

GEOREP No.
30M14-115



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 160-74-30 ^{CONT 79-74} DIST 6

HWY 404

STR SITE 37-280

Regional Road #14 Interchange Underpass
6.4 Miles North of Hwy. #7

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GEOCRE 30M14-115

DATE MAY 02 1977



Memorandum

To: Mr. G.C.E. Burkhardt (3)
Regional Structural Planning Engineer
Central Region
3501 Dufferin Street, Downsview

From: Soil Mechanics Section
Engineering Materials Office
Downsview, Ontario.

Attention:

Date: 77 04 25

Our File Ref.

In Reply to

Subject: Re: Regional Road #14 Interchange Underpass
6.4 Miles North of Hwy. #7
W.P. 160-74-30, Site 37-280
District 6, Toronto

A foundation investigation was carried out during November 25 -26, 1970, for an underpass structure at the crossing of Hwy. #404 and Regional Road #14. The results of this investigation together with recommendations were presented in a report (W.O. 70-11107) submitted to Mr. B.R. Davis, Bridge Engineer dated January 15, 1971.

In a memo dated February 15, 1972, this office was advised by Mr. G.C.E. Burkhardt, Regional Structural Planning Engineer, Central Region, that the Regional Road #14 will be relocated further north to the existing alignment. As a result of this a foundation investigation was carried out by this section during February 24 - 25, 1972. The results of the investigation at the revised location were submitted in a report dated April 25, 1972, under W.O. 72-11032, W.P. 300-61 to Mr. G.C.E. Burkhardt. Since then the W.P. has been changed to W.P. 160-74-30, and a new concept is now adopted for this Hwy #404. Due to the urgency of this project the preliminary recommendations, taking into account the new concept, were submitted in a memo dated Feb. 22, 1977, to the Regional Structural Planning Section.

This new report refers to the latest concept and, therefore, the aforementioned two reports could be discarded. This section in the past submitted a detailed report with regard to Artesian Conditions Study at the structure crossing and at the location of the proposed sewers and culverts along Hwy. #404. This report was submitted to your office under W.O. 71-11089, W.P. 290-61 dated November 1, 1971. The W.P. is now changed and it is understood that a new W.P. will be designated for this project. This report is still valid and should not be discarded since the study results and recommendations are applicable to the new concept.

M. Devata
Supervising Engineer

MD/1f

FOUNDATION INVESTIGATION REPORT
For

Regional Road #14 Interchange Underpass
6.4 Miles North of Hwy. #7
W.P. 160-74-30 Site 37-280
District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project.

Fieldwork was done during the periods of August 24 to September 13, 1971, and February 24 - 25, 1972, utilizing a continuous flight auger machine equipped with solid augers and a conventional diamond drill equipped for wash boring operations with BX casing.

The field investigation consisted of a total of eight sampled boreholes. The boring depths ranged from 10.0 feet to 31.8 feet below ground surface.

SITE DESCRIPTION

The site is located about half mile west of Don Mills Road (Regional Road #8) immediately north of Regional Road #14 (Gormley Road) in the Town of Whitchurch-Stouffville and Richmond Hill, Regional Municipality of York. The topography of the region is flat to rolling. The land is used for farming purposes.

Physiographically the area is located in the region known as the "South Slope." As the name indicates, this region is a southern slope of the interlobate moraine with a gradient of approximately 300-400 feet within an average distance of 6 miles. At our particular area the moraine is smoothed, faintly drumlinized and scored at intervals by valleys tributary to the Rouge River system.

Beneath a thin layer of topsoil is the predominant stratum of cohesive glacial till composed of clayey silt with sand and traces of gravel. This glacial deposit is underlain by a granular stratum consisting of silty sand to sand. The granular deposit was proven only at one location (B.H. #7)

and the majority of boreholes were terminated in the lower portion of the cohesive glacial till stratum since the granular deposit exhibited artesian water pressures relative to the ground surface.

Detailed descriptions of various soil types encountered in boreholes are given on the Record of Borehole Sheets. Locations and elevations of the boreholes, together with the estimated stratigraphical sections inferred from the borehole data, are shown on Drawing No. 1607430-A.

