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GEOCRES No. 40P15-22

DIST. 3 REGION SOUTHWESTERN

W.P. No. _____

CONT. No. _____

W. O. No. _____

STR. SITE No. 35-120

HWY. No. _____

LOCATION TWP. RD $\frac{1}{2}$ CONESTOGA RIVER,
WELLINGTON CO., PEEL TWP., LOT 2, CONJG #17

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: DOCUMENTS TO BE UNFOLDED
BEFORE MICROFILMED



DOMINION SOIL INVESTIGATION LIMITED
CONSULTING SOIL & FOUNDATION ENGINEERS
4400 DELPST. WATERLOO, ONTARIO N2L 3J2
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40 P15-22

GEOCREs No.

REPORT ON SUBSURFACE CONDITIONS
PROPOSED REPLACEMENT OF CONESTOGO
RIVER BRIDGE,
CONCESSION 16 & 17, LOT 2,
TOWNSHIP OF PEEL.

Reference No. 75-12-K4

February 1976

Prepared for:

Township of Peel,

c/o W.E. Kelley & Associates Ltd.,

Consulting Engineers,

13 Spetz Street,

Kitchener, Ontario.

Distribution:

6 copies - W.E. Kelley & Associates Limited

1 copy - Dominion Soil Investigation Limited (TORONTO)

1 copy - Dominion Soil Investigation Limited (KITCHENER-WATERLOO)

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1.0 INTRODUCTION

Dominion Soil Investigation Limited has been retained by W.E. Kelley & Associates Limited to conduct a subsurface investigation at the site of a proposed replacement of a bridge over the Conestogo River in Concession 16 & 17, