



Ministry of  
Transportation and  
Communications

## Memorandum

To: Mr. G.C.E. Burkhardt 2  
Reg. Structural Planning Eng.  
Central Region  
3501 Dufferin Street  
Downsview, Ont.

From: Soil Mechanics Section  
Geotechnical Office  
West Bldg. Downsview

Date: April 29, 1975

Our File Ref.

In Reply to

APR 30 1975

Subject:

FOUNDATION INVESTIGATION REPORT  
FOR  
THE PROPOSED TH AND B RAILWAY  
OVERHEAD ON THE PROPOSED B.S.A.R.  
DISTRICT #4 (HAMILTON)  
WP: 40-74-04  
\*\*\*\*\*



Attached we are forwarding to you our detailed  
Foundation Investigation Report on the subsoil  
conditions existing at the above-mentioned site.

We believe that the factual data and recommen-  
dations contained therein will prove adequate  
for your design requirements. Should additional  
information be required, please do not hesitate  
to contact our office.

*K. G. Selby*

K. G. SELBY  
Supervising Engineer

cc: E.J. Orr  
B.R. Davis  
R.S. Pillar  
B.J. Giroux  
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J. Anderson ) memo only  
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Files  
Record Services

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FOUNDATION INVESTIGATION REPORT  
FOR  
THE PROPOSED TH AND B RAILWAY  
OVERHEAD ON THE PROPOSED B.S.A.R.  
DISTRICT #4 (HAMILTON)  
WP: 40-74-04  
\*\*\*\*\*

1. INTRODUCTION

A field investigation at the crossing of B.S.A.R. and the TH-B Railway was carried out by the Soil Mechanics Section to determine the subsoil conditions existing at the site.

An earlier preliminary investigation covering the same general area was carried out (November, 1974) and was reported under WP; 40-74-01 by Mr. A. Prakash.

This report contains the results of both investigations together with our recommendations pertaining to the design of the proposed structure foundations and approach embankments.

2. DESCRIPTION OF THE SITE

The site of the proposed TH & B Railway Overhead is located in the City of Brantford. The surrounding area is used mainly for commercial and industrial purposes.

It is understood that part of the area was covered by a meandering creek some time in the past. An approximate 8 ft. thick organic silt (Marl) was deposited by this creek. With the development of the area (commercial and industrial) fill material consisting of sand, gravel, industrial waste (coal dust, brick etc.) and organic material, was placed over the organic silt stratum. Excessive settlements of adjacent buildings were observed. These buildings apparently were constructed over the organic deposit.

Geologically the area lies somewhere around the border of the physiographic regions known as the 'Norfolk Sand Plain' and the 'Horseshoe Moraines'. The beds of silts and sands are considered to be deltaic in glacial lakes Whittlesey and Warren. Varved silts and clayey silts were also deposited by Lake Warren during a recession of the Wisconsin glacier.

### 3. FIELD AND LABORATORY INVESTIGATION

Eleven sampled boreholes and nine dynamic cone penetration tests were carried out during the field work.

Boring was achieved by means of Hollow Stem continuous Flight Auger, Mounted on Bombardier. During the field work, disturbed samples were obtained by means of standard split-spoon sampler; the energy used in driving it conformed to the requirements of the Standard Penetration Test. (SPT) 'Undisturbed' samples were recovered using 2-inch O.D. Shelby tubes which were pushed into the soil hydraulically. Wherever possible, in-situ vane tests were carried out 12 inches below the various sample depths.

The bedrock was proved in Borehole #2, using BX Rock Coring equipment.

All boreholes were surveyed in the field by personnel from the Central Region Engineering Surveys. The locations and elevations of the borings are shown on drawing No. 407404-A, which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine the following physical properties:-

- Atterberg Limits
- Natural Moisture Content
- Grain-Size Distribution
- Undrained Shear Strength
- Bulk Density
- Organic Content

The field and laboratory test results are summarized on the record of borehole sheets contained in the appendix of this report.

#### 4. SUBSOIL CONDITIONS

##### 4.1) General:

In general, the subsoil at the site consists of deposits of fill material or sand and gravel or silt, followed by organic silt or sandy silt to silty sand, followed by sand and gravel, followed by clayey silt, followed by Dolomite type bedrock.

The detailed stratigraphy encountered in each boring is shown on the record of borehole sheets. The estimated stratigraphical profile and sections of drawing no. 407404-A are based upon this information.

