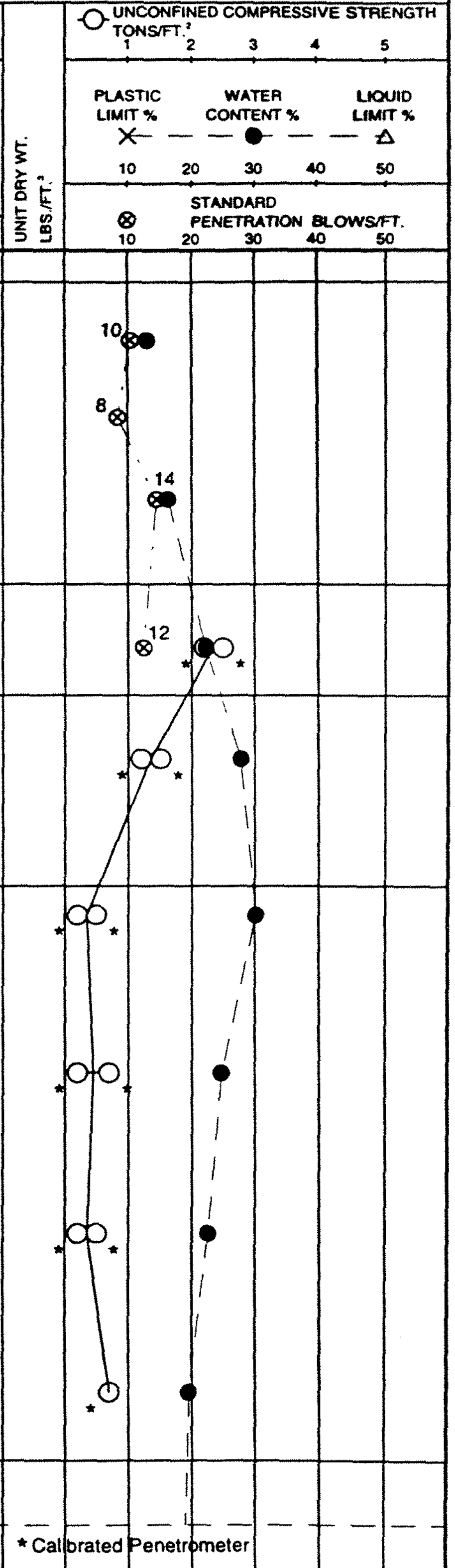
OWNER **Interparking**	LOG OF BORING NUMBER **B-11**
PROJECT NAME **LaSalle/Hubbard Development**	ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.8 CCD

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
						Asphalt (2-3") and base course (10")	
			PA			Urban fill: Cinders, brick, sand, gravel, crushed concrete, clay and slag	
		1	SS				
5.0			PA				
		2	SS				
			PA				
		3	SS				
10.0						Driller's observation: Concrete slab encountered at 10-10.5'.	
			PA			Fill: Silty clay, little brick - brownish gray - very stiff (CL)	
		4	SS				
15.0			RB			Silty clay, trace gravel and sand - brownish gray - stiff (CL)	
		5	ST				
			RB				
20.0							
		6	SS			Silty clay - gray - soft to medium (CL)	
			RB				
25.0							
		7	ST				
			RB				
30.0							
		8	ST				
			RB				
35.0							
		9	ST				
			RB			Silty fine to coarse sand, trace clay and gravel - gray - medium dense - saturated (SM)	
40.0							

. . . continued



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

STS JOB NO. 30852

SHEET NO. 1 OF 3

STS Consultants Ltd.

OWNER
Interparking

LOG OF BORING NUMBER **B-11**

PROJECT NAME
LaSalle/Hubbard Development

ARCHITECT-ENGINEER

SITE LOCATION
SWC LaSalle & Hubbard Streets; Chicago, IL

SURFACE ELEVATION +15.8 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
		10	SS*			Silty fine to coarse sand, trace clay and gravel - gray - medium dense - saturated (SM) 20% drilling fluid loss at 38-48'.	
		10A	SS				
			RB			Silty clay, trace gravel, sand and shale - gray - stiff (CL)	
45.0						Sandy clay to clayey sand, little gravel - gray (CL to SC)	
		11	SS				
			RB				
50.0						Silty clay, trace gravel, sand and shale - gray - stiff to very stiff	
		12	ST				
			RB				
55.0							
		13	ST				
			RB				
60.0							
		14	ST				
			RB				
65.0							
		15	ST				
			RB				
70.0						Silty clay, trace gravel, sand and shale - gray - very stiff to stiff (CL)	
		16	ST				
			RB				
75.0							
		17	ST				
			RB				
80.0							

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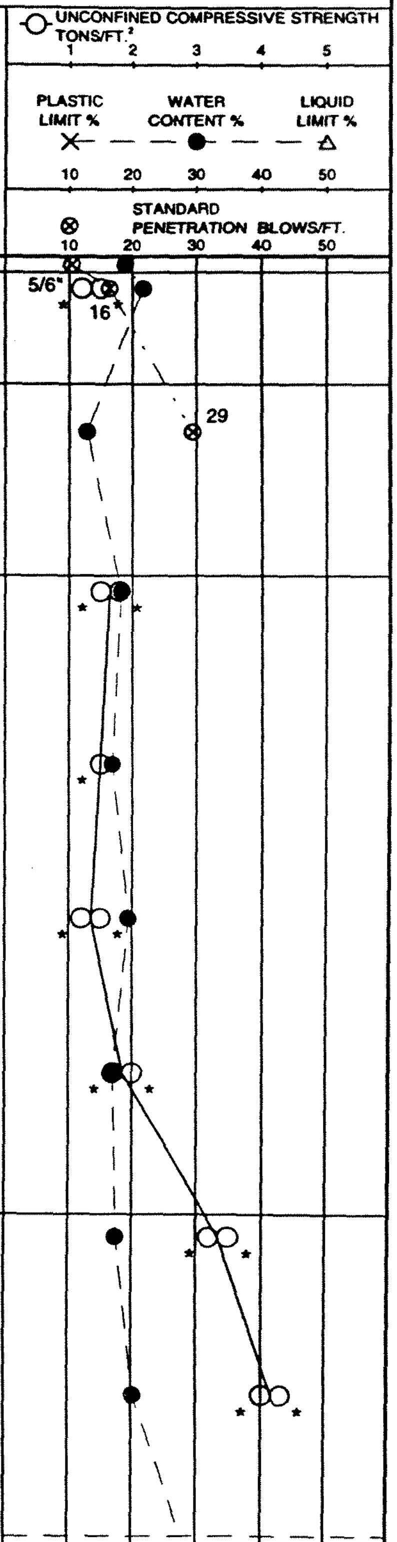


* Calibrated Penetrometer

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

STS JOB NO. 30852

SHEET NO. 2 OF 3

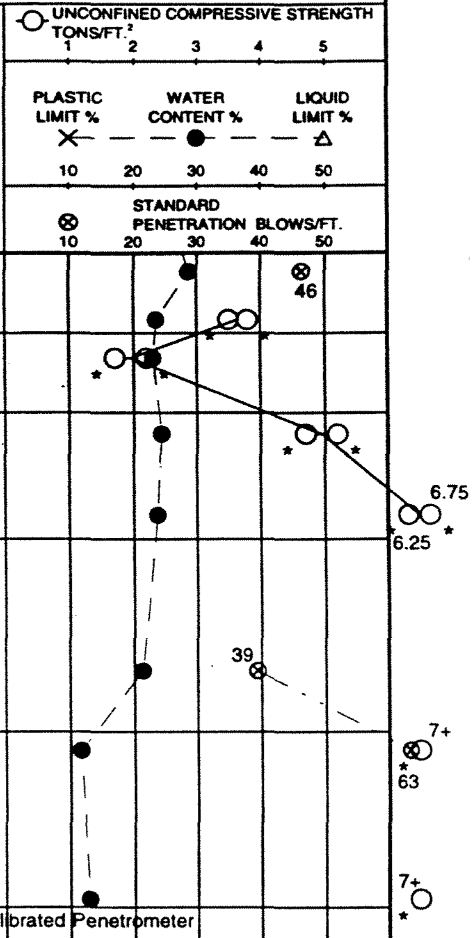
BORING_LOG 30852.GPJ STS.GDT 2/1/00

STS Consultants Ltd.

OWNER	**Interparking**
LOG OF BORING NUMBER	**B-11**
PROJECT NAME	**LaSalle/Hubbard Development**
ARCHITECT-ENGINEER	
SITE LOCATION	**SWC LaSalle & Hubbard Streets; Chicago, IL**

SURFACE ELEVATION +15.8 CCD (Continued)

DEPTH(FT)	ELEVATION(FT)	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.^{3}
		22	SS	Silty clay, trace gravel, sand and shale - gray - very stiff to stiff (CL)	
		18	ST		
			RB		
		19	ST	Clayey silt, trace gravel, sand and shale - gray - stiff to very stiff (CL-ML) Wet silt seams noted.	109
85.0			RB		
		20	ST	Clayey silt, trace gravel, sand and shale - gray - hard - wet (CL-ML to ML)	
			RB		
		21	ST		
90.0			RB	Silt, little clay, trace sand and shale - gray - dense - saturated (ML)	
			RB		
		23	SS		
95.0			RB		
		24	SS	Very silty clay, trace gravel, sand and shale - gray - hard (CL)	
			RB		
100.0		25	ST		
100.5				End of Boring Borehole grouted upon completion. Casing used: 20 ft. of 4 in. Automatic-Mobile Hammer used for Standard Penetration Tests. SS* = SPT value based on first 6 in.	



* Calibrated Penetrometer

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

WL 13.5 ft. WS	BORING STARTED 1/25/00	STS OFFICE Chicago Area - 01	
WL 21.0 ft. BCR; 21.0 ft. ACR	BORING COMPLETED 1/25/00	ENTERED BY KKB	SHEET NO. 3 OF 3
WL	RIG/FOREMAN Mobile B-61/Baker	APP'D BY AJP	STS JOB NO. 30852

BORING_LOG 30852.GPJ STS.GDT 2/1/00

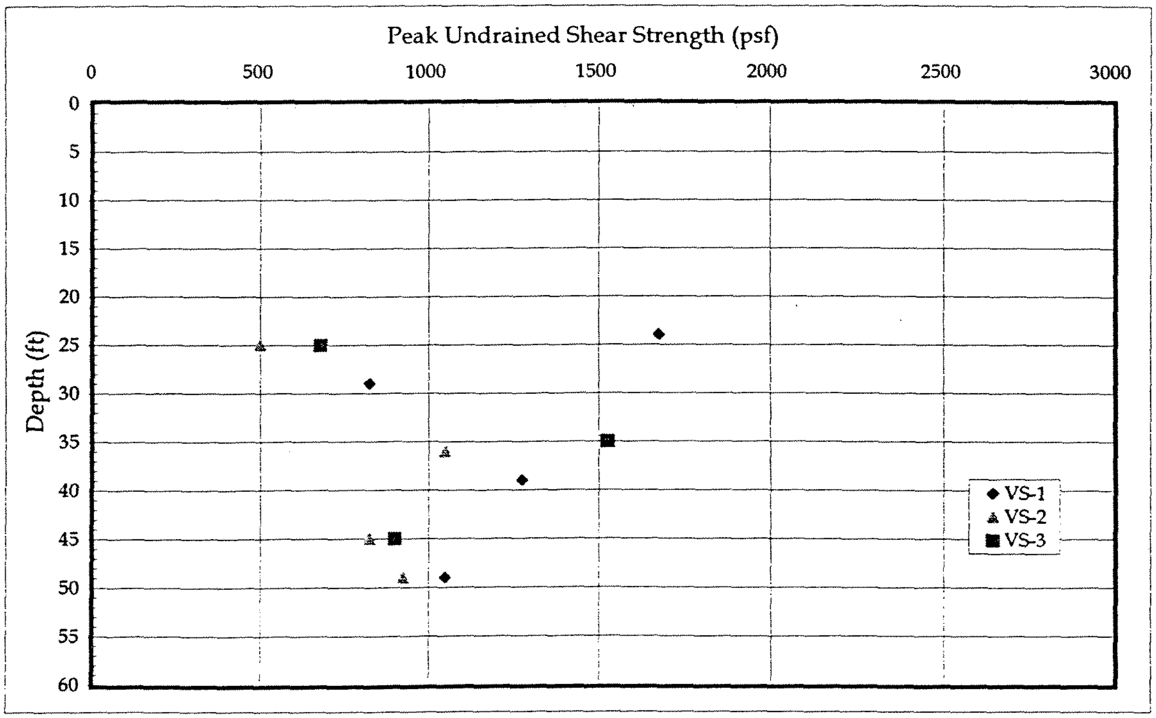
PROJECT: 400 N. LaSalle
STS JOB NUMBER: 30852-A
OPERATOR: Knight
DATE OF TEST: 01/04/01
SURFACE ELEVATION: 15 Feet CCD +/-
DATA REDUCTION: Knight

*VANE SIZE
2.0 = SMALL (11CM X 5CM) VANE
1.0 = MEDIUM (13CM X 6.5 CM) VANE
0.5 = LARGE (17.2CM X 8CM) VANE
VANE CONSTANT, K=1.0071

VANE SHEAR RESULTS

BORING NO.	VANE TIP DEPTH (ft)	VANE	a (in)	PEAK S_u		a (in)	REMOLDED S_u		SENSITIVITY PEAK/REM.	APPROX. VANE TIP ELEVATION (CCD)
				(tsf)	(psf)		(tsf)	(psf)		
VS-1	24.0	1.0	3.21	0.84	1675	-	-	-	-	-9.0
	29.0	1.0	1.59	0.42	825	0.86	0.22	450	1.8	-14.0
	39.0	1.0	2.43	0.63	1275	1.46	0.38	750	1.7	-24.0
	49.0	1.0	2.00	0.52	1050	1.27	0.33	675	1.6	-34.0
VS-2	25.0	1.0	0.94	0.25	500	0.50	0.13	250	2.0	-10.0
	36.0	1.0	2.03	0.53	1050	1.05	0.27	550	1.9	-21.0
	45.0	1.0	1.60	0.42	825	0.80	0.21	425	1.9	-30.0
	49.0	1.0	1.77	0.46	925	0.93	0.24	475	1.9	-34.0
VS-3	25.0	1.0	1.28	0.33	675	0.52	0.14	275	2.5	-10.0
	35.0	1.0	2.91	0.76	1525	1.25	0.33	650	2.3	-20.0
	45.0	1.0	1.74	0.45	900	0.91	0.24	475	1.9	-30.0

Comments: VS-1 (24') test maxed out vane testing limits



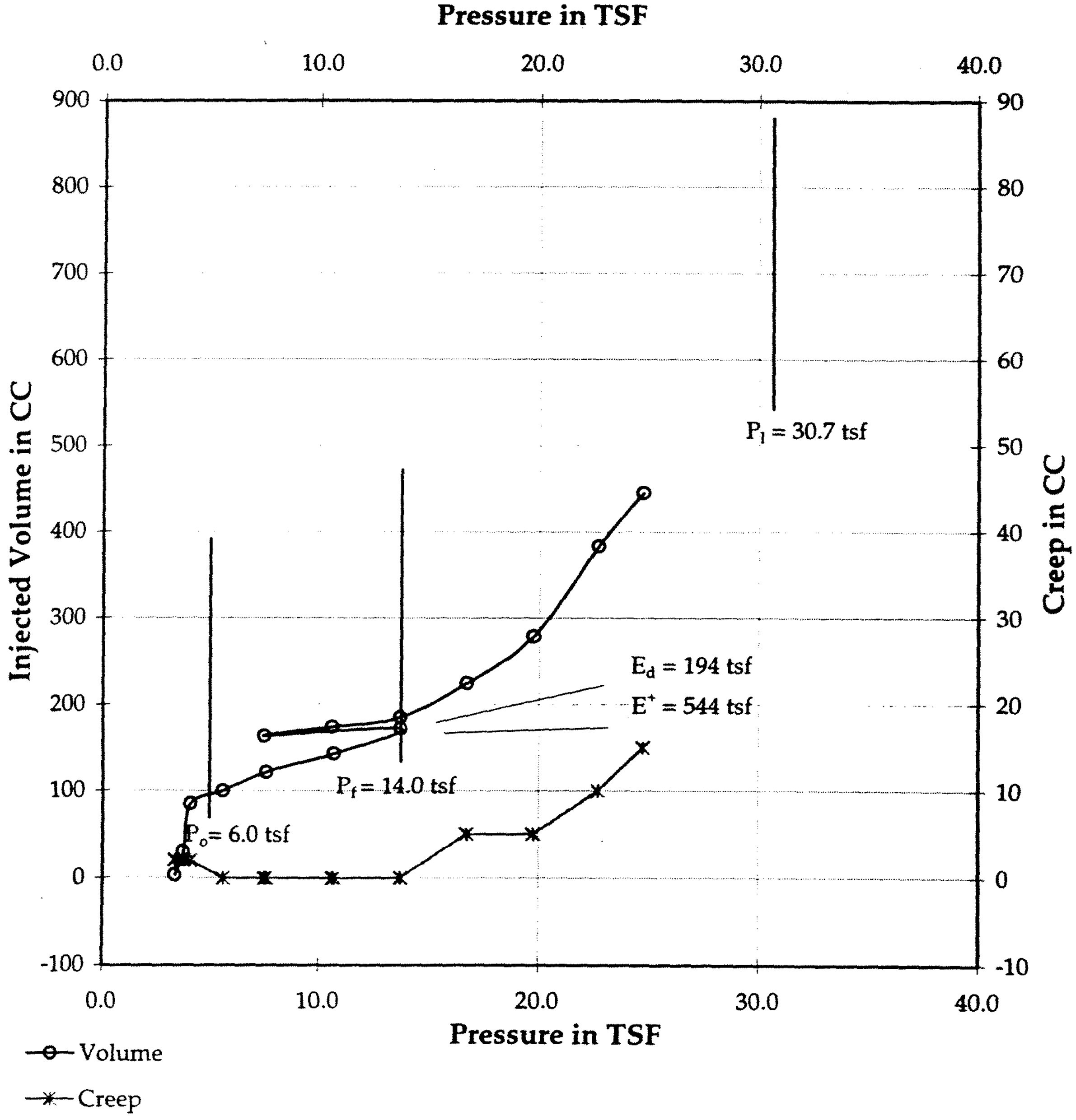
PROJECT NAME: Walker Parking
STS JOB NUMBER: 30852
OPERATOR: Seiler
DATE: 1/15/00

PRESSUREMETER TEST RESULTS

BORING NUMBER	DEPTH (ft)	P_o (tsf)	P_f (tsf)	P_l (tsf)	E_d (tsf)	E^+ (tsf)	E_d / E^+	E_d / P_l	P_l / P_f
1	82.5-85.0	6.0	14.0	30.7	194	544	0.36	6.3	2.2
	87.5-90.0	7.0	34.0	-	697	1597	0.44	-	-
	92.5-95.0	7.0	29.0	-	662	1441	0.46	-	-
5	82.5-85.0	6.0	18.0	35.9	313	481	0.65	8.7	2.0
	87.5-90.0	7.0	37.0	-	1161	3431	0.34	-	-
	92.5-95.0	7.0	26.0	-	677	1134	0.60	-	-
	100.0-102.5	7.0	18.0	34.7	478	798	0.60	13.8	1.9
10	85.0-87.5	6.0	15.0	27.5	240	742	0.32	8.7	1.8
	93.5-96.0	6.0	15.0	30.6	201	434	0.46	6.6	2.0
	97.5-100.0	7.0	18.0	40.3	310	349	0.89	7.7	2.2
					AVERAGE		0.51	8.6	2.0

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-13-00
Boring No. 1
Test Depth: 82.5-85.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 1
Test Depth: 82.5-85.0 Feet

Pressuremeter Data Reduction (BX)

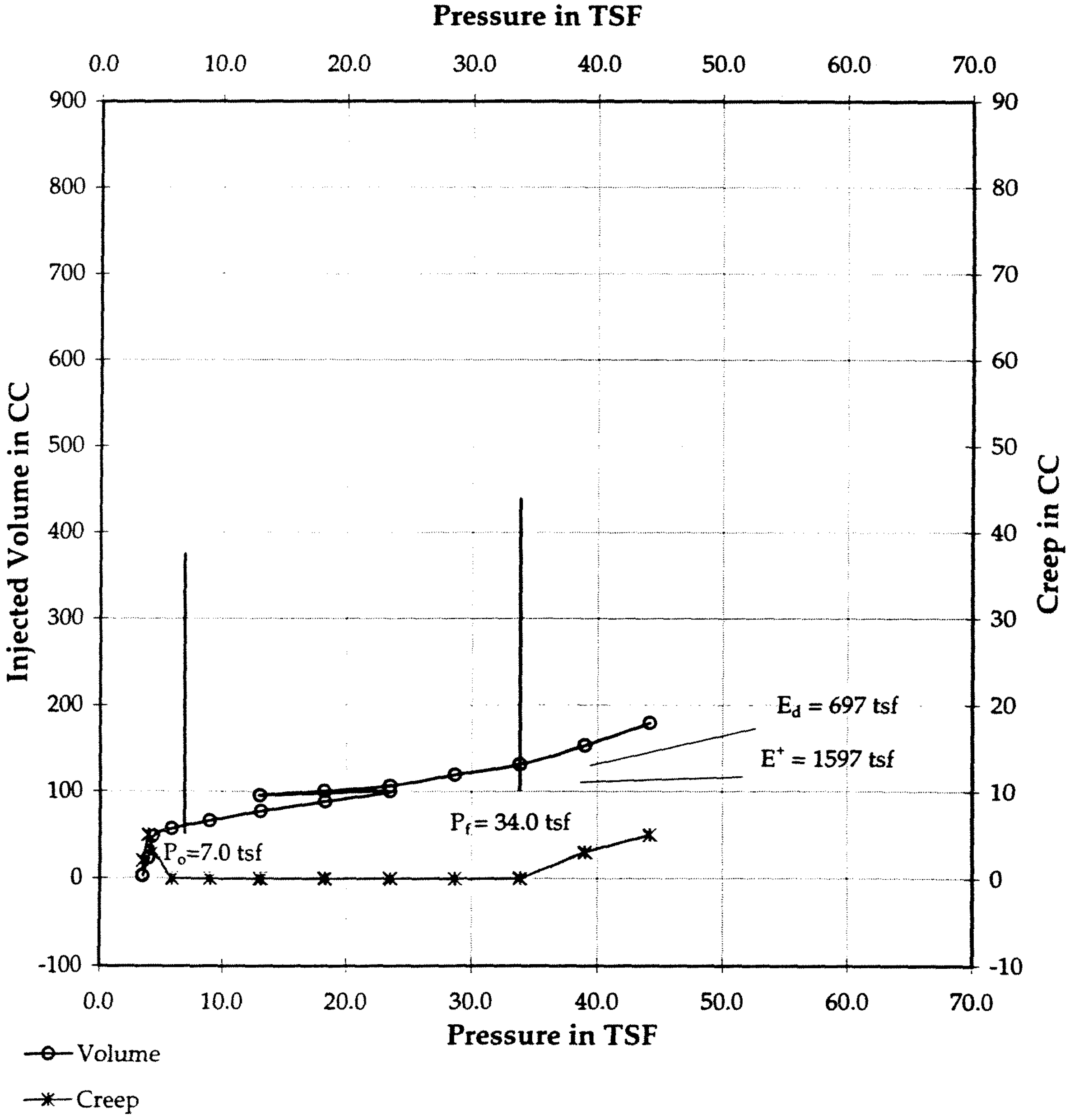
Water Correction: 2.74

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.02	3.4	3	5	2	1.0	3.0	
2	1.00	0.13	3.8	30	32	2	27.8	29.8	22
3	1.50	0.32	4.1	85	87	2	82.7	84.7	9
4	3.00	0.37	5.6	103	103	0	100.1	100.1	164
5	5.00	0.43	7.6	125	125	0	121.5	121.5	162
6	8.00	0.49	10.7	147	147	0	142.8	142.8	257
7	11.00	0.57	13.8	177	177	0	172.1	172.1	191
8	5.00	0.54	7.5	167	167	0	163.5	163.5	1358
9	8.00	0.57	10.6	178	178	0	173.8	173.8	568
10	11.00	0.60	13.7	190	190	0	185.1	185.1	519
11	14.00	0.69	16.8	225	230	5	219.6	224.6	152
12	17.00	0.80	19.8	280	285	5	274.0	279.0	116
13	20.00	0.98	22.7	380	390	10	373.5	383.5	65
14	22.00	1.08	24.7	437	452	15	430.1	445.1	81

E_d= 194 TSF E^+= 544 TSF P_l= 30.7 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-13-00
Boring No. 1
Test Depth: 87.5-90.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 1
Test Depth: 87.5-90.0 Feet

Pressuremeter Data Reduction (BX)

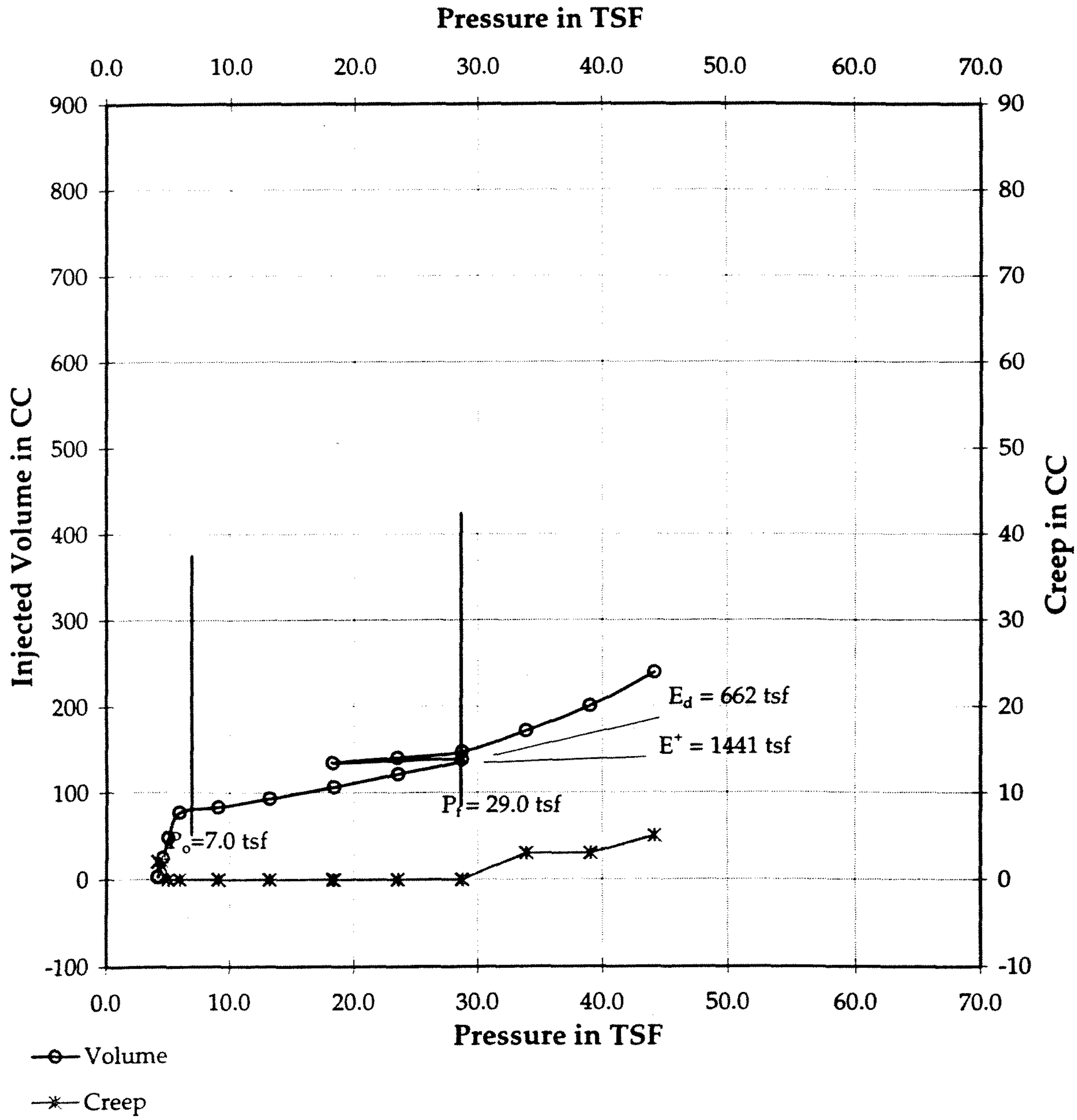
Water Correction: 2.90

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.02	3.5	3	5	2	0.9	2.9	
2	1.00	0.10	4.0	20	25	5	17.7	22.7	32
3	1.50	0.19	4.4	47	50	3	44.6	47.6	26
4	3.00	0.23	5.9	60	60	0	57.0	57.0	252
5	6.00	0.26	9.0	70	70	0	66.2	66.2	539
6	10.00	0.30	13.2	82	82	0	77.3	77.3	601
7	15.00	0.34	18.3	94	94	0	88.3	88.3	771
8	20.00	0.38	23.5	107	107	0	100.4	100.4	719
9	10.00	0.36	13.1	100	100	0	95.3	95.3	3440
10	15.00	0.38	18.3	106	106	0	100.3	100.3	1736
11	20.00	0.40	23.5	113	113	0	106.4	106.4	1458
12	25.00	0.44	28.7	127	127	0	119.4	119.4	687
13	30.00	0.47	33.9	140	140	0	131.3	131.3	764
14	35.00	0.53	39.0	160	163	3	150.2	153.2	425
15	40.00	0.60	44.2	185	190	5	174.1	179.1	371

$E_d=$ 697 TSF $E^+=$ 1597 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-13-00
Boring No. 1
Test Depth: 92.5-95.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 1
Test Depth: 92.5-95.0 Feet

Pressuremeter Data Reduction (BX)

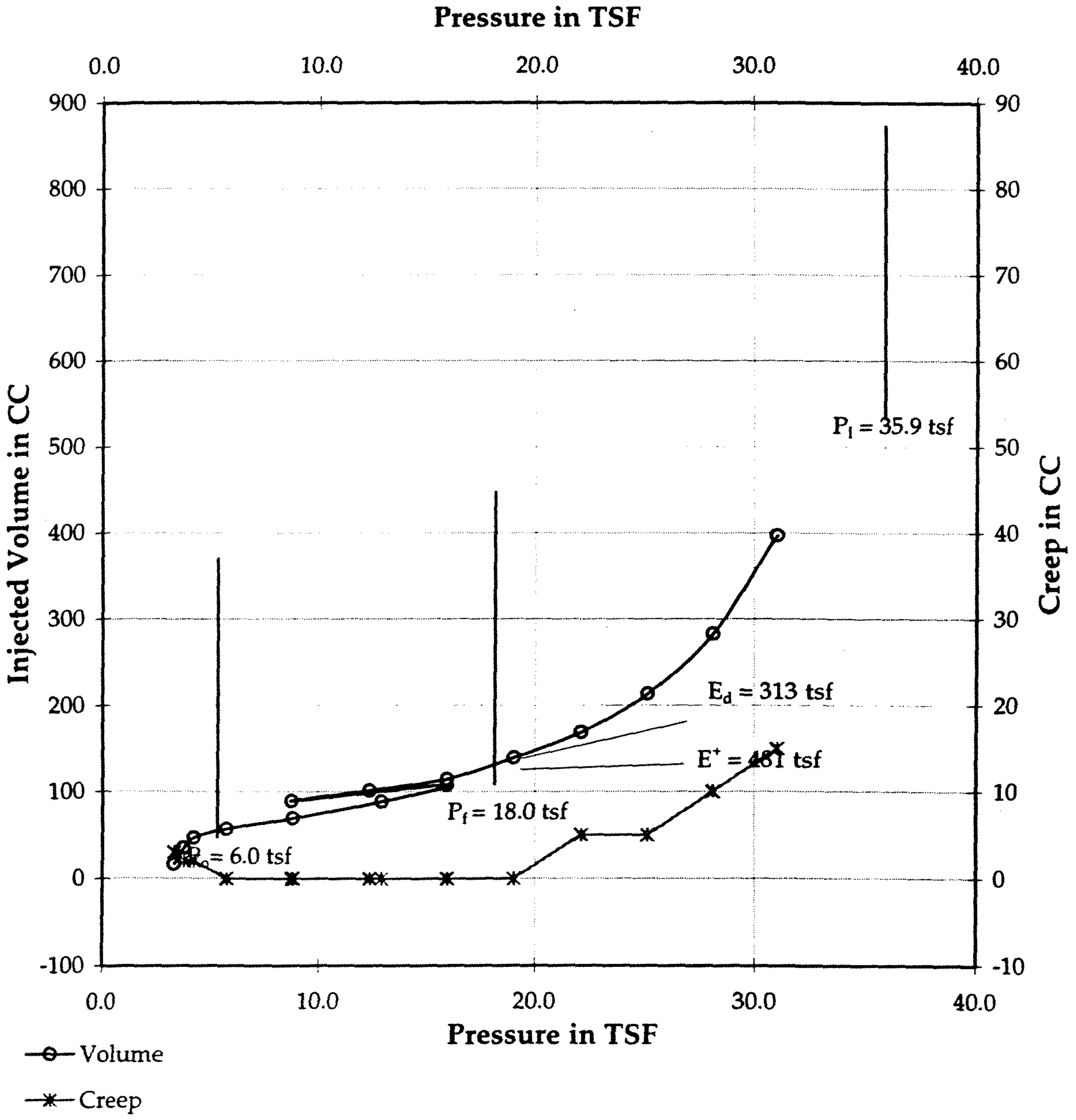
Water Correction: 3.05

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	1.00	0.02	4.2	3	5	2	0.6	2.6	
2	1.50	0.11	4.6	25	27	2	22.5	24.5	29
3	2.00	0.19	5.1	50	50	0	47.3	47.3	29
4	3.00	0.30	6.0	80	80	0	77.0	77.0	50
5	6.00	0.32	9.1	87	87	0	83.1	83.1	830
6	10.00	0.35	13.3	98	98	0	93.2	93.2	680
7	15.00	0.40	18.4	112	112	0	106.3	106.3	670
8	20.00	0.44	23.6	128	128	0	121.3	121.3	593
9	25.00	0.49	28.8	146	146	0	138.3	138.3	538
10	15.00	0.47	18.4	140	140	0	134.3	134.3	4615
11	20.00	0.49	23.6	147	147	0	140.4	140.4	1536
12	25.00	0.51	28.8	155	155	0	147.3	147.3	1345
13	30.00	0.58	33.9	177	180	3	168.3	171.3	398
14	35.00	0.65	39.1	207	210	3	197.2	200.2	342
15	40.00	0.73	44.2	245	250	5	234.1	239.1	265

