

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 33-76-08

DIST 6

HWY NWMA

STR SITE 37-1061

Queen's Drive Underpass

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FOUNDATION INVESTIGATION REPORT

For

Queen's Drive Underpass
W.P. 33-76-08, Site 37-1061
NWMA, District 6, Toronto

INTRODUCTION

This report contains the results of foundation investigations for the above mentioned project. The investigation carried out on February 9, 1965 was for feasibility study purposes. It consisted of one sampled borehole advanced by wash-boring techniques to a depth of 133 feet below the ground surface. The investigation undertaken during the period of October 24, 1977 to October 25, 1977 was for preliminary design of this project. It comprised of three 61 foot deep sampled boreholes advanced by means of a bombardier mounted hollow stem auger drill rig. A supplementary investigation was also subsequently carried out during the period of April 14, 1978 to April 18, 1978 after the design concepts of this project had been modified and finalized. In the supplementary investigation three sampled boreholes ranging in depth from 61 feet to 81 feet were put down using a drilling machine which is equipped with 3½" I.D. hollow stem continuous flight augers.

SITE AND GEOLOGY

The site is on Queen's Drive approximately 0.3 miles east of Jane Street in the Borough of North York, Metropolitan Toronto.

The topography of the surrounding terrain is relatively flat. However, in the immediate vicinity of the site fills up to 8 feet high have been placed on either side of Queen's Drive.

The general area is primarily a developed residential district, consisting mainly of detached houses.

Physiographically, the site is located in a region known as the "South Slope" which is the southern slope of the interlobate moraines laid down in the Pleistocene epoch.

SUBSURFACE CONDITIONS

General

In the vicinity of the site cohesive earthfill up to 8 feet high was placed on either side of Queen's Drive. Below the existing roadway surface of Queen's Drive, a layer of granular fill material which is about 3 feet thick and is composed of silty sand and crushed stones, was also encountered. Across the site beneath the fills or below the ground surface is a 90 foot thick deposit of stiff to hard clayey silt which is followed by an extensive stratum of compact to very dense silty sand to sandy silt. This granular stratum was not fully penetrated but was explored to a depth of 133 feet below the ground surface.

The boundaries between different strata are shown on the Record of Borehole Sheets. The locations and elevations of the borings, together with the estimated stratigraphical sections, are shown on Drawing 337608-A. From ground surface downwards the different soil types encountered are described as follows.

Fill

Cohesive earthfill: Earthfill has been placed at this site on either side of Queen's Drive. This earthfill is composed mainly of clayey silt and has a thickness of up to 8 feet. The Standard Penetration Test 'N' values within the fill range from 4 blows/foot to 14 blows/foot indicating that the fill was not uniformly compacted.

Granular roadway fill: Granular fill was encountered beneath the existing roadway surface. This fill is composed of silty sand and crushed stones and has a thickness of about 3 feet.

Clayey Silt

Beneath the fills or below ground surface is an extensive deposit about 90 feet thick of clayey silt with sand and gravel. Typical grain size distribution curves obtained from samples in this deposit are shown on Figure 1. Within this deposit occasional distinct layers of silt with sand were also encountered. Typical identity indices of the clayey silt are tabulated as follows.

		<u>Ranges</u>
Natural Moisture Content (W)	%	10-30
Plasticity Limit	(W _p) %	12-22
Liquid Limit	(W _L) %	19-39

The Atterberg Limits are also plotted on the Plasticity Chart, Figure 2. The results indicate the cohesive subsoil has a low plasticity.

Unconfined compressive tests and in situ vane tests gave an undrained shear strength of the clayey silt in the order of 1250 psf to 1850 psf. Based on these results, together with the 'N' values which range from 12 blows/foot to 55 blows/foot, the consistency of the clayey silt is classified as stiff to hard.

Silty Sand to Sandy Silt

Below the clayey silt deposit is a stratum of silty sand to sandy silt. This stratum was investigated to a depth of 133 feet below the ground surface. The 'N' values within this stratum range from 14 blows/foot to over 100 blows/foot. The relative density of this granular deposit, inferred from these 'N' values, varies from compact to very dense, but being generally dense to very dense.

Groundwater Conditions

The groundwater level at this site was found to be between elevation 389 and elevation 417. The large variation in groundwater levels may be attributed to the low permeability of the cohesive subsoil and the short duration of observation. Furthermore, the observed high groundwater levels in the fill area may be due to perched water within the fill.

DISCUSSIONS AND RECOMMENDATIONS

In conjunction with the Northwest Metro Arterial (NWMA) project, the existing Queen's Drive will be realigned. At the crossing of NWMA and the relocated Queen's Drive, a two-span underpass structure is to be built to carry the new Queen's Drive over NWMA. The underpass structure will have a total length of 136 feet and perched abutments within the approaches. At the proposed interchange the profile grade of Queen's Drive will be at elevation 418 and that of NWMA will be at elevation 400 approximately. In order to achieve these grades NWMA will be in a cut section up to 16 feet deep and Queen's Drive will require fills about 3 feet high. Our recommendations for the structure foundations and the related earthworks are as follows.

Structure Foundations

It is recommended that the abutments, as well as the pier be supported on piled foundations composed of 50 foot long #14 timber friction piles. These piles can be designed for a bearing capacity of up to 35 tons per pile. The above pile capacity is based on the results of a pile loading test conducted in this general area with a similar subsoil condition. The underside of the pile caps should have a minimum 4 feet of earth cover for frost protection purposes. No major dewatering difficulties during excavation for the pile caps are anticipated because the cohesive subsoil is relatively impervious. Any seepage into the excavations can be removed by pumping.

Approaches

The required 16 foot deep cuts and 3 foot high fills can be safely constructed with forward slopes and sideslopes of 2:1.

B. Ly
B. Ly, P. Eng.
Senior Engineer

M. Devata
M. Devata, P. Eng.
Supervising Engineer



June, 1978



RECORD OF BOREHOLE No 1

W P 33-76-08 LOCATION Co-ords N 15,881,798; E 1,000,087 ORIGINATED BY VK
DIST 6 HWY N.W.M.A. BOREHOLE TYPE Auger Hole COMPILED BY GP
DATUM Geodetic DATE Oct. 24, 1977 CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
417.5	Ground Level											
0.0	Clayey Silt, Some Sand and Trace of Organics(Fill Material)		1	SS	8							
411.5			2	SS	29							
6.0	Clayey Silt with Sand and Occasional Gravel. Stiff to Very Stiff		3	SS	15							
			4	SS	19							
			5	SS	19							
			6	SS	22							
			7	SS	17							
			8	SS	17							
			9	SS	18							
			10	SS	21							
			11	SS	18							
			12	SS	12							
356.0	End of Borehole											
61.5												



RECORD OF BOREHOLE No 2

W P 33-76-08 LOCATION Co-ords N 15,881,740; E 999,949 ORIGINATED BY VK
DIST 6 HWY N.W.M.A. BOREHOLE TYPE Auger Hole COMPILED BY GP
DATUM Geodetic DATE October 25, 1977 CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH						WATER CONTENT (%)		
								○ UNCONFINED							+ FIELD VANE	● QUICK TRIAXIAL
420.3	Ground Level							20 40 60 80 100								
0.0	Clayey Silt with some Sand and Trace of Organics. (Fill Material)		1	SS	9								1 25 53 21			
413.3			2	SS	14											
7.0	Clayey Silt with some Sand and Occasional Gravel. Stiff to Hard		3	SS	19								0 3 52 45			
			4	SS	17											
			5	SS	32											
			6	SS	29											
			7	SS	26											
			8	SS	40											
			9	SS	24											
			10	SS	43											
			11	SS	39											
			12	SS	29											
358.8													1 28 47 24			
61.5	End of Borehole															

3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

W P 33-76-08 LOCATION Co-ords N 15,831,706; E 999,993 ORIGINATED BY VK
DIST 6 HWY N.W.M.A. BOREHOLE TYPE Auger Hole COMPILED BY GP
DATUM Geodetic DATE Oct. 25, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					
418.5	Ground Level												
0.0	Clayey Silt with some Sand and Trace of Organics		1	SS	4								
412.5	(Fill Material)		2	SS	22								
6.0	Clayey Silt with Sand and Occasional Gravel		3	SS	23		410						
			4	SS	37								
			5	SS	42								
			6	SS	29		400						
			7	SS	31								
			8	SS	25								
			9	SS	27								
			10	SS	25								
			11	SS	22		370						
			12	SS	33		360						
357.0													
61.5	End of Borehole												

+³, x⁵ : Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 4 (Formerly BH #11
W.O. 65-F-40)