The vertical and horizontal extent of the different deposits was found to vary; therefore, it is recommended that references be made to the record of borehole sheets for the stratigraphy existing at a particular location.

A brief description of the different soil types is as follows.

##### 4.2) Fill Material:

This stratum was encountered in all the boreholes with the exception of Borehole #1 and #2 from ground level to a maximum depth of 8 ft. The material in the stratum consists of gravel, sand, silt, clay, industrial waste and organic substances.

##### 4.3) Silt:

This stratum consisting of loose silt, was observed in Borehole #2 only at ground surface. The thickness is about 8 ft.

#### 4.4) Sandy Silt to Silty Sand:

In Boreholes #204 and #209, a very loose to loose sandy silt to silty sand deposit was found to underlie the above described fill material. The thickness varies from 3 to 7 feet.

#### 4.5) Organic Silt:

This deposit was encountered in Boreholes No. 3, 205, 205A, 205C, 205D, 207 and 208, below the fill material. The lower boundary was found to vary between Elev. 637 and Elev. 642. The material in the stratum consists of organic silt with sand. The physical properties of this stratum are as follows:

Liquid Limit (WL)	:	44-64%
Plastic Limit (WP)	:	21-50%
Natural Moisture Content (W)	:	48-99%

The organic content is about 18%

The undrained shear strength of the material varies between 100 to 1000 psf. The consistency may be described as very soft to stiff.

#### 4.6) Sand and Gravel:

This stratum was encountered in each boring. The thickness varies from 3 to 12 ft. The material in the deposit consists of sand and gravel with the following average proportion: Sand 46%; Gravel: 54%.

Standard Penetration tests carried out within this stratum indicate that the relative density ranges from compact to dense.

#### 4.7) Clayey Silt, Trace of Sand:

This cohesive stratum was found in every borehole from the sand and gravel zone to the bedrock surface. The thickness of the overall deposit varies from 38 to 58 feet, in borehole no. 208 and #1 respectively.

The material in the deposit consists of clayey silt with traces of sand. Occasional layers of silty clay were also found.

Physical properties of the overall stratum are as follows:

Liquid Limit (WL)	:	22-30%
Plastic Limit (WP)	:	14-19%
Natural Moisture Content (W)	:	14-31%
Undrained Shear Strength:		
Field Vane Test	:	1600-over 2000 psf
Unconfined	:	1000-1600 psf
Bulk Density	:	119 - 130 pcf

The undrained shear strength in general increases with depth.

The consistency is estimated to range from firm to hard.

#### 4.8) Bedrock:

Dolomite type bedrock was encountered in Borehole #2, at elev. 595. In other boreholes, the bedrock surface was assumed to be at elevation where refusal to augering was reached.

### 5. GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

Borehole # 1	Elev:	652.1
2		650.1
3		644.0
204		not established
205		641.6
205A		641.4
205C		not established
205D		643.6
206		not established
207		not established
208		639.8
209		not established

In general, the groundwater level was found to be 7 - 11 ft. below the ground surface.

#### 6. DISCUSSION AND RECOMMENDATIONS

It is proposed to cross the Toronto, Hamilton and Buffalo railway with a three span (110' - 115' - 110') overhead structure. Retaining walls are also proposed (Ref. drawing no. A5-3A) adjacent to the abutments. The length of the walls are as follows:

West Abutment;	North Side	:	40 ft.
	South Side	:	20 ft.
East Abutment;	North Side	:	20 ft.
	South side	:	80 ft.

The proposed profile grade of Brantford Southern Access Road varies:

Sta: 134+00	;	Elev: 678 <sup>±</sup>
Sta: 141+00	;	Elev: 688 <sup>±</sup>
Sta: 144+00	;	Elev: 685 <sup>±</sup>

The existing ground level elevations at the respective stations are as follows: Elev: 651<sup>±</sup>; Elev: 658<sup>±</sup>; and Elev: 666<sup>±</sup>.

The maximum height of embankment will be about 32 ft. above the ground surface (Sta: 137+30<sup>±</sup>).

##### 6.1) Approaches:

As mentioned previously, up to 32 ft. high embankment will be placed over the west side of the proposed structure. A considerable portion of this fill will be underlain by soft, compressible organic silt. To ensure that stability of the embankment, it is recommended that the organic material be completely sub-excavated from within the plan limits of the fill section. The sub-excavation so formed should be back-filled with suitable material (see Fig. 1). No stability problems are anticipated if the sub-excavation and backfilling operations are adhered to and 2:1 slopes are employed.