E_d= 662 TSF E^+= 1441 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-7-00
Boring No. 5
Test Depth: 82.5-85.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 5
Test Depth: 82.5-85.0 Feet

Pressuremeter Data Reduction (BX)

Water Correction: 2.74

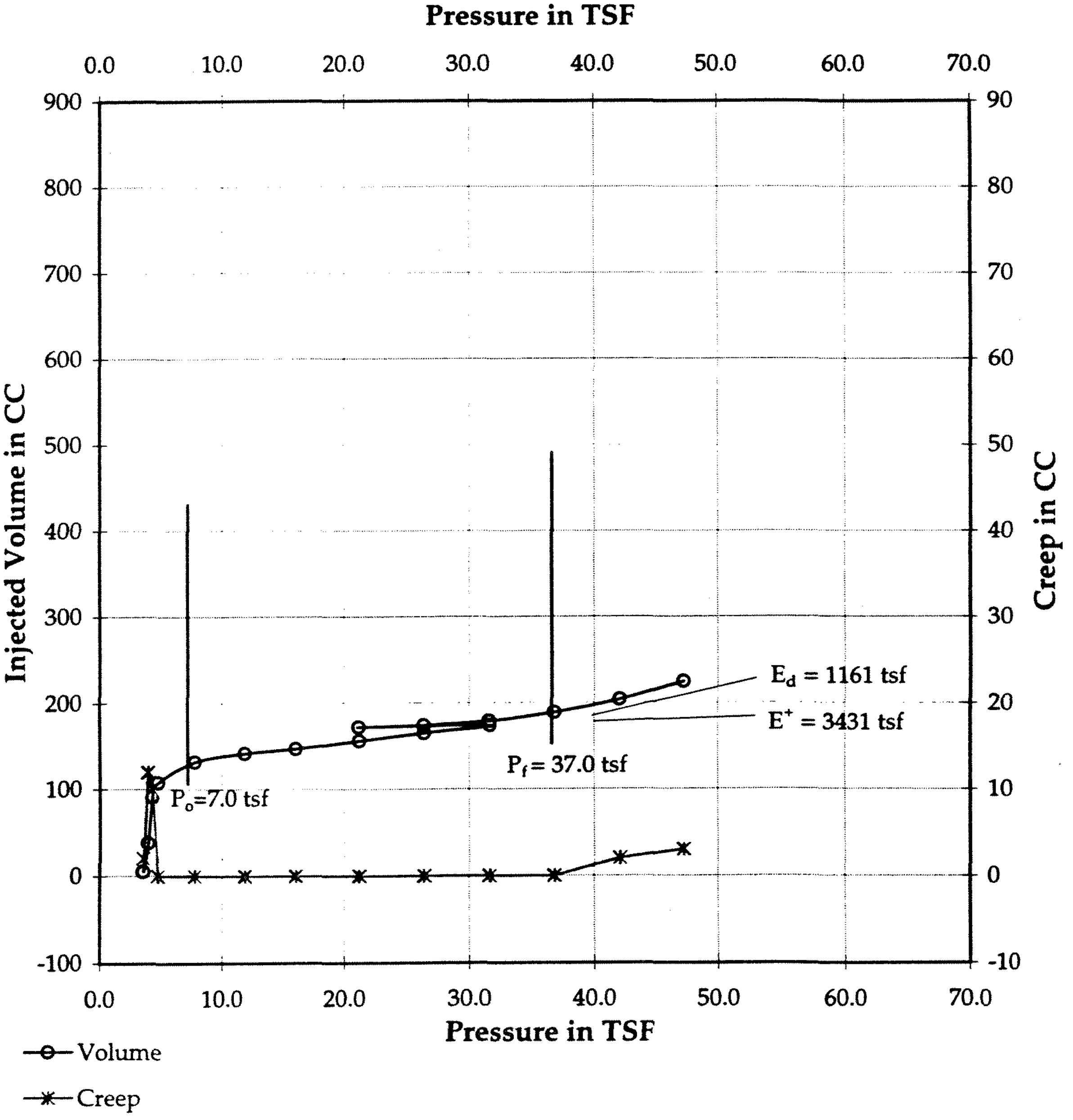
No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.07	3.3	15	18	3	13.0	16.0	
2	1.00	0.15	3.8	35	37	2	32.8	34.8	35
3	1.50	0.19	4.2	47	49	2	44.6	46.6	62
4	3.00	0.23	5.8	60	60	0	57.1	57.1	228
5	6.00	0.27	8.8	73	73	0	69.2	69.2	405
6	10.00	0.34	13.0	93	93	0	88.3	88.3	351
7	13.00	0.40	16.0	113	113	0	107.7	107.7	266
8	6.00	0.34	8.8	93	93	0	89.2	89.2	660
9	9.50	0.38	12.4	106	106	0	101.4	101.4	497
10	13.00	0.42	16.0	120	120	0	114.7	114.7	464
11	16.00	0.49	19.1	145	145	0	139.2	139.2	220
12	19.00	0.56	22.1	170	175	5	163.6	168.6	190
13	22.00	0.67	25.1	215	220	5	208.1	213.1	131
14	25.00	0.81	28.1	280	290	10	272.5	282.5	90
15	28.00	1.01	31.1	390	405	15	381.9	396.9	60

$E_d=$ 313 TSF $E^+=$ 481 TSF $P_l=$ 35.9 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852
Boring No. 5
Test Depth: 87.5-90.0 Feet

Date: 1-7-00



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 5
Test Depth: 87.5-90.0 Feet

Pressuremeter Data Reduction (BX)

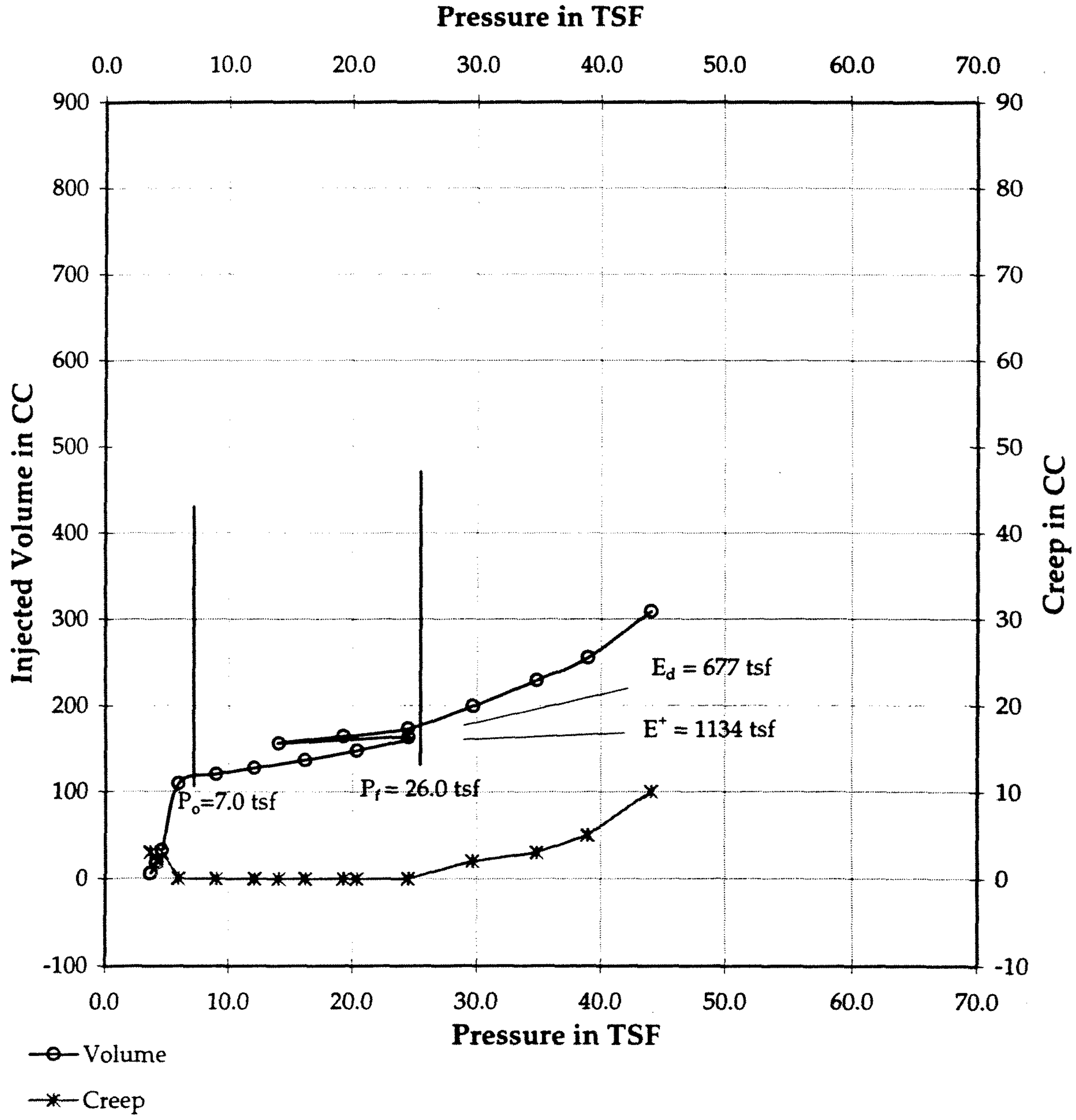
Water Correction: 2.90

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.03	3.5	5	7	2	2.9	4.9	
2	1.00	0.16	3.9	28	40	12	25.7	37.7	17
3	1.50	0.34	4.2	83	93	10	80.6	90.6	10
4	2.00	0.39	4.7	110	110	0	107.4	107.4	47
5	5.00	0.46	7.8	135	135	0	131.5	131.5	222
6	9.00	0.49	11.9	146	146	0	141.5	141.5	739
7	13.00	0.51	16.1	152	152	0	146.7	146.7	1444
8	18.00	0.53	21.3	162	162	0	155.8	155.8	1046
9	23.00	0.56	26.5	172	172	0	164.8	164.8	1065
10	28.00	0.58	31.7	182	182	0	173.7	173.7	1089
11	18.00	0.57	21.2	178	178	0	171.8	171.8	10053
12	23.00	0.58	26.4	181	181	0	173.8	173.8	4867
13	28.00	0.59	31.7	187	187	0	178.7	178.7	1995
14	33.00	0.62	36.9	198	198	0	188.6	188.6	1004
15	38.00	0.65	42.0	212	214	2	201.5	203.5	677
16	43.00	0.70	47.2	233	236	3	221.4	224.4	492

E_d= 1161 TSF E^+= 3431 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852
Date: 1-7-00
Boring No. 5
Test Depth: 92.5-95.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 5
Test Depth: 92.5-95.0 Feet

Pressuremeter Data Reduction (BX)

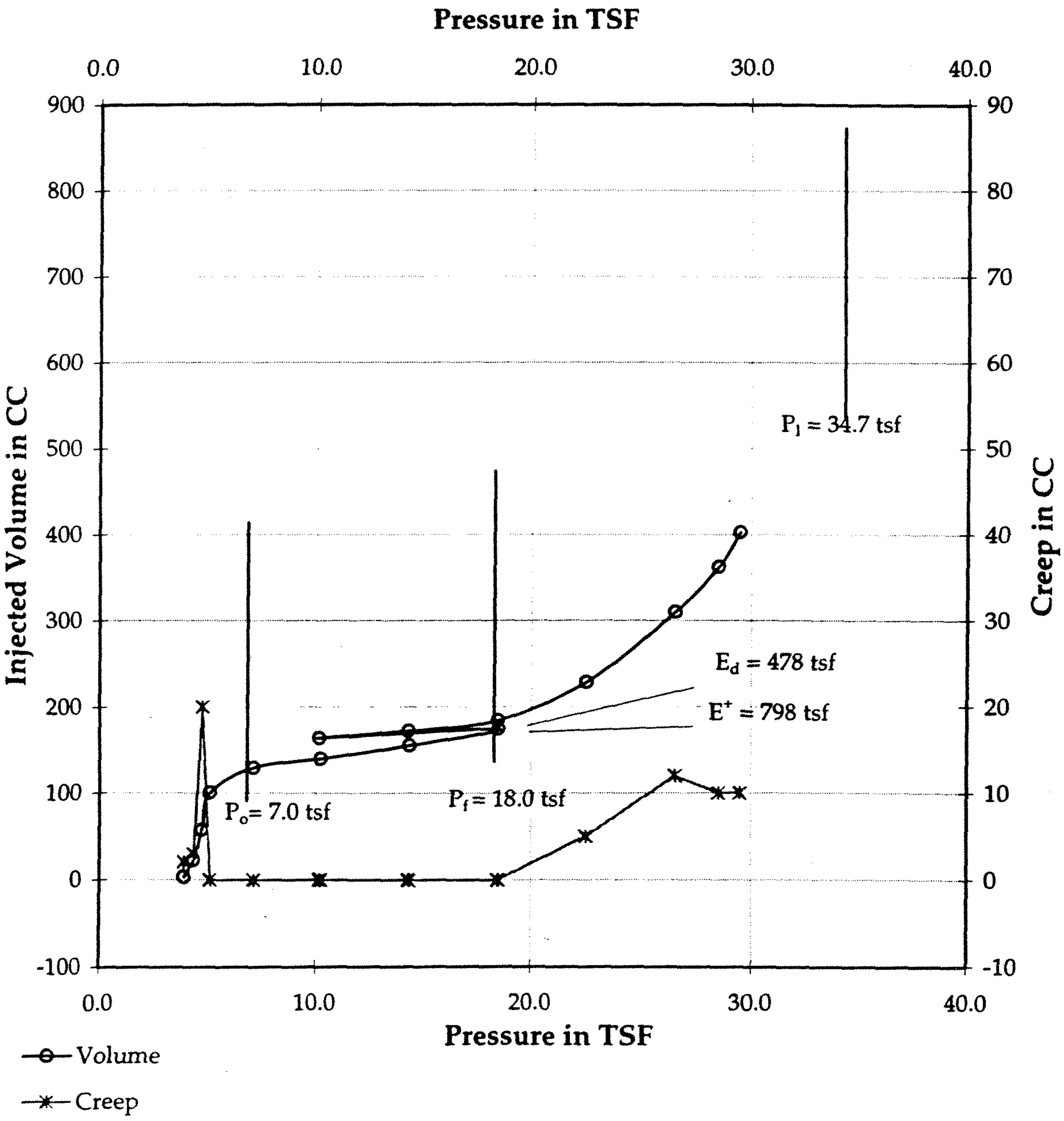
Water Correction: 3.05

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.03	3.7	5	8	3	2.8	5.8	
2	1.00	0.08	4.1	18	20	2	15.7	17.7	58
3	1.50	0.14	4.6	32	35	3	29.5	32.5	46
4	3.00	0.40	5.9	112	112	0	109.0	109.0	27
5	6.00	0.43	9.0	124	124	0	120.2	120.2	481
6	9.00	0.45	12.1	132	132	0	127.5	127.5	746
7	13.00	0.48	16.3	142	142	0	136.7	136.7	799
8	17.00	0.51	20.4	154	154	0	147.9	147.9	663
9	21.00	0.55	24.5	170	170	0	163.2	163.2	499
10	11.00	0.53	14.1	161	161	0	156.1	156.1	2711
11	16.00	0.55	19.3	170	170	0	164.1	164.1	1192
12	21.00	0.58	24.5	180	180	0	173.2	173.2	1075
13	26.00	0.64	29.7	205	207	2	197.2	199.2	381
14	31.00	0.71	34.8	235	238	3	226.1	229.1	343
15	35.00	0.76	38.9	260	265	5	250.2	255.2	326
16	40.00	0.86	44.1	310	320	10	299.1	309.1	206

E_d= 677 TSF E^+= 1134 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-7-00
Boring No. 5
Test Depth: 100.0-102.5 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 5
Test Depth: 100.0-102.5 Feet

Pressuremeter Data Reduction (BX)

Water Correction: 3.28

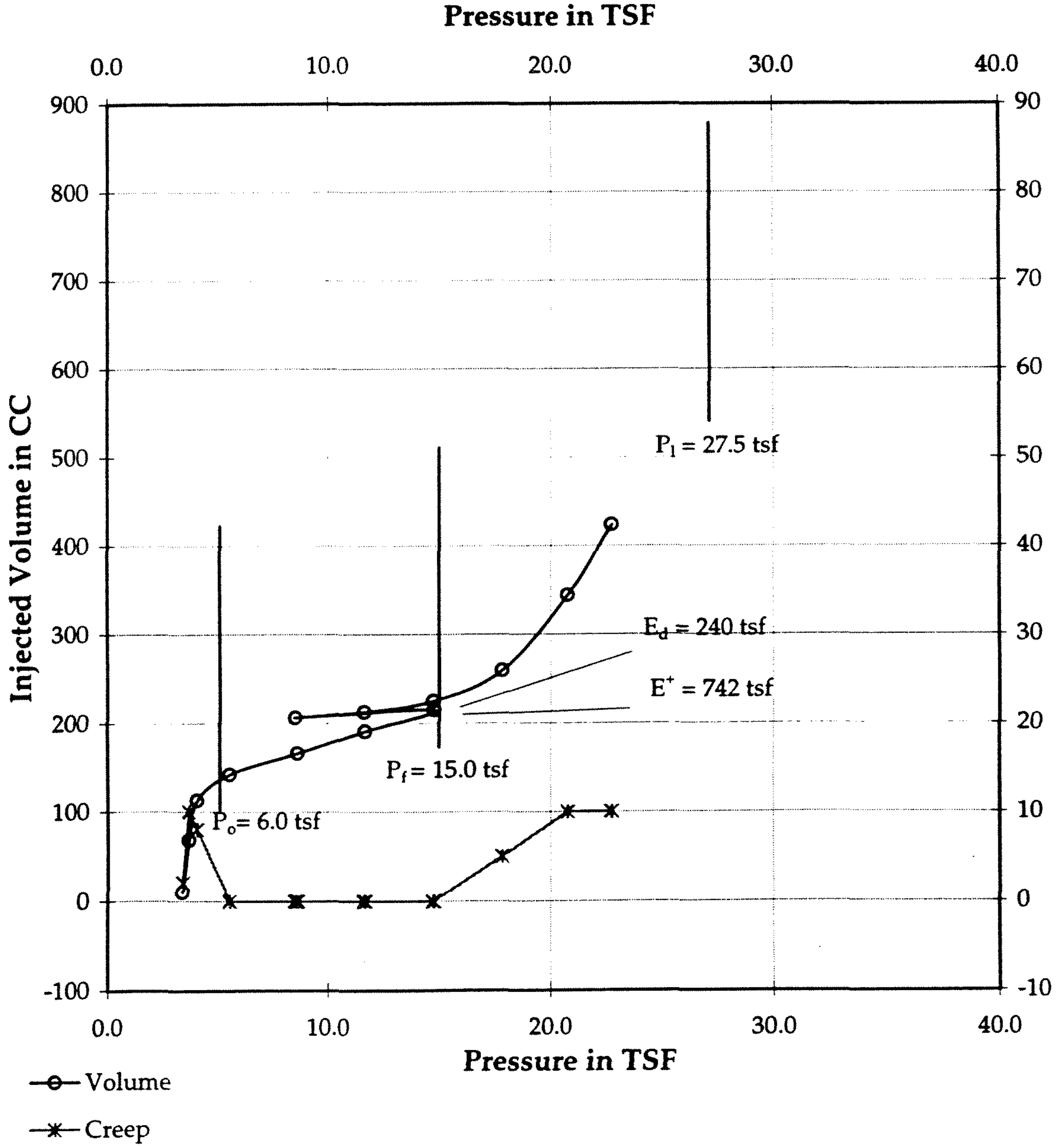
No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.02	3.9	3	5	2	0.7	2.7	
2	1.00	0.10	4.4	22	25	3	19.6	22.6	32
3	1.50	0.23	4.8	40	60	20	37.4	57.4	17
4	2.00	0.37	5.1	103	103	0	100.3	100.3	14
5	4.00	0.45	7.1	133	133	0	129.7	129.7	118
6	7.00	0.48	10.2	144	144	0	139.9	139.9	541
7	11.00	0.53	14.4	160	160	0	155.0	155.0	495
8	15.00	0.58	18.5	180	180	0	174.3	174.3	399
9	7.00	0.55	10.2	168	168	0	163.9	163.9	1500
10	11.00	0.57	14.3	177	177	0	172.0	172.0	953
11	15.00	0.60	18.5	190	190	0	184.3	184.3	642
12	19.00	0.70	22.5	230	235	5	223.5	228.5	181
13	23.00	0.86	26.6	305	317	12	297.8	309.8	106
14	25.00	0.95	28.5	360	370	10	352.4	362.4	88
15	26.00	1.02	29.5	400	410	10	392.2	402.2	60

E_d= 478 TSF E^+= 798 TSF P_l= 34.7 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852
Boring No. 10
Test Depth: 85.0-87.5 Feet

Date: 1-17-00



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 10
Test Depth: 85.0-87.5 Feet

Pressuremeter Data Reduction (BX)