W P 33-76-08 LOCATION Co-ords N 15,881,762; E 1,000,236

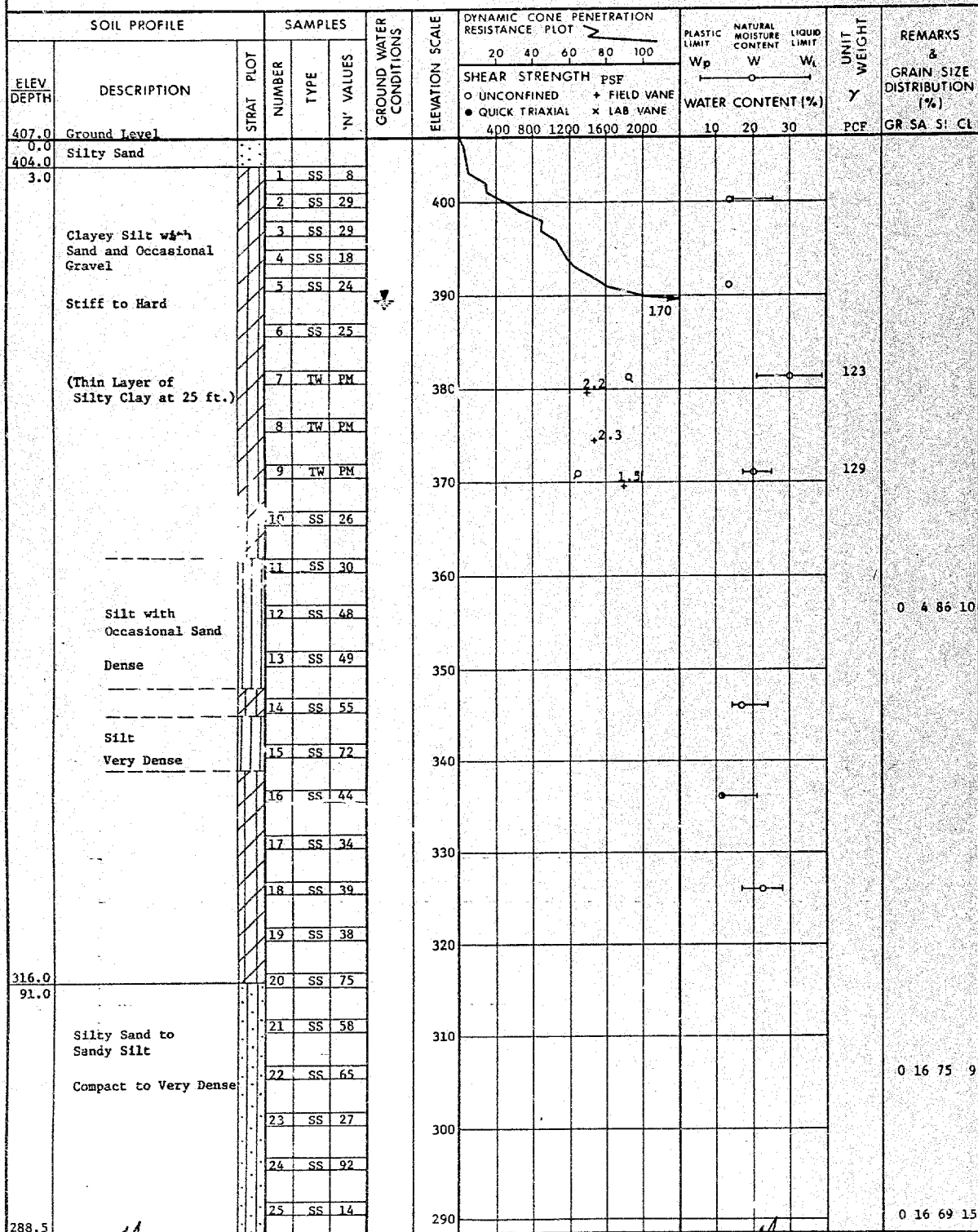
ORIGINATED BY HS

DIST 6 HWY N.W.M.A. BOREHOLE TYPE Washboring and Cone Test

COMPILED BY HS

DATUM Geodetic DATE Feb. 9, 1965

CHECKED BY *EP*

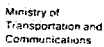


Continued

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued



W. # 33-76-08 LOCATION Co-ords N 15,881,762; E 1,000,236 ORIGINATED BY HS
DIST 6 HWY N.W.M.A. BOREHOLE TYPE Washboring and Cone Test COMPILED BY HS
DATUM Geodetic DATE Feb. 9, 1965 CHECKED BY JP

[illegible]

OFFICE 'REPORT ON SOIL EXPLORATION

***3, *5: Numbers refer to Sensitivity**

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

W P 33-76-08 LOCATION Coords. N 15,881,777; E 1,000,144 ORIGINATED BY O.J.
DIST 6 HWY NWMA BOREHOLE TYPE 3 1/2" Hollow Stem Augers & Cone Test COMPILED BY B.L.
DATUM Geodetic DATE April 14 and 17, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
415.1	Ground Level										
0.0											
			1	SS	26		410				
	Brown		2	SS	22						
	Grey		3	SS	19		400				
	Clayey Silt, Some Sand and Gravel		4	SS	23						
	Stiff to Very Stiff		5	SS	24		390				
			6	SS	30						
			7	SS	38		380				
			8	SS	20						
			9	SS	22		370				
			10	SS	14						
			11	SS	21		360				
			12	SS	27						
353.6											
61.5	End of Borehole										
	Note: Water Level Not Established										



RECORD OF BOREHOLE No 6

W P 33-76-08 LOCATION Coords. N 15,881,693; E 1,000,100 ORIGINATED BY B.L.
DIST 6 HWY NWMA BOREHOLE TYPE 3 1/2" Hollow Stem Augers COMPILED BY L.J.
DATUM Geodetic DATE April 17, 1978 CHECKED BY P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							SHEAR STRENGTH	WATER CONTENT (%)
								O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
414.9	Ground Level															
0.0	Fill, Silty Sand and Crushed Stones Brown ----- Grey Clayey Silt, Some Sand and Gravel Stiff to Very Stiff															
411.9																
3.0																
				1	SS	16		410								
				2	SS	25										
				3	SS	12		400								
				4	SS	18										
				5	SS	14		390								
				6	SS	14										
				7	SS	13		380								
				8	SS	22										
				9	SS	27		370								
				10	SS	43										
		11	SS	18		360										
		12	SS	37		350										
		13	SS	28		340										
333.4																
81.5	End of Borehole															

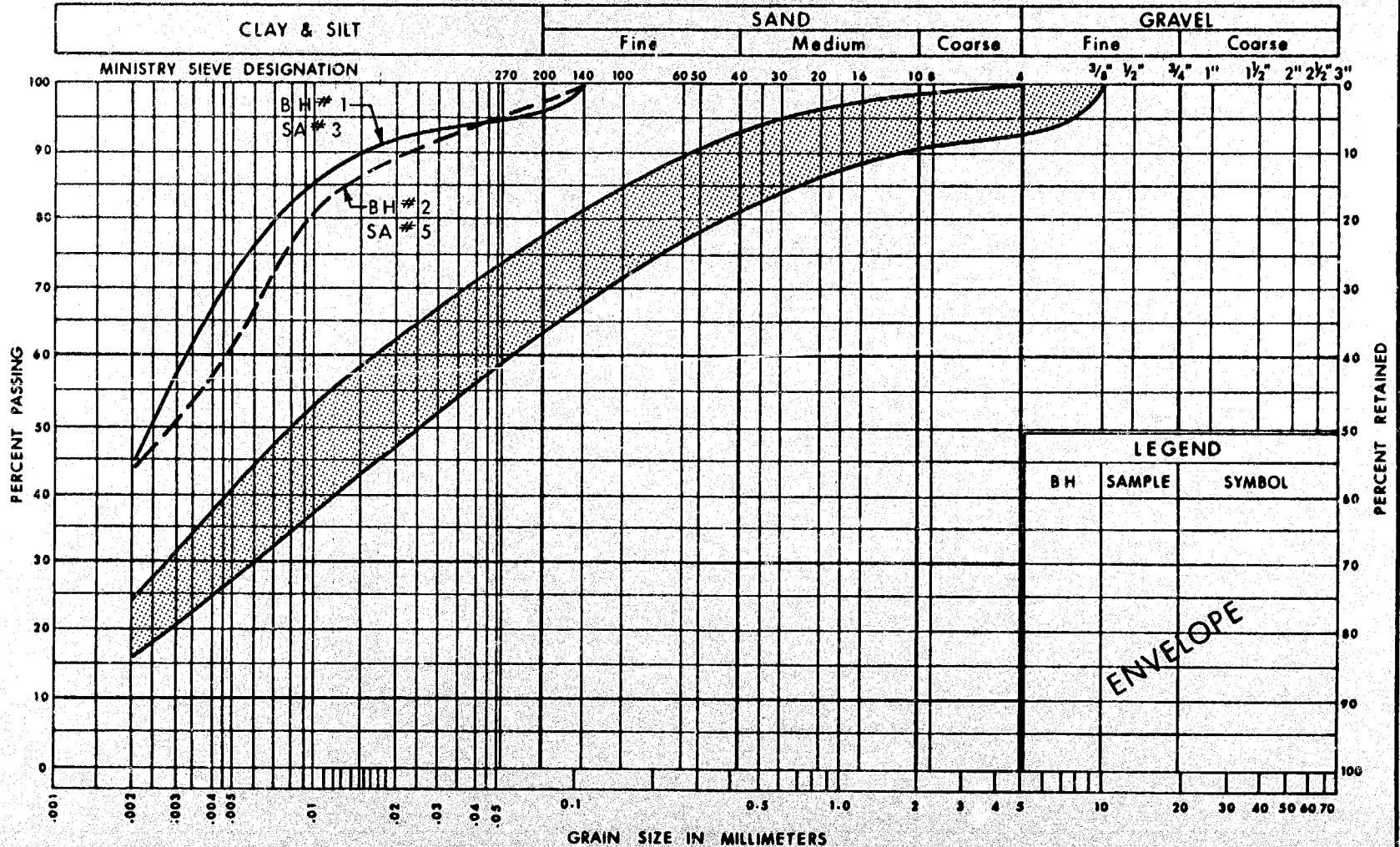


RECORD OF BOREHOLE No 7

W P 33-76-08 LOCATION Coords. N 15,881,724; E 1,000,080 ORIGINATED BY B.L.
DIST 6 HWY NWMA BOREHOLE TYPE 3 1/2" Hollow Stem Augers COMPILED BY L.J.
DATUM Geodetic DATE April 17, 1978 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
414.9	Ground Level																
0.0																	
			1	SS	31		410										
	Brown		2	SS	18												
	Grey		3	SS	17		400										1 19 53 27
	Clayey Silt, Some Sand and Gravel		4	SS	17												
	Stiff to Very Stiff		5	SS	19		390										1 29 50 20
			6	SS	26												
			7	SS	30		380										
			8	SS	28												
			9	SS	43		370										
			10	SS	29												
			11	SS	21		360										
353.4			12	SS	20												
61.5	End of Borehole																

UNIFIED SOIL CLASSIFICATION SYSTEM



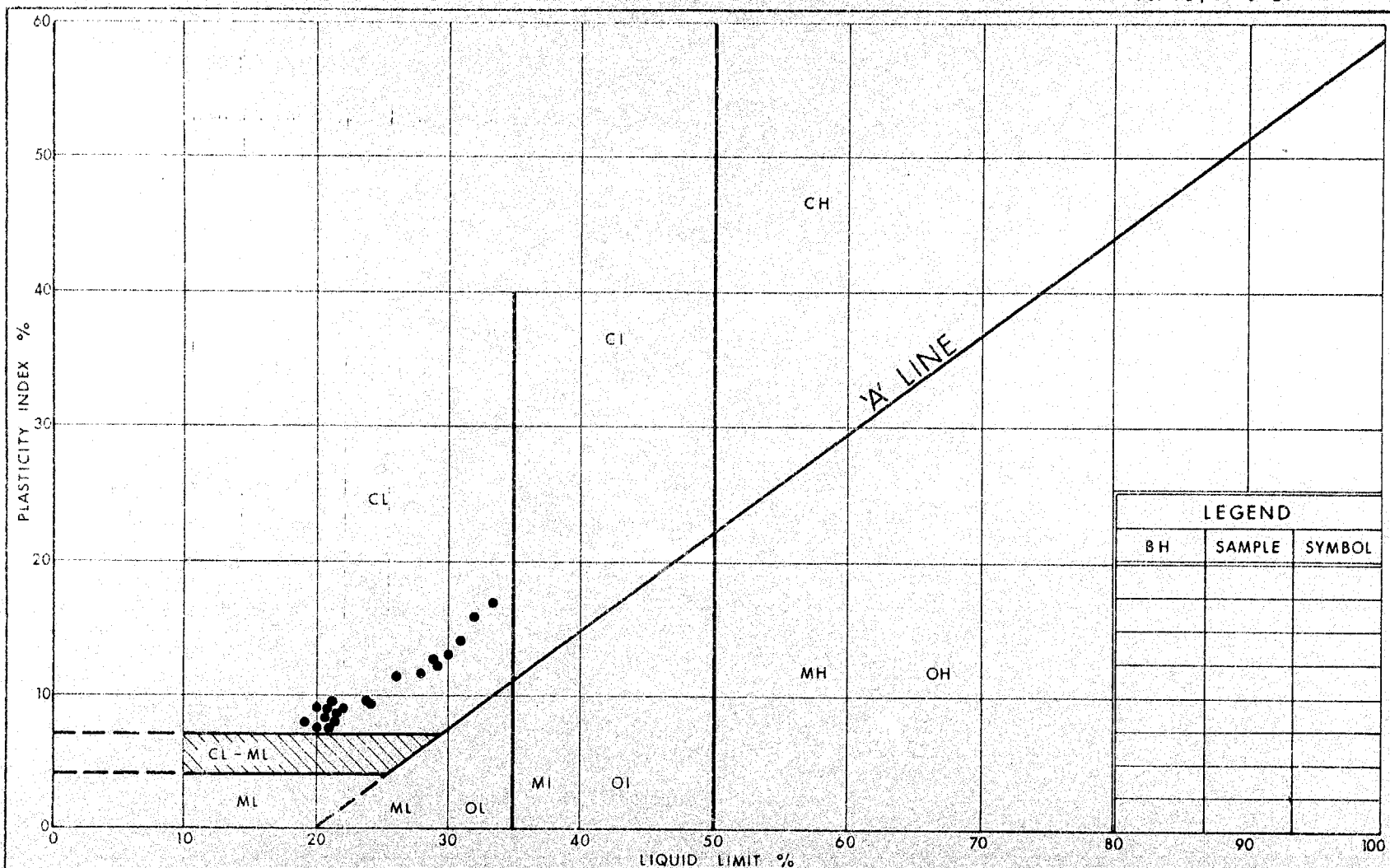
**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, WITH TO SOME SAND & OCC GRAVEL

FIG No 1

WP 33-76-08



LEGEND		
BH	SAMPLE	SYMBOL



Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT, WITH TO SOME SAND & OCC GRAVEL

FIG No 2

W P 33-76-08

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 30	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) E.G. CIU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 ω SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N, N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
 A_c ACTIVITY = $\frac{I_c}{2.5}$
 OM ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(undisturbed)}{S_u(remoulded)}$

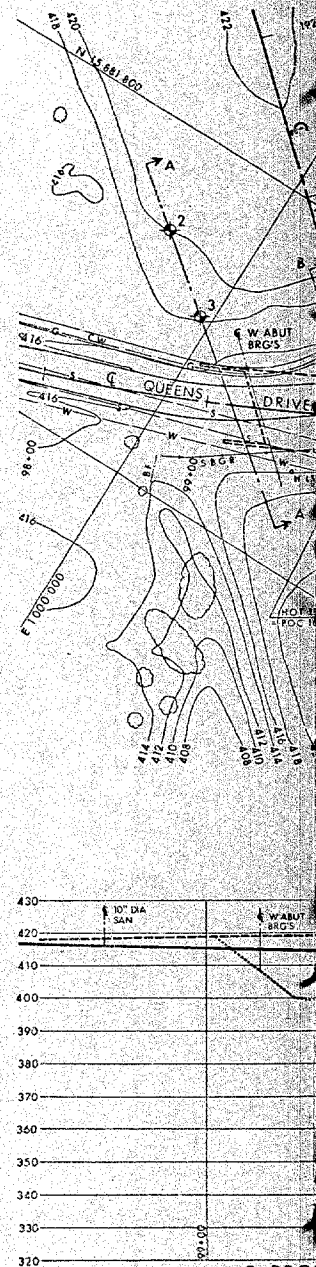
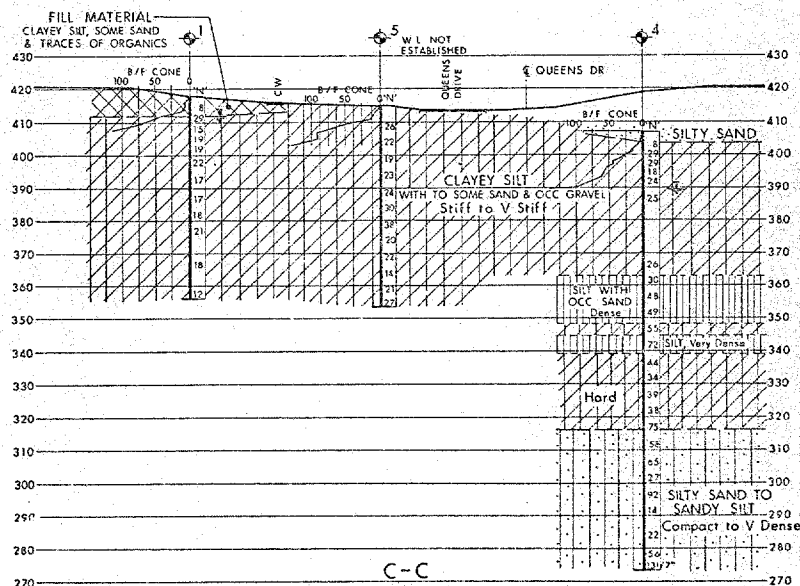
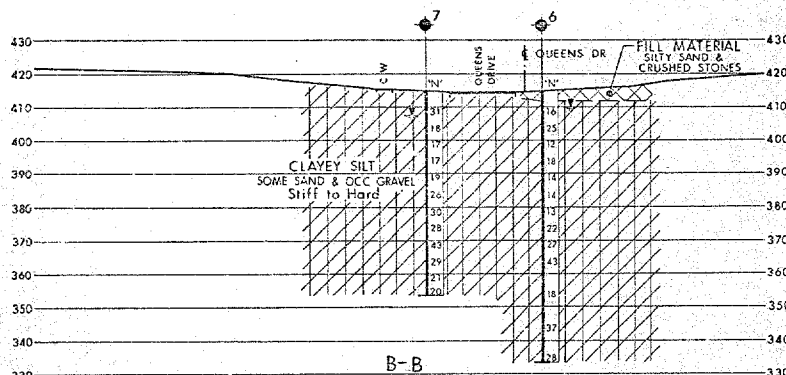
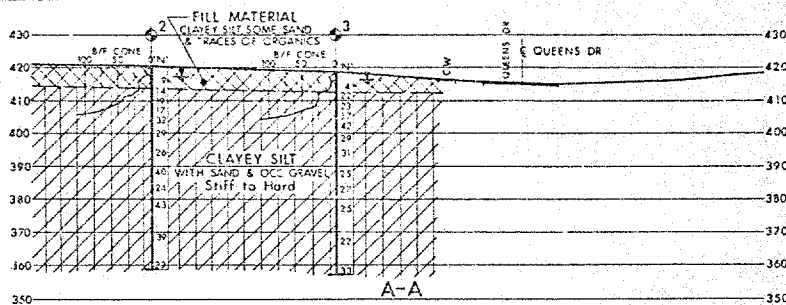
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 α_v COEFFICIENT OF VOLUME CHANGE
 C_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 z DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

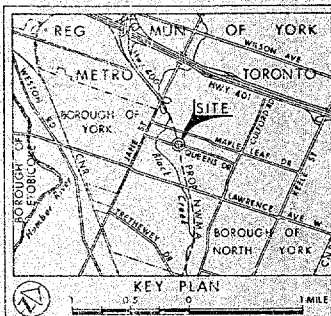


CONT No
WP No 33-76-08

QUEENS DRIVE UNDERPASS
(AT NORTHWEST METRO ARTERIAL)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

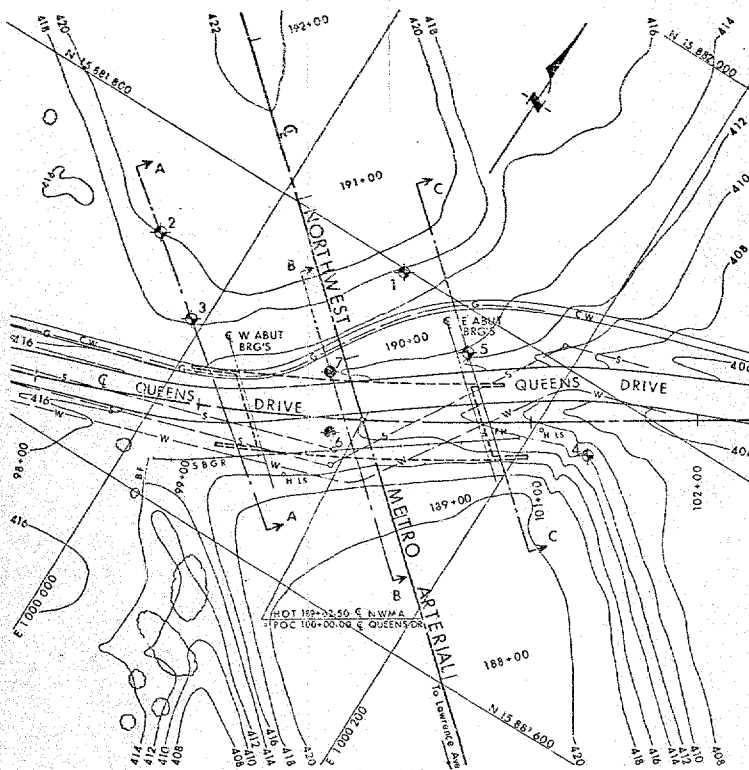
- ⊕ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N' Flows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ WL at time of investigation Oct 1977
- WL for BH #4 Feb 1965
- WL for BH #6 & 7 April 1978
- WL Not established for BH #5