Additional shallow borings will be carried out by the Regional Materials Office to further delineate the vertical and horizontal extent of the organic silt deposit. Elsewhere, the mixed surficial fill should be replaced with granular material.

The underlying clayey silt strata will undergo settlement under the weight of the approach embankments. It is estimated that the maximum settlement will be in the order of 4 to 6 inches.

#### 6.2) Structure Foundation:

Closed-type abutments are proposed. The subsoil conditions are not suitable for spread footing type foundations. Therefore, it is recommended that the abutments and piers be supported on end-bearing piles driven to bedrock. For estimating purposes, the pile tips will meet refusal between Elev: 595<sup>±</sup> and Elev: 592<sup>±</sup>.

The piles can be designed for the maximum allowable load for the respective pile section selected (e.g. 12BP74 Steel 'H' Piles may be designed for 95 tons/pile).

It will be necessary to sub-excavate the fill material within the plan limits of the footings and backfill with a granular type material. No rock or bouldery fill should be placed in areas where piles are to be driven. A minimum of 4 ft. of earth cover should be provided to the underside of the footings for Frost Protection purposes.

Suitable weep holes should be provided at the base of the walls, according to current MTC Standards.

#### 7. MISCELLANEOUS

The field work was carried out during the periods of September 24-26, 1974 and March 7-April 2, 1975, under the supervision of Mr. P. Stewart and Mr. G. Cautillo, Project Engineers.

Equipment used was owned and operated by Master Soil Investigation Ltd., and Atcost Soil Drilling Inc.

This report was prepared by Mr. P. Payer, Senior Engineer and reviewed by Mr. K. G. Selby, Supervising Engineer.

*P. Payer*  
P. PAYER, P. Eng.



*K. G. Selby*  
K.G. SELBY, P. Eng.

## APPENDIX

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 1

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,041N; 798,172E.

ORIGINATED BY PJS

DIST. 4 HWY. B.S.A.R.

BORING DATE SEPTEMBER 24, 1974

COMPILED BY PJS

DATUM GEODETIC

BOREHOLE TYPE HOLLOW STEM 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
661.1	GROUND LEVEL															
0.0	Sand and Gravel some silt		1	SS	35	660										40 46 (14)
650.8	Dense		2	SS	14	650										
10.3	Clayey Silt		3	TW	PH											
	Grey		4	SS	12	640										
			5	TW	PH											
			6	SS	14	630										
	Traces of sand and gravel		7	TW	PH											
			8	SS	20	620										
			9	SS	11											
	Stiff to Very Stiff		10	TW	PH	610										
			11	SS	17											
			12	SS	114	600										
593.8	Hard															
67.3	End of Borehole Probable Bedrock															

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 2

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,116N; 797,953E.

ORIGINATED BY PJS

DIST. 4 HWY. B.S.A.R.

BORING DATE SEPTEMBER 23, 1974

COMPILED BY PJS

DATUM GEODETIC

BOREHOLE TYPE HOLLOW STEM 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
659.1	GROUND LEVEL						400	800	1200	1600	2000	10	20	30	P.C.F.	GR. SA. SI. CL.
0.0	Silt, Traces of Sand and Clay		1	SS	10											0 4 90 6
651.1	Loose															
8.0	Sand and Gravel		2	SS	27	650										67 27 (6)
647.1	Compact															
12.0	Clayey Silt		3	SS	12											
			4	TW	PH											
	Grey		5	SS	17											
	Stiff		6	TW	PH											
	Very Stiff		7	SS	19											
			8	TW	PH											
	Traces of Sand		9	SS	17											
			10	SS	81											
	Hard		11	SS	71/5"											
			12	SS	71											
595.1																
64.0	Dolomite Bedrock		13	BW RC	100% Rec.											
590.0	Sound															
69.1	End of Borehole															

## RECORD OF BOREHOLE NO 3

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,130N; 797,669E. ORIGINATED BY PJS  
 DIST. 4 HWY. B.S.A.R. BORING DATE SEPTEMBER 26, 1974 COMPILED BY PJS  
 DATUM GEODETIC BOREHOLE TYPE HOLLOW STEM 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 $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
651.0	GROUND LEVEL															
0.0	Fill Coal Dust					650										
647.0	Material Sand & Grav.															
4.0	Organic Silt		1	SS	4											
639.0	Soft		2	SS	3											
12.0	Sand & Gravel															
636.5	Clayey Silt		3	SS	14											
14.5	Grey		4	TW	PH											
			5	TW	PH											
			6	SS	10											
			7	TW	PH											
			8	SS	17											
	Stiff to		9	TW	PH											
	Very		10	SS	22											
	Stiff															
	Hard		11	SS	127											
598.0						600										
53.0	End of Borehole Probable Bedrock															

## RECORD OF BOREHOLE NO 204

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,131N; 797,859E.

ORIGINATED BY G.C.

DIST. 4 HWY. B.S.A.R.

BORING DATE MARCH 7, 1975

COMPILED BY P.P.

DATUM GEODETIC

BOREHOLE TYPE CONT. FLIGHT AUGER (HS)

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
656.6	GROUND LEVEL															
653.1	Coal Dust, Sand Fill Material															
3.5	Silty Sand		1	SS	7											
	Traces of Clay		2	SS	6											
647.6	Loose		3	SS	10											
9.0	Sand and Gravel		4	SS	18											
642.1	Compact		5	SS	21											
14.5	Clayey Silt		6	SS	8											
	Traces of Sand		7	TW	PH											
	Occasional Silt Layers		8	SS	22											
	Firm to Hard		9	TW	PH											
			10	SS	6											
			11	TW	PH											
			12	SS	28											
			13	SS	65											
595.6																
61.0	Refusal Probable Bedrock End of borehole															
	NOTE: WATER LEVEL NOT ESTABLISHED															

RECORD OF BOREHOLE NO 205

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,052N; 797,621E.

ORIGINATED BY G.C.

DIST. 4 HWY. B.S.A.R.

BORING DATE MARCH 10, 1975

COMPILED BY P.P.

DATUM GEODETIC

BOREHOLE TYPE CONT. FLIGHT 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
650.6	GROUND LEVEL					650										
0.0	Fill Material Sand, Gravel and Organics		1	SS	11											
645.6			2	SS	2											
5.0	Organic Silt with Sand and gravel		3	SS	1/18"	640										
637.1	Very Soft		4	SS	23											
13.5	Sand & Gravel		5	SS	7											
633.6	Compact															
17.0	Clayey Silt Trace of Sand		6	TW	PH											
620.6	Firm to Very Stiff					630										
30.0	End of Borehole					620										
610.6																
40.0	End of Cone Test															
	SS#2: W = 68.5%															



## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 205 A

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,113N; 797,641E.

ORIGINATED BY GC


DIST. 4 HWY. B.S.A.R.

BORING DATE APRIL 2, 1975

COMPILED BY PP

DATUM GEODETIC

BOREHOLE TYPE CONT. FLIGHT AUGER (HS)

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
650.9	GROUND LEVEL															
0.0	Fill Material		1	SS	40	650										
	Industrial Waste		2	SS	28											
644.4			3	SS	5											
6.5	Organic Silt with Sand		4	TW	PH											
	Very Soft to Stiff		5	SS	1k	640										
635.9	Sand and gravel		6	SS	15											
15.0	End of Borehole		7	SS	14											
	SS#5: W = 86.0%															
	SS#6: W = 66.5%															
	$W_L$ = 44%															
	$W_P$ = 21%															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 205 C

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,120N; 797,686E. ORIGINATED BY G.C.  
 DIST. 4 HWY. B.S.A.R. BORING DATE APRIL 2, 1975 COMPILED BY pp  
 DATUM GEODETIC BOREHOLE TYPE CONT. FLIGHT 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
651.1	GROUND LEVEL															
0.0	Fill Material					650										
	Gravel, Sand Silt		1	SS	6											
	and clay		2	SS	4											
643.1	Some organics		3	SS	3	640										
8.0	Organic Silt		4	SS	8											
	with Sand															
	Soft															
636.6	Sand and Gravel															
14.5	End of Borehole															
	NOTE: Water Level not established															
	NOTE: 'A' Air Dried 'O' Oven Dried															

## ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 205 D

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,151N; 797,658E.

ORIGINATED BY G.C.

DIST. 4 HWY. B.S.A.R.

BORING DATE APRIL 2, 1975

COMPILED BY P.P.

DATUM GEODETIC

BOREHOLE TYPE CONT. FLIGHT AUGER

CHECKED BY *EP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					$w_p$
651.1	GROUND LEVEL																
0.0	Fill Material					650											
	Coal Dust, Gravel																
645.1	Sand, Silt		1	SS	4												
6.0	Organic Silt with Sand		2	SS	6												
640.1	Soft to Firm		3	SS	8												
11.0	Sand & Gravel		4	SS	26	640											
	Compact																
634.6	Clayey Silt		5	SS	14												
16.5	End of Borehole																
NOTE: SS#3  Air Dried W = 83% $w_L$ = 64% $w_p$ = 50%																	

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 205 E

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,155N: 797,756E. ORIGINATED BY C.C.  
 DIST. 4 HWY. B.S.A.R. BORING DATE APRIL 2, 1975 COMPILED BY P.P.  
 DATUM GEODETIC BOREHOLE TYPE CONE TEST ONLY 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
651.5	GROUND LEVEL															
0.0						650										
						640										
627.5						630										
24.0	End of Cone Test															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 206

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,168N; 797,628E. ORIGINATED BY G.C.  
DIST. 4 HWY. B.S.A.R. BORING DATE MARCH 11, 1975 COMPILED BY PP  
DATUM GEODETIC BOREHOLE TYPE CONT. FLIGHT 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 $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
651.1	GROUND LEVEL															
0.0	Fill material	X				650										
644.1	Asphalt, Gravel		1	SS	6											
	Organics		2	SS	3											
7.0	Sand & Gravel	.														
	Compact to Dense		3	SS	40	640										
633.1			4	SS	18											
18.0	Clayey Silt	/				630										
	Trace of Sand		5	SS	13											
623.1	Stiff to V. Stiff		6	TW	PH											
28.0	End of Borehole					620										
611.1																
40.0	End of Cone Test															
	NOTE: Water Level not established.															

## RECORD OF BOREHOLE NO 207

W.P. 40-74-04

LOCATION CO-ORDS. 15,673,036N; 797,400E.

ORIGINATED BY G.C.

DIST. 4 HWY. B.S.A.R.

BORING DATE March 11, 1975

COMPILED BY P.P.

DATUM GEODETIC

BOREHOLE TYPE CONT. FLIGHT AUGER (HS)

 CHECKED BY *ep*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$	
651.2	GROUND LEVEL														
0.0	Fill Material					650									
647.2	Organic Silt with clayey silt layer and sand		1	SS	6										
4.0			2	SS	6										
640.2			3	SS	40										
11.0	Sand & Gravel														
637.2	Dense														
14.0	Clayey Silt Trace of Sand Firm to Very Stiff		4	SS	8										
			5	TW	PH										
			6	TW	PH										
618.2															
33.0	End of Borehole														
604.2															
47.0	End of Cone Test														
	NOTE: Water level not established.														
	NOTE:														
	'A' Air Dried														
	'O' Oven Dried														

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

## RECORD OF BOREHOLE NO 208

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,064N; 797,347E. ORIGINATED BY GC  
DIST. 4 HWY. B.S.A.R. BORING DATE MARCH 12, 1975 COMPILED BY PP  
DATUM GEODETIC BOREHOLE TYPE CONT. FLIGHT AUGER CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — W <sub>L</sub> PLASTIC LIMIT — W <sub>P</sub> WATER CONTENT — W			UNIT WEIGHT Y P.C.F.	REMARKS % GR.SA.SI.CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		
651.1	GROUND LEVEL						400	800	1200	1600	2000	10	20	30		
0.0	Fill Material					650										
648.1	Sand & Gravel		1	SS	8											0 14 68 18
3.0	Organic Silt with Sand		2	SS	4											
641.6	Soft		3	SS	5											
9.5	Sand & Gravel		4	SS	33	640										67 27 (6)
639.1	Dense		5	SS	7											
12.0	Clayey Silt Trace of Sand Occ. Silt and Silty clay layers  Firm to Hard		6	SS	12											
			7	TW	PH	630										
			8	SS	29											
			9	TW	PH	620										
			10	SS	10											
			11	TW	PH	610										
600.9			12	SS											124	0 0 95 5
50.2	End of Borehole Refusal Probable Bedrock															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO  
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 209

W.P. 40-74-04 LOCATION CO-ORDS. 15,673,108N; 797,328E. ORIGINATED BY GC  
DIST. 4 HWY. B.S.A.R. BORING DATE MARCH 13, 1975 COMPILED BY PP  
DATUM GEODETIC BOREHOLE TYPE CONT. FLIGHT AUGER (HS) 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 $\gamma$ pcf	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
651.1	GROUND LEVEL						400	800	1200	1600	2000	10	20	30		
0.0	Fill Material Sand and Gravel, silt					650										
646.6	Some organics															
4.5	Sandy Silt		1	SS	2											0 44 52 4
643.1	Very Loose															
8.0	Sand and Gravel															
639.1	Dense		2	SS	45	640										0 0 60 40
12.0			3	SS	10											
	Clayey Silt															
	Trace of Sand															
	Stiff		4	SS	13	630										
	to															
	V. Stiff															
618.1						620										
33.0	End of Borehole															
611.1																
40.0	End of Cone Test															
	NOTE: Water Level not established															