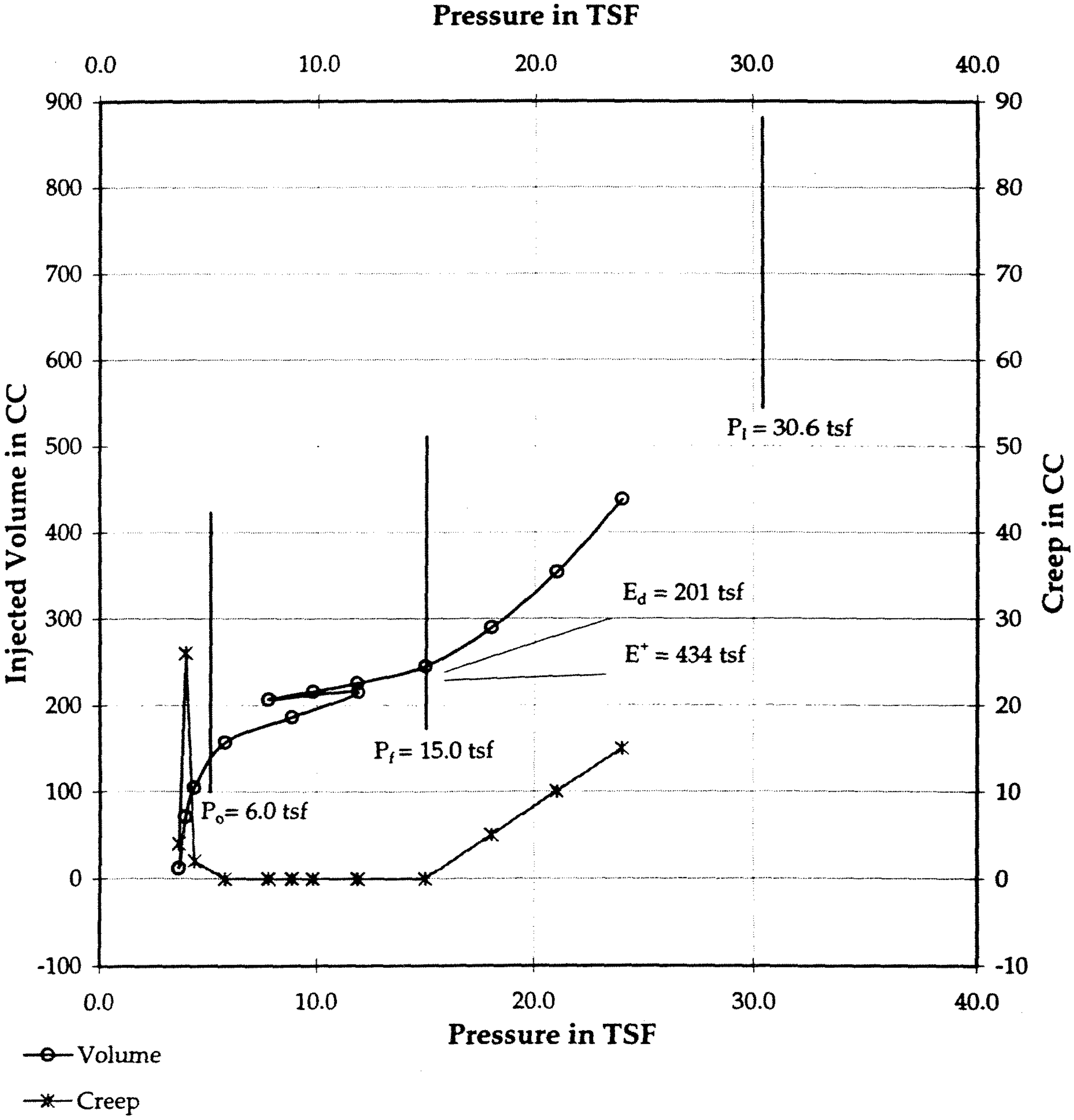
Water Correction: 2.82

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.05	3.4	10	12	2	7.9	9.9	
2	1.00	0.26	3.7	60	70	10	57.8	67.8	8
3	1.50	0.40	4.1	107	115	8	104.7	112.7	14
4	3.00	0.49	5.6	145	145	0	142.1	142.1	88
5	6.00	0.55	8.6	170	170	0	166.2	166.2	233
6	9.00	0.61	11.7	195	195	0	190.5	190.5	240
7	12.00	0.67	14.8	220	220	0	214.9	214.9	247
8	6.00	0.65	8.5	210	210	0	206.3	206.3	1428
9	9.00	0.66	11.7	217	217	0	212.6	212.6	983
10	12.00	0.69	14.8	230	230	0	224.9	224.9	502
11	15.00	0.76	17.8	260	265	5	254.4	259.4	184
12	18.00	0.92	20.8	340	350	10	333.9	343.9	78
13	20.00	1.05	22.7	420	430	10	413.5	423.5	60

E_d= 240 TSF E^+= 742 TSF P_l= 27.5 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-17-00
Boring No. 10
Test Depth: 93.5-96.0 Feet



STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 10
Test Depth: 93.5-96.0 Feet

Pressuremeter Data Reduction (BX)

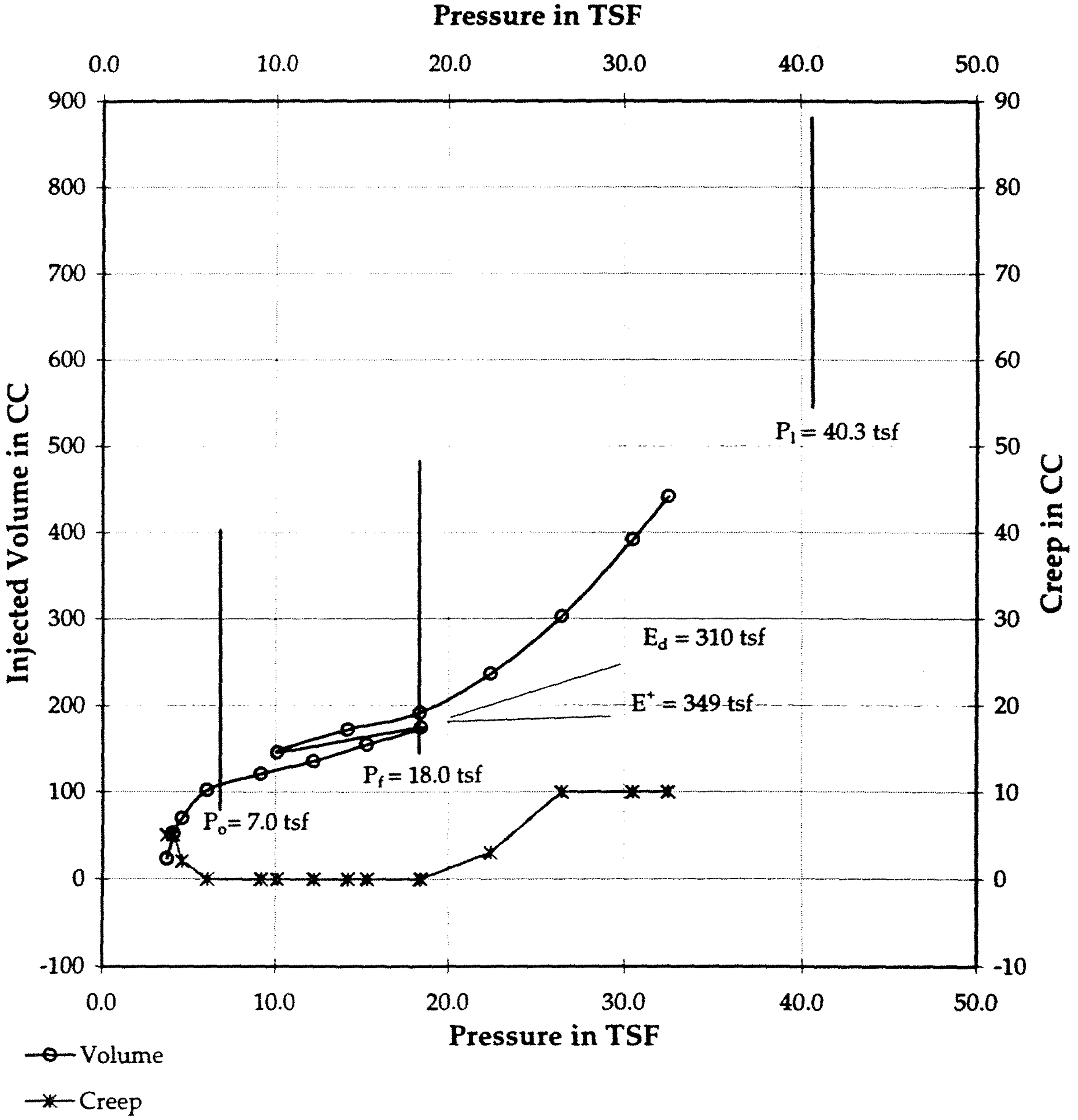
Water Correction: 3.08

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.06	3.7	10	14	4	7.8	11.8	
2	1.00	0.27	4.0	47	73	26	44.7	70.7	8
3	1.50	0.38	4.4	105	107	2	102.6	104.6	20
4	3.00	0.53	5.8	160	160	0	157.1	157.1	48
5	6.00	0.60	8.9	190	190	0	186.2	186.2	197
6	9.00	0.67	11.9	220	220	0	215.5	215.5	205
7	5.00	0.65	7.8	210	210	0	206.5	206.5	914
8	7.00	0.67	9.8	220	220	0	216.0	216.0	433
9	9.00	0.69	11.9	230	230	0	225.5	225.5	435
10	12.00	0.73	15.0	250	250	0	244.9	244.9	326
11	15.00	0.82	18.0	290	295	5	284.4	289.4	146
12	18.00	0.93	21.0	350	360	10	343.8	353.8	106
13	21.00	1.07	24.0	430	445	15	423.3	438.3	88

$E_d=$ 201 TSF $E^+=$ 434 TSF $P_l=$ 30.6 TSF

Pressuremeter Data Reduction (BX)

STS Job Number: 30852 Date: 1-17-00
Boring No. 10
Test Depth: 97.5-100.0 Feet



Pressuremeter Data Reduction (BX)

STS Consultants, Ltd.
STS Job Number: 30852
Boring No.: 10
Test Depth: 97.5-100.0 Feet

Water Correction: 3.20

No.	Pressure Readings (bars)	Inertia Correction (bars)	Corrected Pressure (tsf)	30 Sec. Volume (cc)	60 Sec. Volume (cc)	Creep (cc)	Corrected 30 Sec. Volume (cc)	Corrected 60 Sec. Volume (cc)	Incremental Modulus (tsf)
1	0.50	0.10	3.8	20	25	5	17.8	22.8	
2	1.00	0.21	4.2	50	55	5	47.6	52.6	21
3	1.50	0.27	4.6	70	72	2	67.5	69.5	43
4	3.00	0.37	6.1	105	105	0	102.0	102.0	74
5	6.00	0.43	9.2	125	125	0	121.1	121.1	276
6	9.00	0.47	12.2	140	140	0	135.4	135.4	381
7	12.00	0.53	15.3	160	160	0	154.8	154.8	287
8	15.00	0.58	18.4	180	180	0	174.3	174.3	295
9	7.00	0.50	10.1	150	150	0	145.9	145.9	539
10	11.00	0.57	14.2	177	177	0	172.0	172.0	290
11	15.00	0.62	18.4	197	197	0	191.3	191.3	409
12	19.00	0.72	22.4	240	243	3	233.6	236.6	179
13	23.00	0.85	26.5	300	310	10	292.8	302.8	131
14	27.00	1.00	30.5	390	400	10	382.0	392.0	106
15	29.00	1.08	32.5	440	450	10	431.6	441.6	103

$E_d=$ 310 TSF $E^+=$ 349 TSF $P_l=$ 40.3 TSF

STS General Notes

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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-3" Shelby Tube
HS : Hollow Stem Auger
WS : Wash Sample
FT : Fish Tail
RB : Rock Bit
BS : Bulk Sample
PM : Pressuremeter Test, In-Situ
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 times 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 & 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: clays or clayey silts if they are cohesive and silts 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 Components Also Present in Sample	Percent Of Dry Weight
Trace	1-9
Little	10-19
Some	20-34
And	35-50

CONSISTENCY OF COHESIVE SOILS:

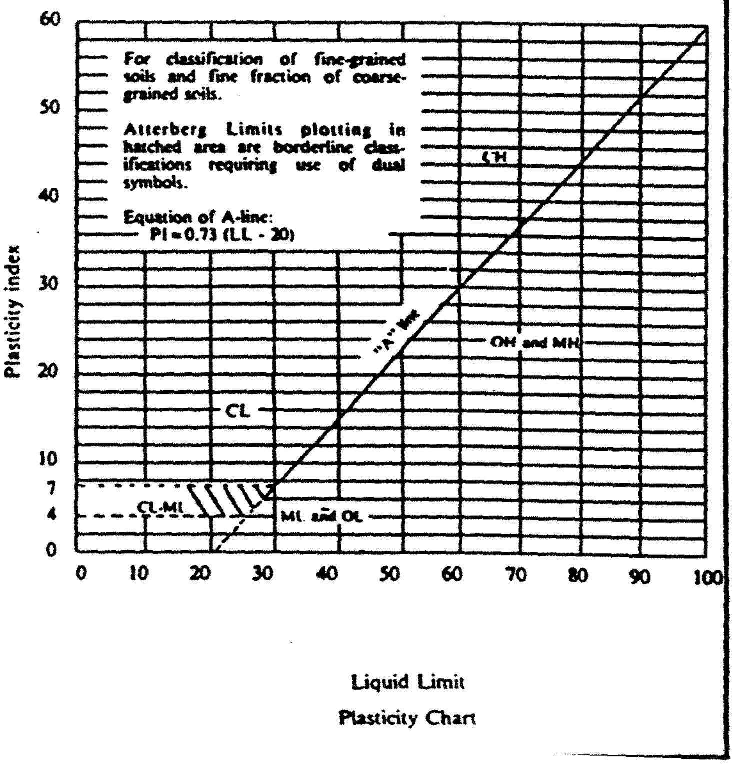
Unconfined Compressive Strength, Qu, tsf	Consistency
0.25	Very Soft
0.25-0.49	Soft
0.50-0.99	Medium (Firm)
1.00-1.99	Stiff
2.00-3.99	Very Stiff
4.00-8.00	Hard
>8.00	Very Hard

RELATIVE DENSITY OF GRANULAR SOILS:

N-Blows per ft.	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

UNIFIED SOIL CLASSIFICATION

Major Divisions			Group symbols		Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is *larger* than No. 200 sieve size)	Gravels (More than half of coarse fraction larger than No. 4 sieve size)	Clean gravels (Little of no fines)	GW		Well-grades gravels, 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 per cent .... GW, GP, SW, SP More than 12 per cent .... GM, GC, SM, SC 5 to 12 per cent .... *Borderline* cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	d u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} x D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	d u	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is *smaller* than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
ighly ganic oils			Pt		Peat and other highly organic soils			

For classification of fine-grained soils and fine fraction of coarse-grained soils.