Clayey Silt with Sand and Traces of Gravel (Glacial Till)

Under a thin cover of topsoil a deposit of cohesive glacial till is composed of clayey silt with sand and traces of gravel. This stratum was explored to its full depth of 14.5 feet at one location (B.H. #7). Elsewhere, it was proven that this deposit will be in excess of 31 feet in thickness. In one location a distinct 2 foot thick layer of sand was observed in the lower portion of the deposit below elevation 856.

The results of Atterberg Limit tests performed on samples recovered from the cohesive glacial till stratum were plotted on the Record of Borehole Sheets and are as follows:

	<u>Range</u>
Liquid Limit (W_L) %	16 - 24
Plastic Limit (W_P) %	12 - 15
Natural Moisture Content (W) %	8 - 19

The above results indicate that the cohesive portion of the glacial till is inorganic and of low plasticity.

The Standard Penetration Resistance Test 'N' values ranged from 24 blows to over 100 blows per foot, generally increasing with depth. This indicates that the consistency of the glacial till stratum varies from very stiff to hard.

Silty Sand to Sand

A granular deposit consisting of silty sand to sand underlies the cohesive glacial till stratum and was found to act as an aquifer containing water under uplift pressures. In certain locations as mentioned previously, sand seams or layers were also observed within the main portion of the cohesive till in random order. These seams appear to be connected with the underlying sands, thus artesian pressures were also noted within these seams. The relative density of the granular deposit is very dense, with 'N' values ranging from 64 blows/ft. to over 100 blows/ft.

Groundwater Conditions

The groundwater level observations were carried out by measuring water levels in the open boreholes and also by installing piezometers. An artesian groundwater pressure head was encountered once the borehole penetrated through the cohesive glacial till stratum down into the lower granular deposit. Once this occurred, water filled the borehole and in most cases, water continuously flowed out of the borehole. The water which flowed out of the borehole was clear, indicating no loss of fines in the aquifer. In order to establish the groundwater table and to observe the variations in artesian pressure head at various depths, a total of 3 piezometers were installed at B.H. #7. The location and relative depth of the piezometers are shown on Borehole Sheet #7, as well as in Dwg. #1607430-A. The pertinent details are as follows:

<u>Location</u>	<u>Piezometer No.</u>	<u>Tip Elev.</u>	<u>Ground Elev.</u>	<u>Water Level Elev.</u>
West Side	P 10)	835 (in Sand)	867.9	872.5
	P 11) (B.H. #7)	855 (in clayey silt)	867.9	870.0
	P 12)	861 (in clayey silt)	867.9	863.0
East Side	No Piezometer open hole (B.H.#8)	840 (when borehole extended to this elev.)	860.7	855.0

These observations indicate that the artesian pressure head was found to be as much as 4.5 feet above the ground surface, corresponding to elev. 872.5. The results are also plotted on Figure No. 1. Artesian conditions within the granular deposit are more or less constant. Further, the artesian head is not solely confined to the granular deposit. Instead, it dissipates throughout the glacial till stratum as well.

It should also be noted that there is no water in the boreholes which were terminated in the glacial till some 10.5 feet below the ground surface. If these boreholes are left for a considerable length of time the stabilized water level would have been similar to piezometer P. 11 located at about this elevation.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct an interchange where Hwy. 404 crosses Regional Road #14 revision (Gormley Road) in the Regional Municipality of York. The Hwy. 404 at this crossing will be built initially with only two 12 foot lanes per direction separated by a 98 foot wide median. Provision has been made on the overall design to expand the highway to four lanes each way, the future widening to be carried out toward the "inside" whereby reducing the median width to 50 feet. In order to achieve the proposed interchange an underpass structure will be required. In the initial scheme the structure width will be 73 feet and for the future scheme this will be widened by 49 feet on either side to facilitate the future scheme. The overall length of the proposed structure will be 230 feet consisting of two spans (115'-115').

The proposed grade of Hwy. 404 at this crossing will be at approximate elevation of 869.0. The future grade of Regional Road #14 revision (Gormley Road) will vary between elevations 894.0 (east side) and 896.0 (west side) of the crossing. The existing ground elevation ranges from 861.0 (east side) to 866.5 (west side). The grade requirements are such that fills up to 33 feet in height will be required.

The subsoil at this site consists of a very stiff to hard glacial till (clayey silt with sand and traces of gravel) underlain by a very dense granular stratum of silty sand to sand which was found to be the primary source of artesian water.

In the subsections to follow, the foundation support for the proposed structure, together with stability and settlement considerations associated with the approach fills, will be discussed.

Structure Foundations

The subsoil is competent, therefore, it is recommended that the centre pier and closed type abutments be supported on spread footings located within the very stiff to hard parent cohesive glacial till stratum. In order to fulfill the frost protection requirements, the underside of the footings should be at least 4 feet below the finished grade. As mentioned elsewhere, the granular stratum below the cohesive glacial fill is the primary source of artesian water. In order to prevent any basal heave at the footing excavation base, the foundation base should not extend below elevation 862. However, at the east abutment location the cohesive glacial till is thicker and consequently the footing base can be extended to elevation 858.

An allowable bearing value of up to 3 t.s.f. may be used in designing the foundations. In computing the lateral resistance of the footings, an adhesion value of 2,000 p.s.f. may be used between the rough concrete surface and glacial till.

The excavations for the pier footings will be carried out within the cohesive glacial till. In view of the relatively impervious nature of the glacial till, no major-dewatering problems are anticipated. As mentioned elsewhere in this report, thin silty sand layers are present within this cohesive deposit. Once these granular layers are intercepted, excess water seepage into the excavations can be expected. However, it is believed that this could be handled by employing ordinary pumping methods.

The foundation subsoil will settle due to the imposed foundation loading. The subsoil is composed of a competent cohesive glacial till, thus the settlement will be of a recompression nature. For a spread footing foundation of the size contemplated, imposing the aforementioned pressure, it is estimated that the settlement should not exceed one half of an inch, provided the subsoil is not softened by groundwater seepage or uncontrolled surface runoff. It may be advantageous to protect the cohesive glacial till at the founding level by covering it with a lean concrete working slab immediately after the completion of the excavation.

Perched Abutments

The abutments for this structure may be perched within the approach fills. The presence of artesian condition precludes the use of end-bearing piles driven to the very dense granular stratum to support the abutments, since the piles may penetrate and disturb the artesian zone in the granular subsoil and consequently endanger the stability of the overall structure complex. In view of this, it is recommended that the abutments be supported on spread footings constructed in the approach fills.

The abutments may be supported on spread footings perched within the approach fills. The material below the tops of the footings should consist of well compacted Granular 'A' and should extend to a horizontal distance of at least 8 feet from the footing edges in the plane of the footing tops. This portion of the fill should be constructed with side slopes no steeper than 1:1. The remainder of the fill should be completed to about profile grade for a distance of about 50 feet behind the abutments before re-excavating for the abutment footings. An allowable bearing value of 2.5 t.s.f. may be used in footing design.

Related Considerations

The abutments should be designed to withstand a lateral earth pressure exerted by the backfill and this pressure is dependent of the deformation characteristics of the retaining structures. If some movement of the top of the wall is permitted, then a coefficient of active earth pressure (K_a) of 0.35 can be used. On the other hand, if the structures are designed as rigid frames, then a coefficient of earth pressure at rest (K_o) of 0.5 should be used.

Approaches to the Structure

The grades for Hwy. 404 and Regional Road #14 (Gormley Road) at this crossing are such that fills up to 33 feet in height will be required for Regional Road #14. Fills of this height will be inherently stable with respect to a deep-seated failure within this foundation subsoil, provided they are constructed with standard 2:1 slopes.

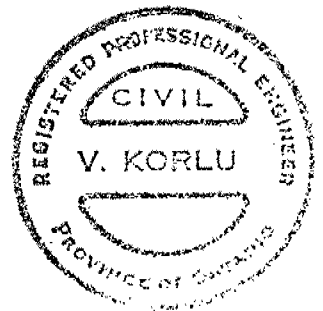
MISCELLANEOUS

The previous fieldwork was carried out during November 25-26, 1970, September 7-10, 1971 and February 24-25, 1972 by this Section, M.T.C., Ontario.

This report was prepared by Mr. V. Korlu, Project Engineer and reviewed by Mr. M. Devata, Supervising Engineer.

V. Korlu
V. Korlu, P. Eng.
Project Engineer

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



MD/VK/gs/lf
April, 1977

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 7

WP 160-74-30 LOCATION Co-ords. N 15 966 042; E 1 028 824 ORIGINATED BY CK
 DIST 6 HWY 404 BORING DATE Sept 7-9, 1971 COMPILED BY AKB
 DATUM Geodetic BOREHOLE TYPE Auger & Washboring BX Casing CHECKED BY af

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
867.9	Ground Level															
0.0	Clayey Silt with sand, traces of gravel (Glacial Till)		1	SS	44											
	Hard		2	SS	34											
			3	SS	35											
	Sand, some gravel		4	SS	51											
853.4			5	SS	64											
14.5	Silty sand to Sand		6	WS												
			7	SS	64											
			8	SS	172											
	Very Dense		9	SS	100											
836.1																
31.8	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 8

WP 160-74-30 LOCATION Co-ords N 15 966 194; E 1 029 144 ORIGINATED BY CK
 DIST 6 HWY 404 BORING DATE Sept. 9-10, 1971 COMPILED BY PK
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT <u>W_L</u> PLASTIC LIMIT <u>W_p</u> WATER CONTENT <u>W</u>			UNIT WEIGHT <u>γ</u>	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
860.7	Ground Level															
0.0	Clayey silt with sand, trace of gravel. (Glacial Till)		1	SS	38											2 29 58 11
			2	SS	32											
	Hard		3	SS	34											
			4	SS	38											
			5	SS	36											
839.2			6	SS	67											
21.5	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 21

WP 160-74-30 LOCATION Co-ords. N 15 966 029; E 1 028 878 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 24, 1972 COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
866.4	Ground Level															
0.0	Clayey silt with sand, traces of gravel (Glacial Till)		1	SS	41	860							o			3 30 47 26
			2	SS	161								o			
855.9	Hard		3	SS	67								10-1			
10.5	End of Borehole Note: Water Level not established															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 22

WP 160-74-30 LOCATION Co-ords. N 15 966 139; E 1 028 865 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 25, 1972. COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
866.8	Ground Level															
0.0	Clayey silt with sand, traces of gravel (Glacial Till)		1	SS	26	850										
			2	SS	53											
856.3	Very Stiff to Hard		3	SS	127											3 36 37 24
10.5	End of Borehole Note: Water Level Not Established															

20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 23

WP 160-74-30 LOCATION Co-ords. N 15 966 154; E 1 028 991 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 25, 1972. COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
864.1	Ground Level															
0.0	Clayey silt with sand, traces of gravel (Glacial Till)		1	SS	24	860										6 25 44 25
	Very Stiff to Hard		2	SS	54											
853.6			3	SS	48											
10.5	End of Borehole Note: Water Level not established															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 24

WP 160-74-30 LOCATION Co-ords. N 15 966 043; E 1 029 002 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 25, 1972 COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
863.8	Ground Level															
0.0	Clayey silt with sand, traces of gravel (Glacial Till)		1	SS	34	860										
			2	SS	75											
853.8	Hard		3	SS	100/16"											
10.0	End of Borehole Note: Water Level not Established															

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 25

WP 160-74-30 LOCATION Co-ords. N 15 966 166: E 1 029 116 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 25, 1972 COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					w_p — w — w_L				
							SHEAR STRENGTH					WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					10 20 30				
861.4	Ground Level					860									GR SA SI CL	
0.0	Clayey Silt with sand, traces of gravel (Glacial Till)		1	SS	41										3 44 37 16	
			2	SS	38											
850.9	Hard		3	SS	56											
10.5	End of Borehole Note: Water Level not established															


20
15 ϕ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 26

WP 160-74-30 LOCATION Co-ords N 15 966 057; E 1 029 128 ORIGINATED BY JB
 DIST 6 HWY 404 BORING DATE February 25, 1972. COMPILED BY JB
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
861.7	Ground Level															
0.0	Clayey silt with sand, traces of gravel (Glacial Till) Very Stiff to Hard		1	SS	24	860							o			
			2	SS	37								o			
851.2			3	SS	84								o			
10.5	End of Borehole Note: Water Level not Established															

OFFICE REPORT ON SOIL EXPLORATION

GROUND WATER REGIME

REGIONAL ROAD 14 (GORMLEY RD) & HWY 404

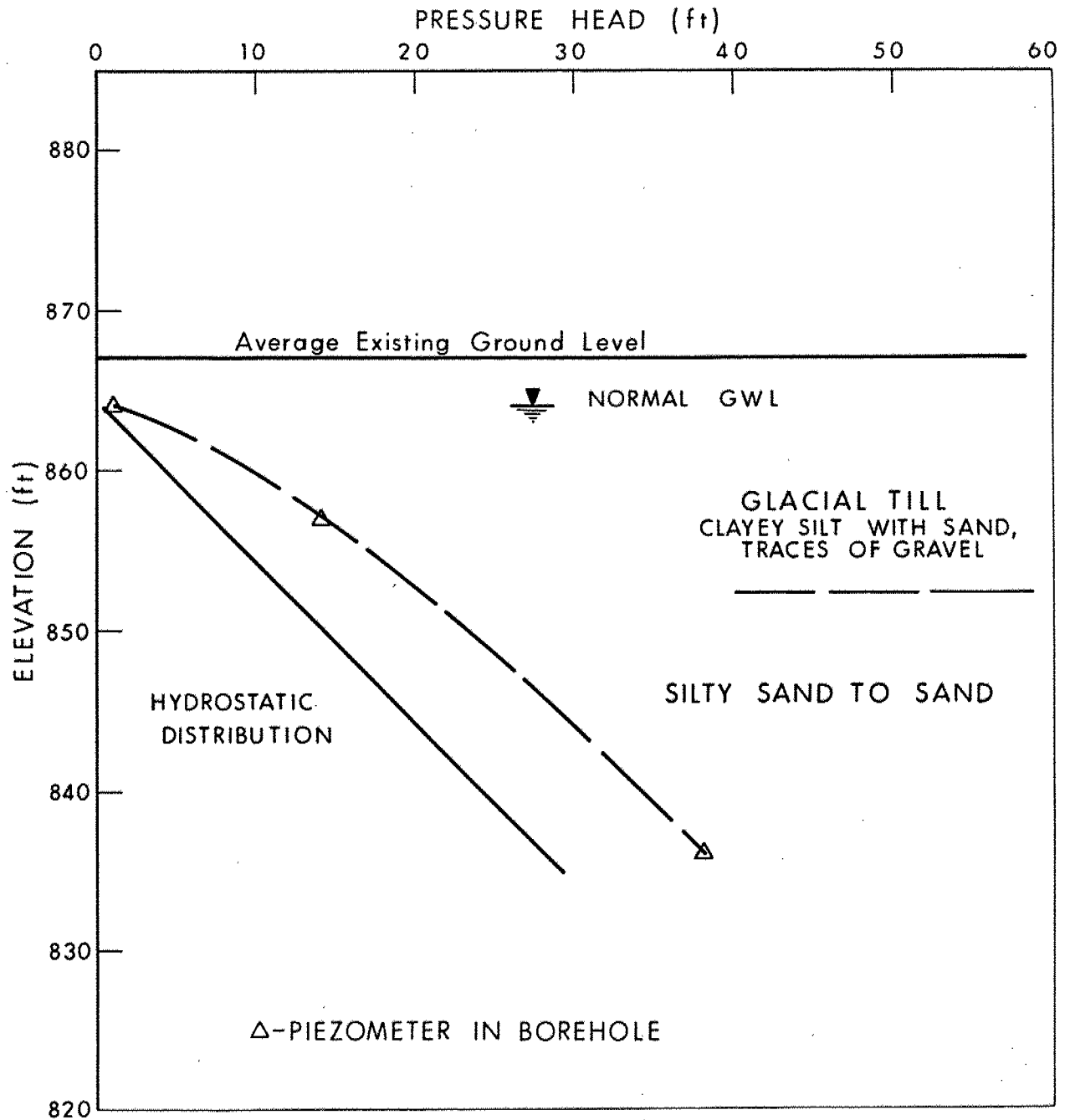


FIG No 1

WP 160-74-30

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

'N' STANDARD PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB/SQ FT</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS :-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W	THINWALL OPEN
W.S	WASHED SAMPLE	T.P	THINWALL PISTON
S.T	SLOTTED TUBE SAMPLE	O.S	OESTERBERG SAMPLE
A.S	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
w_S	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

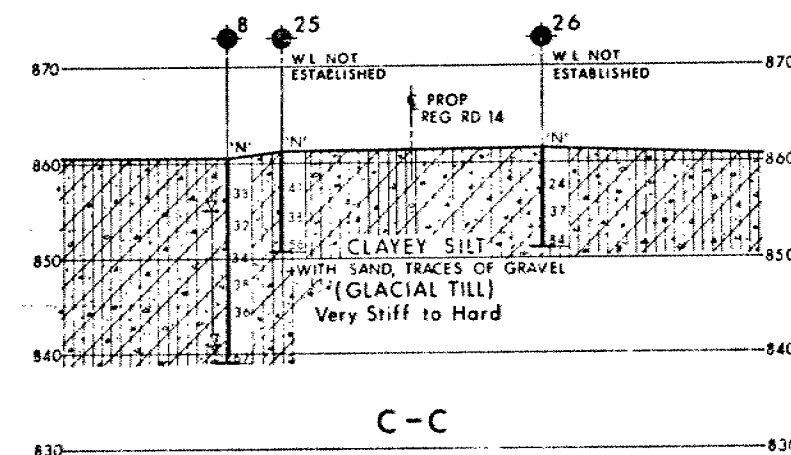
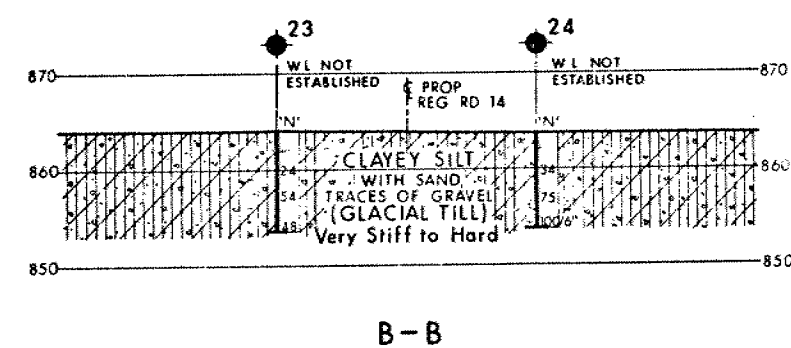
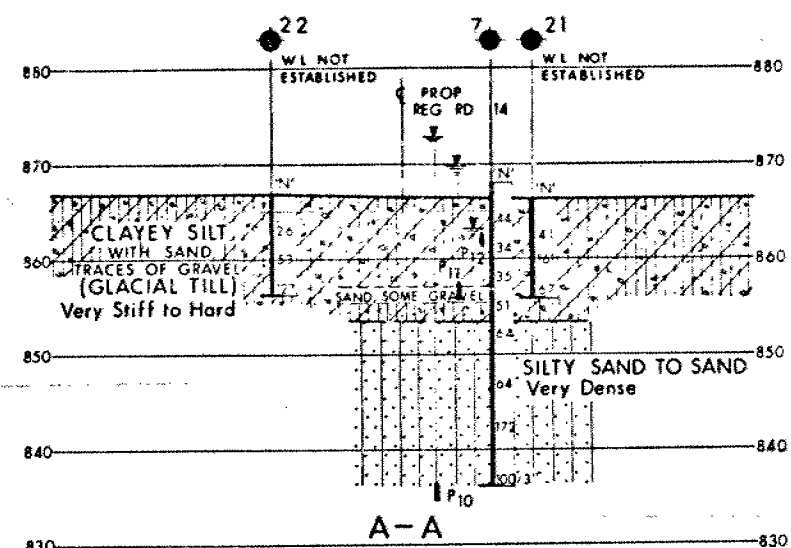
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

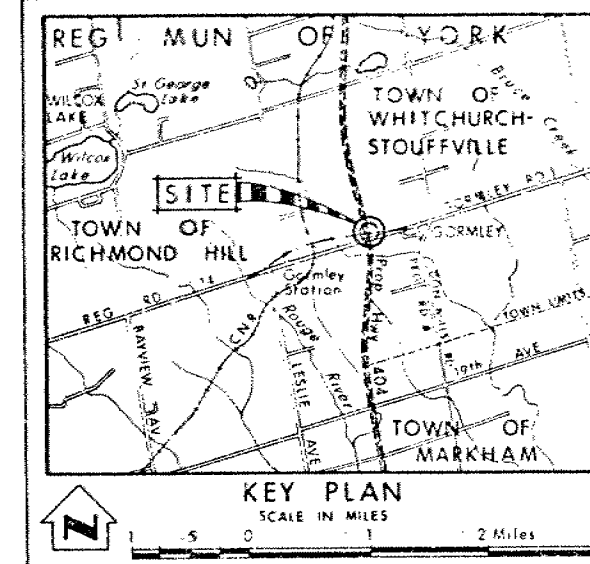
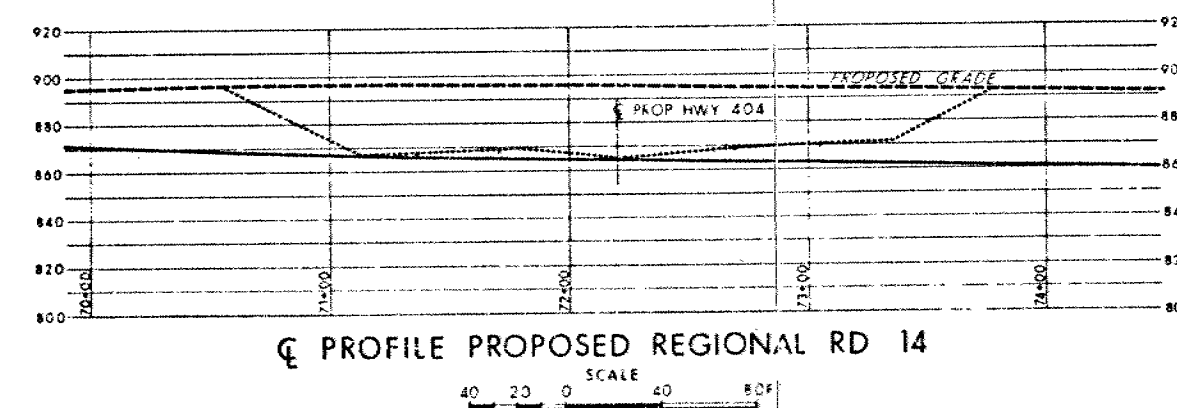
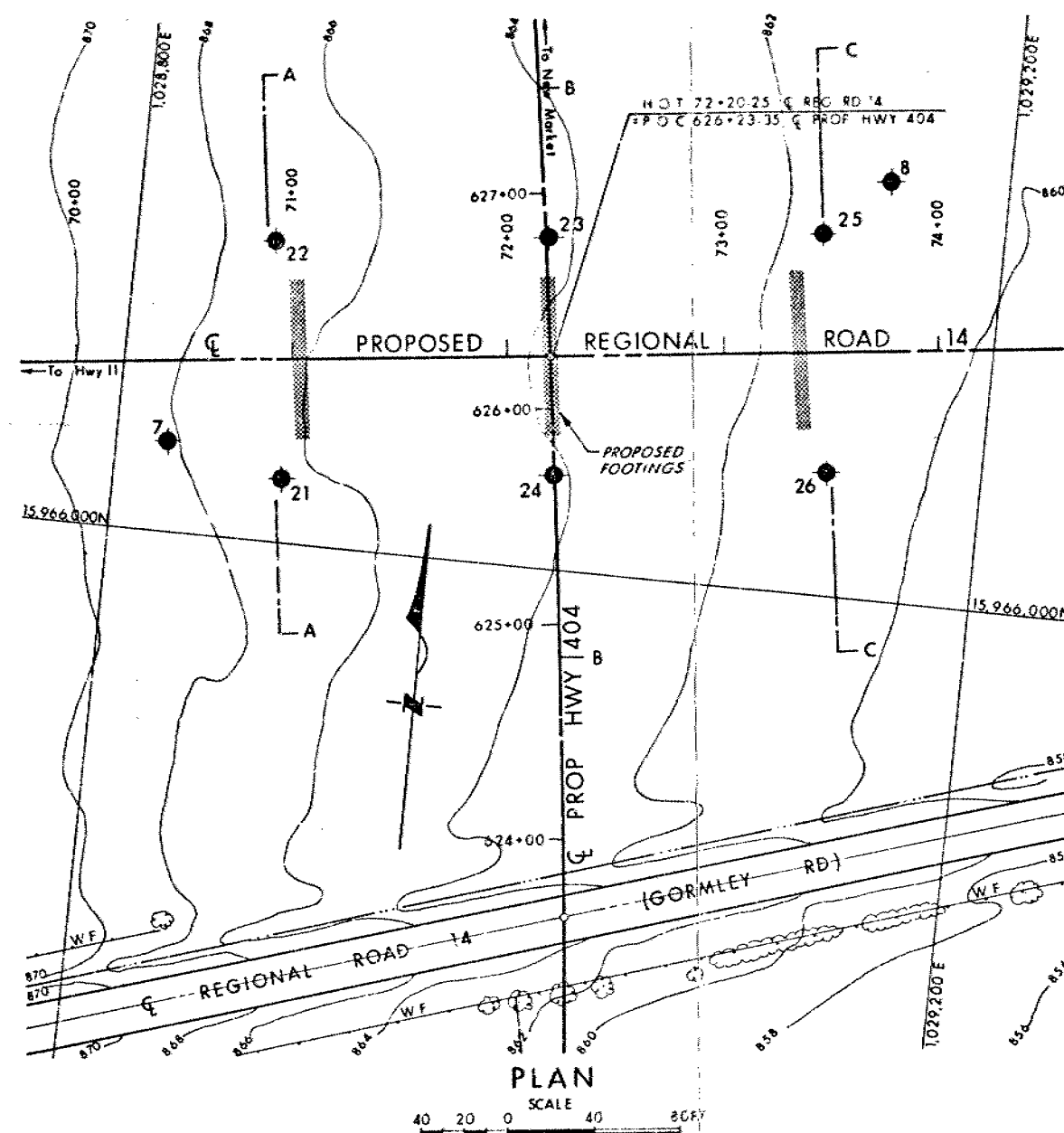


SECTIONS

SCALE

HOR 40 20 0 40 80 FT

VERT 10 5 0 10 20 FT



LEGEND				
	Bore Hole			
	Cone Penetration Test			
	Bore Hole & Cone Test			
	Water Levels established at time of field investigation, Sept 1971			
	Piezometer			
	Head ARTESIAN CONDITION Encountered			
NO	ELEVATION	CO-ORDINATES		
		NORTH	EAST	
7	867.9	966,042	29,824	
8	860.7	966,194	29,144	
21	866.4	966,029	28,878	
22	866.8	966,139	28,865	
23	864.1	966,154	28,991	
24	863.8	966,043	29,002	
25	861.4	966,166	29,116	
26	861.7	966,057	29,128	

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION
1	Apr/77	GP	PLAN & PROFILE REVISED, SUBSOIL ALTERED ON SECTIONS

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

REGIONAL ROAD 14 UNDERPASS
(6.4 Miles North of Hwy 7)

HIGHWAY NO. Prop 404 DIST NO. 6
Reg. Mun. of YORK Town of Whitchurch-Stouffville
Town of Richmond Hill LOT 1 CON. III

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD A & B CHECKED	WP NO 160-74-30	DRAWING NO
DRAWN BY	CHECKED	FOR NO
DATE Apr 18, 1972	SITE NO 37-280	BRIDGE DRAWING NO
APPROVED	CONT NO	

1607430-A