No.	ELEVATION	CO-ORDINATES NORTH	EAST
1	417.5	15 851 798	1000 087
2	420.3	15 881 740	999 949
3	418.5	15 881 706	999 993
4	407.0	15 881 762	1000 236
5	415.1	15 881 777	1000 144
6	414.9	15 881 693	1000 100
7	414.9	15 881 724	1000 080

-NOTE-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

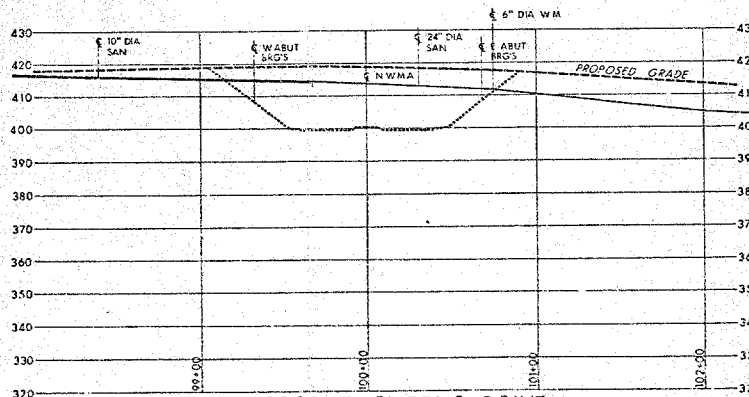
DATE	BY	DESCRIPTION

Geacres No 30M11-178
DRAWN BY: [Signature] CHECKED BY: [Signature] DATE: May 29, 1978
SHEET: 81 OF 81
PROJECT: [Signature] DATE: May 29, 1978
DRAWN: [Signature] CHECKED: [Signature] DATE: May 29, 1978
DWG 337608-A



PLAN

SCALE
40 20 0 20 40 FT



Q PROFILE-QUEENS DRIVE

SCALE
HOR 40 20 0 20 40 FT
VERT 20 10 0 20 FT

Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin Street, Downsview

Soil Mechanics Section
Engineering Materials Office
West Building, Downsview

Mr. W. Kulmatickas

77 11 10

08 Re: Northwest Metro Arterial and
Queen's Drive New Structure
W.P. 33-76-06, Site 37-1061
District 6, Toronto

At the request of the Structural Section, Central Region, by memorandum dated September 27, 1977, a foundation investigation was carried out at the above mentioned site. This investigation consisted of three sampled boreholes advanced by means of a C.M.E.-75 auger machine adapted for soil sampling. An additional borehole from a previous preliminary investigation (formerly B.H. 11, Feb. 9, 1965) at this site has also been incorporated as B.H. 4.

Due to the urgency of this project we have been requested to provide necessary recommendations immediately upon completion of the fieldwork to facilitate finalizing the preliminary bridge drawings. A detailed foundation report will be submitted after the completion of drafting work and borehole log sheets.

Information from our preliminary investigation report W.O. 65-F-40 (Ref. B.H. 11) for Hwy. 400 extension and recent additional information from our field study consisting of 3 boreholes carried out during October 24 and 25, 1977, reveals that the subsurface conditions are quite uniform in this area.

A surficial deposit consisting of 3 feet of silty sand in B.H. 4 (formerly B.H. 11) and 4 to 7 feet of fill material (clayey silt with trace of organics) in B.H. 1, 2 and 3 is underlain by a deep stratum of clayey silt with sand and occasional gravel extending to 91 feet. In-situ shear strength measurements in this cohesive deposit ranged from 1200 to 1800 psf. The 'N' values ranged from 14 to 55 blows/foot. From these results the consistency of the cohesive stratum is estimated as stiff to hard. In B.H. 4, within this cohesive deposit, two distinct layers of silt (elev. 362 to elev. 348 and elev. 345 to elev. 339) were encountered. The relative density of these noncohesive layers varied from dense to very dense. The clayey silt stratum in B.H. 4 is followed by a deposit of silty sand to sandy silt at a depth of 91 feet below the ground surface. This borehole was terminated within this stratum at a depth of 134 feet. The 'N' values in this granular deposit ranged from 14 to over 100 blows per foot, indicating a relative density of compact to very dense.

The groundwater level as observed in the recent boreholes (B.H. 1, 2 and 3) was measured at 2.5 to 6.0 feet below ground surface (elev. 4. to elev. 411.5). However, the groundwater level in B.H. 4 taken on February 9, 1965, was measured at 17.5 feet below ground surface (elev. 389.5).

cont'd.....

According to the available data a single span underpass structure is proposed at this crossing of N.W.A.R. and Queen's Drive. The structure can be supported either on spread footings or large displacement friction piles. For spread footings placed at about elevation 410.0 or lower, a safe design load of $1\frac{1}{2}$ t.s.f. may be used. Provide for 4 foot frost protection coverage over all footings and pile caps. For #14 timber piles driven at least 45 feet into the subsoil, a safe design load of 25 tons per pile may be used. No approach fill or cut stability problems are anticipated if standard 2:1 side slopes are used.

We trust this preliminary soil information will suffice in order to proceed with the preliminary design of the proposed structure. A complete foundation report will be submitted after the submission of the preliminary design drawings from the Structural Office.

V. Korlu
Project Engineer

For: M. Devata
Supervising Engineer

VK/gs

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher
C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

Files

DATE OF VISIT _____ LOCATION _____

GEOGRAPHIC No. 30 H H - 178

DIST 6 REGION CENTRAL

W.P. No. 33-78-08

CONT. No. _____

W. O. No. 37-1061

STR. SITE No. _____

HWY. No. _____

LOCATION QUEEN'S BOWLS TERRACE

REMARKS 2

REMARKS _____

REMARKS _____

REMARKS _____

30411-178

CONT No
WP No 33-76-08

QUEENS DRIVE UNDERPASS
AT NORTHWEST METRO ARTERIAL
FOOTING DETAILS

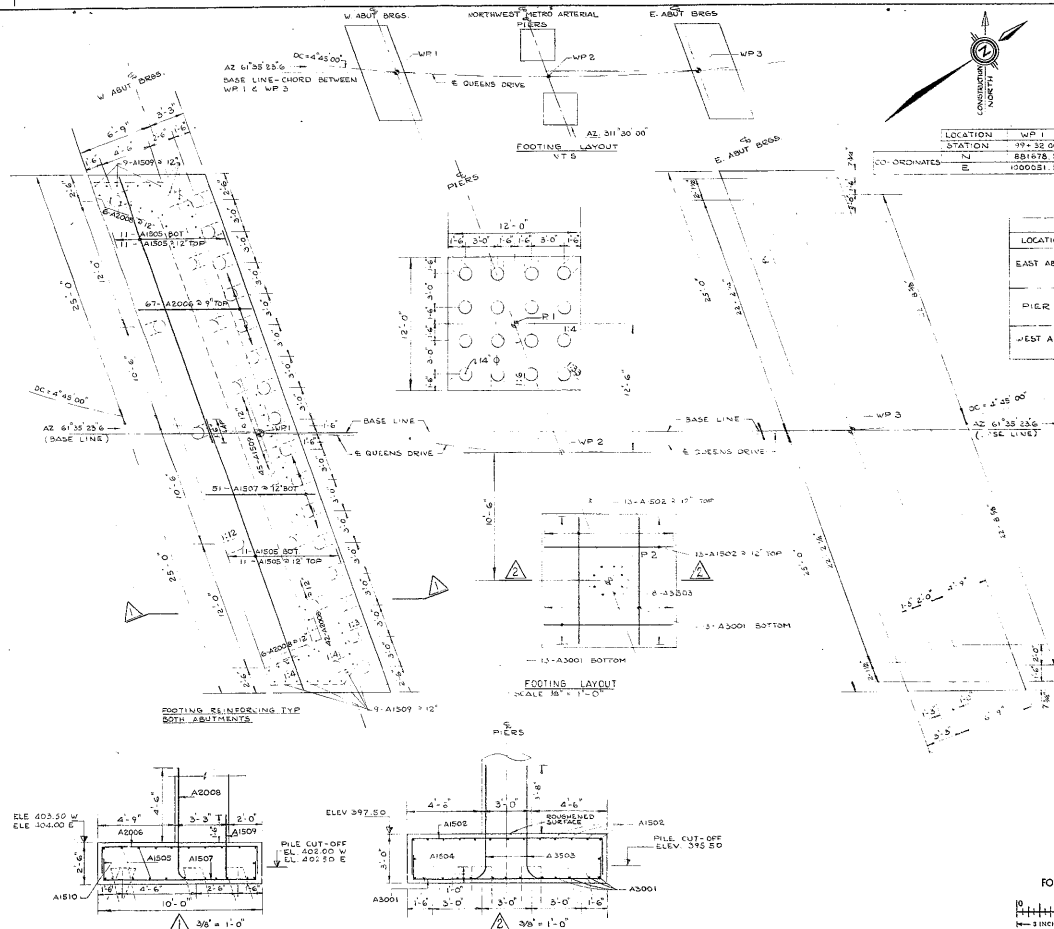
SHEET

LOCATION	WP 1	WP 2	WP 3	P 1	P 2
STATION	39+18.00	51+20.00	100+88.00		
N	881678.25	881708.90	881724.92	881717.72	881701.49
E	1000021.55	100012.21	1000171.08	1000102.24	1000120.58

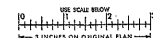
PILE DATA						
LOCATION	N°	BATTER	LENGTH	CUT OFF ELEVATION	TIP ELEV.	TYPE
EAST ABUT.	16	1:3	40'		367.4	
	17	1:4	40'	402.5	365.6	
	18	1:4	40'		361.7	
PIER	19	1:4	40'		360.1	
	20	1:4	40'	395.5	347.5	
	21	1:3	40'		351.5	
WEST ABUT.	22	1:3	40'		364.9	
	23	1:4	40'	402.0	362.1	
	24	1:4	40'		350.6	

NOTES

- PILES ARE TO BE DRIVEN TO ELEVATIONS
 - 1) W ABUT
 - 2) PIERS
 - 3) E ABUT
- PILES TO BE TREATED WITH CREOSOTE 8"/6" RETENTION
- TREATMENT SHALL BE IN ACCORDANCE WITH CSA STANDARDS D80-14 AND AWWA STANDARDS M1, M2, M3
- MOISTURE CONTENT OF MATERIAL PRIOR TO TREATMENT SHALL BE 22% MAXIMUM
- PILE SPACINGS MEASURED AT UNDERSIDE OF FOOTINGS



FOR REDUCED PLAN



DATE BY	DESIGN	CHECK	LOADING	DATE