Atterberg Limits plotting in hatched area are borderline classifications requiring use of dual symbols.

Equation of A-line:
PI = 0.73 (LL - 20)

Plasticity Chart

SUBSURFACE EXPLORATION PROCEDURES

Hand-Auger Drilling (HA)

In this procedure, a sampling device is driven into the soil by repeated blows of a sledge 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 bore hole 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 bore holes. They are turned and hydraulically advanced by a truck or track-mounted unit as site accessibility dictates. In auger drilling, casing and drilling mud are not required to maintain open bore holes.

Hollow Stem Auger Drilling (HS)

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

Rotary Drilling (RB)

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

Diamond Core Drilling (DB)

Diamond core drilling is used to sample cemented formations. In this procedure, a double tube (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.

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-1586-84)

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-1587-83)

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 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-ft. sections of thin-wall tubing which are capable of retrieving continuous columns of soil in 5-ft. 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-ft. 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), 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 ($^{\gamma}$D)

The dry density is the quantity used as a measure of the amount of solids in a unit volume of soil aggregate. 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 classified on the basis of their texture and plasticity in accordance with United Soil Classification System (USCS). The soil descriptions on the boring logs are in conformance with this system and the estimated group symbols according to this system are included in parentheses following the soil descriptions on the boring logs. Included on a separate sheet entitled "General Notes" is a brief explanation of this system of soil classification.

STS Standard Boring Log Procedures

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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 more experienced soil engineers, and differences between the field logs and the final logs may exist.

The engineer preparing the report reviews the field and laboratory logs, classifications and test data, and using judgment and experience in interpreting this data, may make further changes.

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 destroyed 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.

It is common practice in the geotechnical engineering profession that field logs and laboratory data sheets not included 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. On the other hand, we are aware that perhaps certain contractors and subcontractors submitting bids or proposals on work might have an interest in studying these documents before submitting a bid or proposal. For this reason, the field logs are retained in our office for review by all contractors submitting a bid or proposal. We would welcome the opportunity to explain any changes that have been and typically are made in the preparation of our final reports, to the contractor or subcontractors, before the firm submits its bid or proposal, and to describe how the information was obtained to the extent the contractor or subcontractor wishes. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

The descriptive terms and symbols used on the logs are described on the attached sheet, entitled: "General Notes".

AMERICAN SOCIETY FOR TESTING AND MATERIALS

Standard Method for
PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of the last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (€) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 ASTM Standards:

D2487 Test Method for Classification of Soils for Engineering Purposes[2]

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D4220 Practice for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 anvil—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 cathead—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 drill rods—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 drive-weight assembly—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 hammer—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 hammer drop system—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 hammer fall guide—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 N-value—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 number of rope turns—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 sampling rods—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 SPT—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or N-value, and the engineering behavior of earthworks and foundation are available.

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D1586—58T. Last previous edition D1586—67 (1974).

[2] Annual Book of ASTM Standards, Vol 04.08.

5. Apparatus

5.1 Drilling Equipment—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 Drag, Chopping, and Fishtail Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharging bits are permitted.

5.1.2 Roller-Cone Bits, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 Hollow-Stem Continuous Flight Augers, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 Solid, Continuous Flight, Bucket and Hand Augers, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 Sampling Rods—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the N-values to depths of at least 100 ft (30 m).

5.3 Split-Barrel Sampler—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that N-values may increase between 10 to 30% when liners are used.

5.4 Drive-Weight Assembly:

5.4.1 Hammer and Anvil—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 Hammer Drop System—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 Accessory Equipment—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 m) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "N-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ of 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type of sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

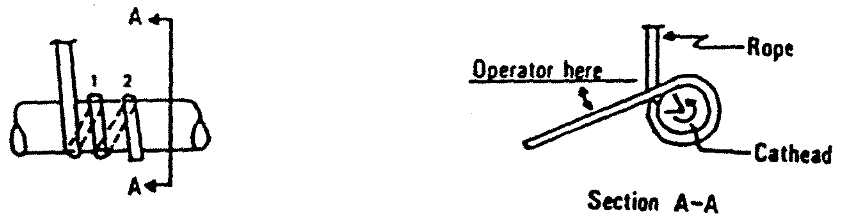
8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

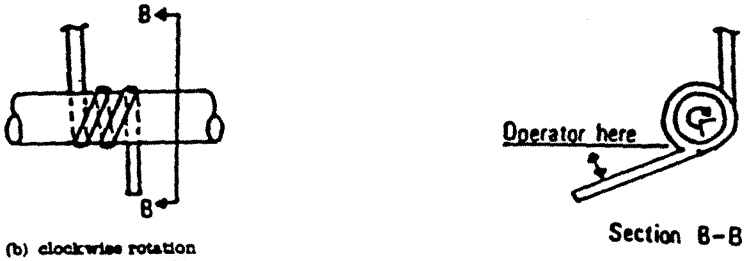
9.1 Variations in N-values of 100% or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N-values in the same soil can be reproduced with a coefficient of variation of about 10%.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N-values obtained between operator-drill rig systems.

9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.

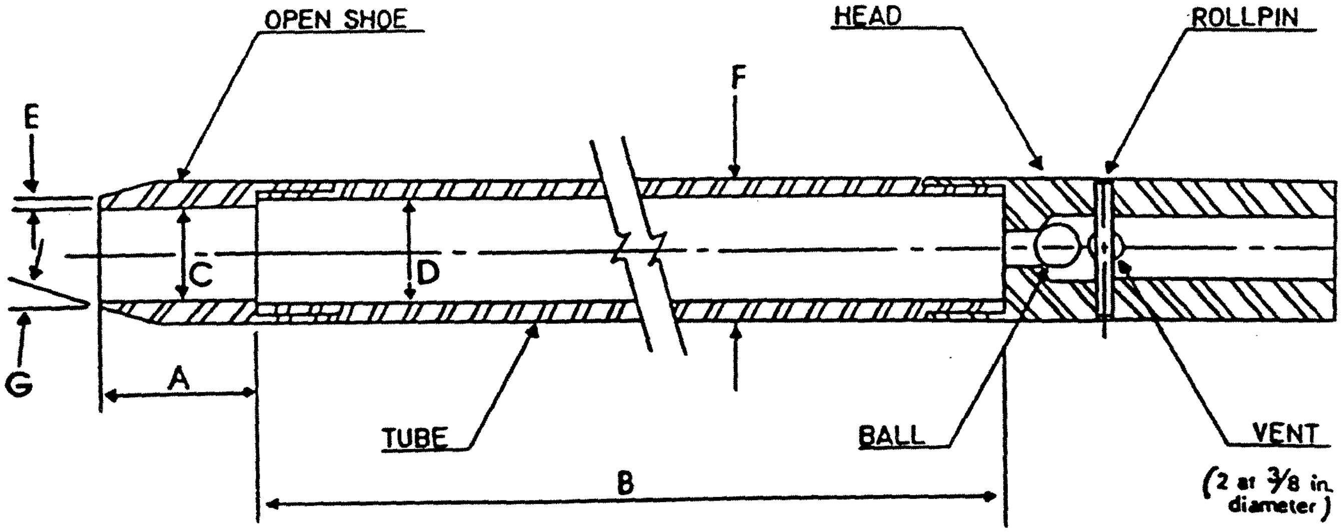


(a) counterclockwise rotation
approximately 1¼ turns



(b) clockwise rotation
approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

AMERICAN SOCIETY FOR TESTING AND MATERIALS

Standard Practice for

THIN-WALLED TUBE SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of the last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This practice has been approved for use by agencies of the Department of Defense and for listing in the DOD Index os Specifications and Standards.

1. Scope

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of structural properties. Thin-walled tubes used in piston, plug, or rotary-type samplers, such as the Denison or Pitcher, must comply with the portions of this practice which describe the thin-walled tubes (5.3).

NOTE 1—This practice does not apply to liners used within the above samplers.

2. Applicable Documents

2.1 ASTM Standards:

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D3550 Practice for Ring-Lined Barrel Sampling of Soils[2]

D4220 Practice for Preserving and Transporting Soil Samples[2]

3. Summary of Practice

3.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil, removing the soil-filled tube, and sealing the ends to prevent the soil from being disturbed or losing moisture.

4. Significance and Use

4.1 This practice, or Practice D3550, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of structural properties or other tests that might be influenced by soil disturbance.

5. Apparatus

5.1 Drilling Equipment—Any drilling equipment may be used that provides a reasonably clean hole; that does not disturb the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

5.2 Sampler Insertion Equipment, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

5.3 Thin-Walled Tubes, should be manufactured as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. and be made of metal having adequate strength for use in the soil and formation intended. Tubes shall be clean and free of all surface irregularities including projecting weld seams.

5.3.1 Length of Tubes—See Table 1 and 6.4.

5.3.2 Tolerances, shall be within the limits shown in Table 2.

5.3.3 Inside Clearance Ratio, should be 1% or as specified by the engineer or geologist for the soil and formation to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled. See Fig. 1 for definition of inside clearance ratio.

5.3.4 Corrosion Protection—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating. Tubes which will contain samples for more than 72 h shall be coated. The type of coating to be used may vary depending upon the material to be sampled. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, and others. Type of coating must be specified by the engineer or geologist if storage will exceed 72 h. Plating of the tubes or alternate base metals may be specified by the engineer or geologist.

5.4 Sampler Head, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a suitable check valve and a venting area to the outside equal to or greater than the area through the check valve. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

6. Procedure

6.1 Clean out the borehole to sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the sampling operation.

6.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled.

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[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigation.

Current edition approved Aug. 17, 1983. Published October 1983. Originally published as D 1587-83T. Last previous edition D 1587-74.

[2] Annual Book of ASTM Standards, Vol 04.08.

Reprinted from Annual Book of ASTM Standards, Volume 04.08

NOTE 2—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

6.3 Place the sample tube so that its bottom rests on the bottom of the hole. Advance the sampler without rotation by a continuous relatively rapid motion.

6.4 Determine the length of advance by the resistance and condition of the formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays.

NOTE 3—Weight of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

6.5 When the formation is too hard for push-type insertion, the tube may be driven or Practice D3550 may be used. Other methods, as directed by the engineer or geologist, may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

6.6 In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. for sludge-end cuttings.

NOTE 4—The tube may be rotated to shear bottom of the sample after pressing is complete.

6.7 Withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample.

7. Preparation for Shipment

7.1 Upon removal of the tube, measure the length of sample in the tube. Remove the disturbed material in the upper end of the tube and measure the length again. Seal the upper end of the tube. Remove at least 1 in. of material from the lower end of the tube. Use this material for soil description in accordance with Practice D2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube if so directed by the engineer or geologist.