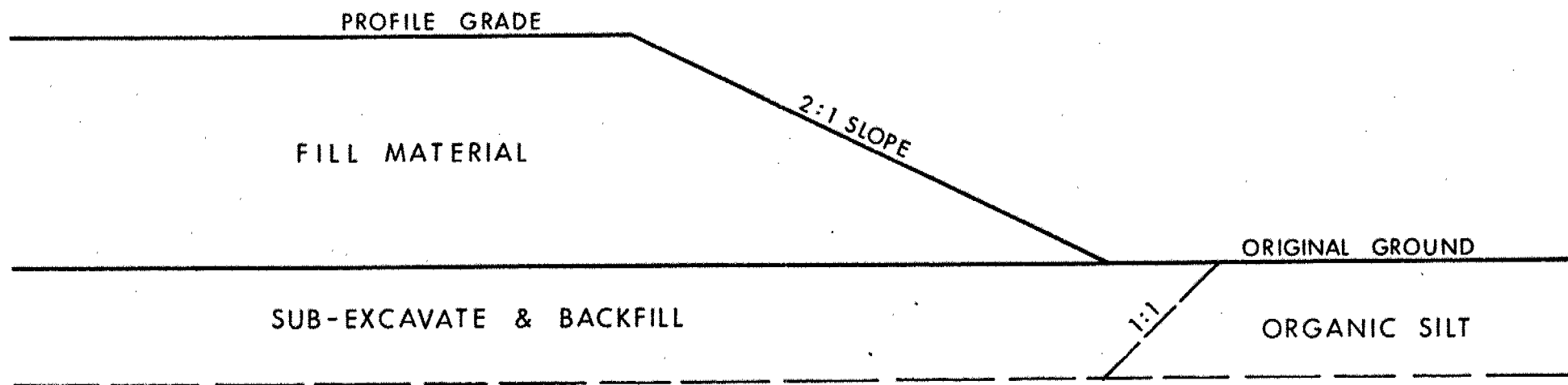


FIG. 1

W.P. 40-74-04

## 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

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF $\sigma$
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF $\sigma$ 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
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

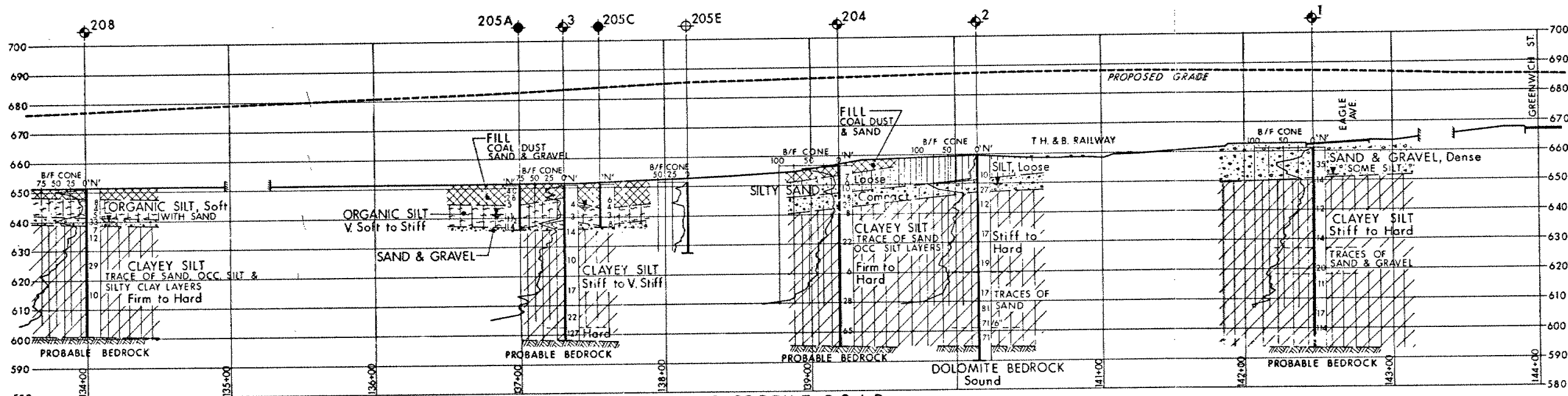
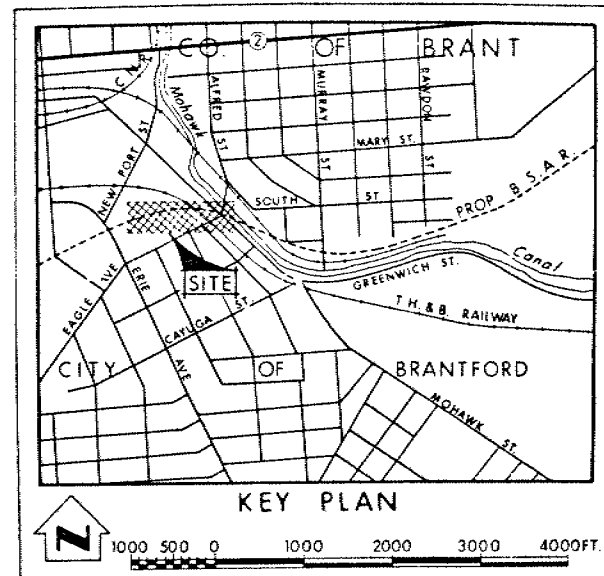
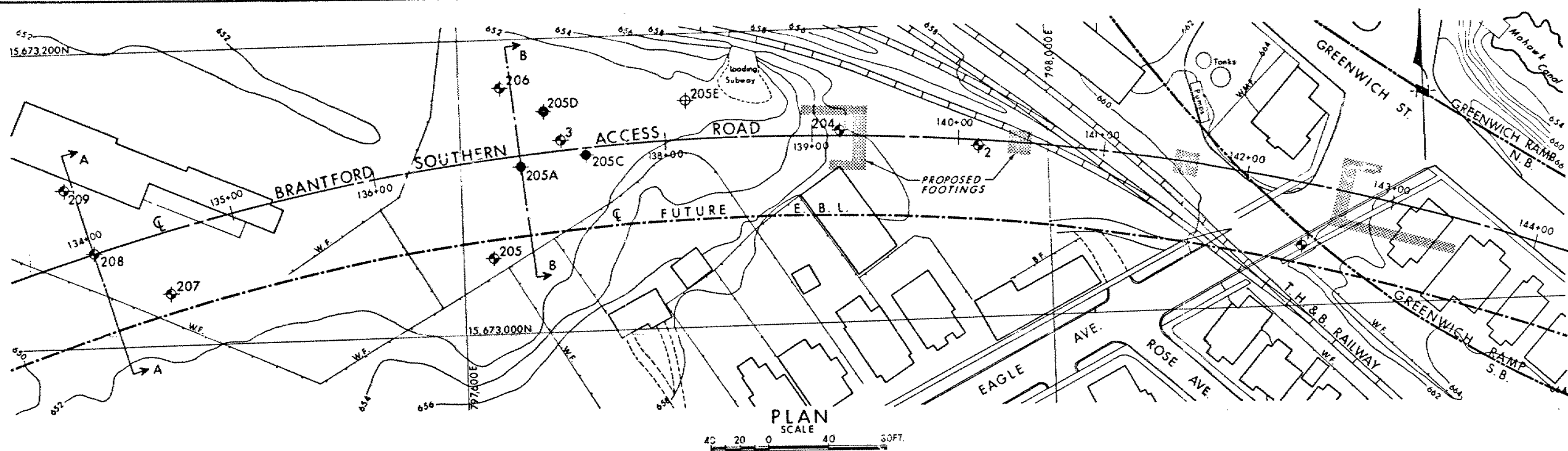
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

## 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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL



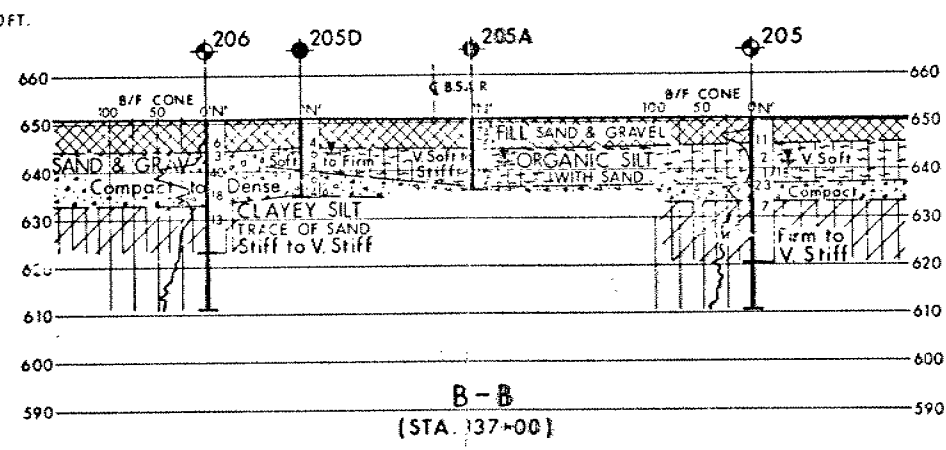
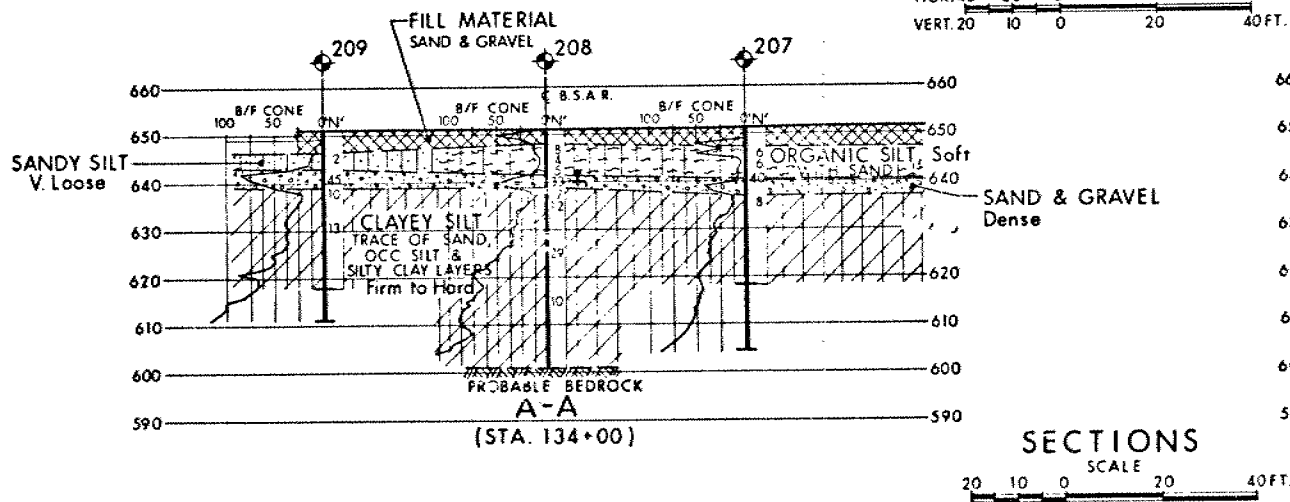
**LEGEND**

- Bore Hole
- Dynamic Cone Penetration Resistance Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation Mar. & Apr. 1975  
W.L. in Boreholes 1, 2 & 3, Sept 1974  
W.L. in Boreholes 204, 205C, 206, 207 & 209 NOT established

NO.	ELEVATION	CO-ORDINATES NORTH	EAST
1	661.1	15,673,041	798,172
2	659.1	15,673,116	797,953
3	651.0	15,673,130	797,669
204	655.6	15,673,131	797,859
205	650.6	15,673,052	797,621
205A	650.9	15,673,113	797,641
205C	651.1	15,673,120	797,686
205D	651.1	15,673,151	797,658
205E	651.5	15,673,155	797,756
206	651.1	15,673,168	797,628
207	651.2	15,673,036	797,400
208	651.1	15,673,064	797,347
209	651.1	15,673,108	797,328

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

**NOTE: FOR CONTRACT DOCUMENT**  
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO  
ENGINEERING SERVICES BRANCH—GEOTECHNICAL OFFICE—SOIL MECHANICS SECTION

**T.H. & B. RAILWAY**

HIGHWAY NO. Brantford Southern Access Road DIST NO. 4  
CO. BRANT City of BRANTFORD  
TWP. LOT CON.

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBNO. P.P.	CHECKED	APPROVED	DATE
407404-A	APR 28, 1975	APR 28, 1975	APR 28, 1975

REF NO. B-86-49