NOTE 5—Field extrusion and packaging of extruded samples under the specific direction of a geotechnical engineer or geologist is permitted.

NOTE 6—Tubes sealed over the ends as opposed to those sealed with expanding packers should contain end padding in end voids in order to prevent drainage or movement of the sample within the tube.

7.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample. Assure that the markings or labels are adequate to survive transportation and storage.

8. Report

8.1 The appropriate information is required as follows:

8.1.1 Name and location of the project,

8.1.2 Boring number and precise location on project,

8.1.3 Surface elevation or reference to a datum,

8.1.4 Date and time of boring—start and finish,

8.1.5 Depth to top of sample and number of samples,

8.1.6 Description of sampler: size, type of metal, type of coating,

8.1.7 Method of sampler insertion: push or drive,

8.1.8 Method of drilling, size of hole, casing, and drilling fluid used,

8.1.9 Depth to groundwater level: date and time measured,

8.1.10 Any possible current or tidal effect on water level,

8.1.11 Soil description in accordance with Practice D2488,

8.1.12 Length of sampler advance, and

8.1.13 Recovery: length of sample obtained.

9. Precision and Bias

9.1 This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.

TABLE 1 Suitable Thin-Walled Steel Sample Tubes[A]

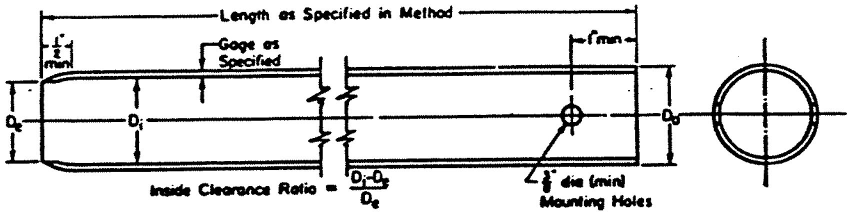
Outside diameter:			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Clearance ratio, %	1	1	1

[A] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

TABLE 2 Dimensional Tolerances for Thin-Walled Tubes

Nominal Tube Diameters from Table 1[A] Tolerances, in.			
Size Outside Diameter	2	3	5
Outside diameter	+0.007	+0.010	+0.015
	−0.000	−0.000	−0.000
Inside diameter	+0.000	+0.000	+0.000
	−0.007	−0.010	−0.015
Wall thickness	±0.007	±0.010	±0.015
Ovality	0.015	0.020	0.030
Straightness	0.030/ft	0.030/ft	0.030/ft

[A] Intermediate or larger diameters should be proportional. Tolerances shown are essentially standard commercial manufacturing tolerances for seamless steel mechanical tubing. Specify only two of the first three tolerances; that is, O.D. and I.D., or O.D. or O.D. and Wall, or I.D. and Wall.



NOTE 1—Minimum of two mounting holes on opposite sides for 2 to 3½ in. sampler.
NOTE 2—Minimum of four mounting holes spaced at 90° for samplers 4 in. and larger.
NOTE 3—Tube held with hardened screws.
NOTE 4—Two-inch outside-diameter tubes are specified with an 18-gage wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gage tubes are generally readily available.

Metric Equivalents

in.	mm
3/16	4.77
½	12.7
1	25.4
2	50.8
3½	88.9
4	101.6

FIG. 1 Thin-Walled Tube for Sampling

Designation: D 2573 – 94

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If not listed in the current combined index, will appear in the next edition.

Standard Test Method for
Field Vane Shear Test in Cohesive Soil[1]

This standard is issued under the fixed designation D 2573; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope*

1.1 This test method covers the field vane test in soft, saturated, cohesive soils. Knowledge of the nature of the soil in which each vane test is to be made is necessary for assessment of the applicability and interpretation of the test.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Summary of Test Method

2.1 The vane shear test basically consists of placing a four-bladed vane in the undisturbed soil and rotating it from the surface to determine the torsional force required to cause a cylindrical surface to be sheared by the vane; this force is then converted to a unit shearing resistance of the cylindrical surface. It is of basic importance that the friction of the vane rod and instrument be accounted for; otherwise, the friction would be improperly recorded as soil strength. Friction measurements under no-load conditions (such as the use of a blank stem in place of the vanes, or a vane that allows some free rotation of the rod prior to loading) are satisfactory only provided that the torque is applied by a balanced moment that does not result in a side thrust. As torsional forces become greater during a test, a side thrust in the instrument will result in an increase in friction that is not accounted for by initial no-load readings. Instruments involving side thrust are not recommended. The vane rod may be of sufficient rigidity that it does not twist under full load conditions; otherwise a correction must be made for plotting torque-rotation curves.

3. Significance and Use

3.1 This test method provides an indication of in-situ shear strength.

3.2 This test method is used extensively in a variety of geotechnical explorations, such as in cases where a sample for laboratory testing cannot be obtained.

4. Apparatus

4.1 The vane shall consist of a four-bladed vane as illustrated in Fig. 1. The height of the vane shall be twice the diameter. Vane dimensions shall be as specified in Table 1. Sizes other than those specified in Table 1 shall be used only with the permission of the engineer in charge of the boring program. The ends of the vane may be tapered (see Fig. 1). The penetrating edge of the vane blade shall be sharpened having an included angle of 90°.

4.2 The vane shall be connected to the surface by means of steel torque rods. These rods shall have sufficient diameter such that their elastic limit is not exceeded when the vane is stressed to its capacity (Note 1). They shall be so coupled that the shoulders of the male and female ends shall meet to prevent any possibility of the coupling tightening when the torque is applied during the test. If a vane housing is used,

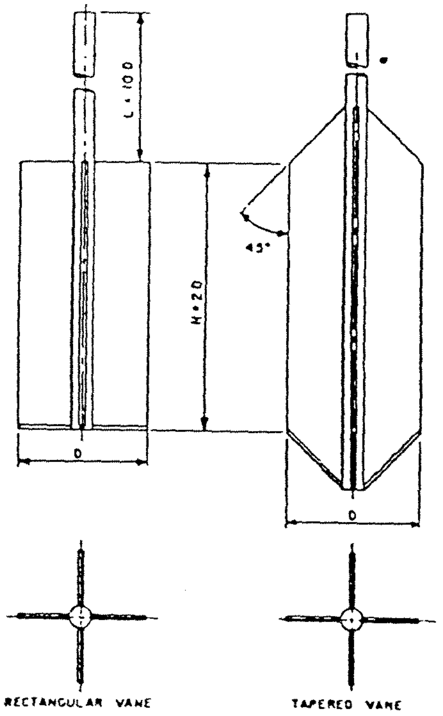

FIG. 1 Geometry of Field Vane

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[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 15, 1994. Published November 1994. Originally published as D 2573 – 67 T. Last previous edition D 2573 – 72 (1978).

* A Summary of Changes section appears at the end of this test method.

TABLE 1 Recommended Dimensions of Field Vanes[A]

Casing Size	Diameter, in. (mm)	Height, in. (mm)	Thickness of Blade, in. (mm)	Diameter of Vane Rod, in. (mm)
AX	1½ (38.1)	3 (76.2)	1/16 (1.6)	½ (12.7)
BX	2 (50.8)	4 (101.6)	1/16 (1.6)	½ (12.7)
NX	2½ (63.5)	5 (127.0)	⅛ (3.2)	½ (12.7)
4 in. (101.6 mm)[B]	3⅝ (92.1)	7¼ (184.1)	⅛ (3.2)	½ (12.7)

[A] Selection of the vane size is directly related to the consistency of the soil being tested, that is, the softer the soil the larger the vane diameter.

[B] Inside diameter.

the torque rods shall be equipped with well-lubricated bearings where they pass through the housing. These bearings shall be provided with seals to prevent soil from entering them. The torque rods shall be guided so as to prevent friction from developing between the torque rods and the walls of casing or boring.

NOTE 1—If torque *versus* rotation curves are to be determined, it is essential that the torque rods be calibrated (prior to use in the field). The amount of rod twist (if any) must be established in degrees per foot per unit torque. This correction becomes progressively more important as the depth of the test increases and the calibration must be made at least to the maximum depth of testing anticipated.

4.3 Torque shall be applied to the torque rods, thence to the vane. The accuracy of the torque reading should be such that it will produce a variation not to exceed ±25 lb/ft^2 (1.20 kPa) shear strength.

4.4 It is preferable to apply torque to the vane with a geared drive. In the absence of a geared drive, it is acceptable to apply the torque directly by hand with a torque wrench or equivalent. The duration of the test should be controlled by the requirements of 5.3.

5. Procedure

5.1 In the case where a vane housing is used, advance the housing to a depth which is at least five vane housing diameters less than the desired depth of the vane tip. Where no vane housing is used, stop the hole in which the vane is lowered at a depth such that the vane tip may penetrate undisturbed soil for a depth of at least five times the diameter of the hole.

5.2 Advance the vane from the bottom of the hole or the vane housing in a single thrust to the depth at which the test is to be conducted. Take precautions to make sure no torque is applied to the torque rods during the thrust.

5.3 With the vane in position, apply the torque to the vane at a rate which should not exceed 0.1°/s. This generally requires a time to failure of from 2 to 5 min, except in very soft clays where the time to failure may be as much as 10 to 15 min. In stiffer materials, which reach failure at small deformations, it may be desirable to reduce the rate of angular displacement so that a reasonable determination of the stress-strain properties can be obtained. During the rotation of the vane, hold it at a fixed elevation. Record the maximum torque. With apparatus with geared drives, it is desirable to record intermediate values of torque at intervals of 15 s or at lesser frequency if conditions require.

5.4 Following the determination of the maximum torque, rotate the vane rapidly through a minimum of 10 revolutions; the determination of the remoulded strength should be started immediately after completion of rapid rotation and in all cases within 1 min after the remoulding process.

5.5 In the case where soil is in contact with the torque rods, determine the friction between the soil and the rod by means of torque tests conducted on similar rods at similar depths with no vane attached. Conduct the rod friction test at least once on each site; this shall consist of a series of torque tests at varying depths.

5.6 In apparatus in which the torque rod is completely isolated from the soil, conduct a friction test with a blank rod (Note 2) at least once on each site to determine the magnitude of the friction of the bearings. In a properly functioning vane apparatus, this friction should be negligible.

NOTE 2—In some cases it is not necessary to remove the vane for the friction test. As long as the vane is not in contact with the soil, that is, where it is retracted into a casing, the friction measurement is not affected.

5.7 Conduct undisturbed and remoulded vane tests at intervals of not less than 2½ ft (0.76 m) throughout the soil profile when conditions will permit vane testing (Note 3). Do not conduct the vane test in any soil that will permit drainage or dilates during the test period, such as sands or silts or in soils where stones or shells are encountered by the vane in such a manner as to influence the results.

NOTE 3—This spacing may be varied only by the engineer in charge of the boring program.

6. Calculation

6.1 Calculate the shear strength of the soil in the following manner. The turning moment required to shear the soil is as follows:

$$T = s \times K$$

where:

T = torque, lbf·ft (or N·m),

s = shear strength of the clay, lbf/ft^2 (or kPa), and

K = constant, depending on dimensions and shape of the vane, ft^3 (or m^3).

6.2 Assuming the distribution of the shear strength is uniform across the ends of a cylinder and around the perimeter, calculate the value of K as follows:

Inch-Pound Units:

$$K = (\pi/1728) \times (D^2H/2) \times [1 + (D/3H)]$$

Metric Units:

$$K = (\pi/10^6) \times (D^2H/2) \times [1 + D/3H)]$$

where:

D = measured diameter of the vane, in. (or cm), and

H = measured height of vane, in. (or cm).

It is important that these dimensions are checked periodically to ensure the vane is not distorted or worn.

6.3 As the ratio of length to breadth of the vane is 2:1, the value of K may be simplified in terms of the diameter so that it becomes the following: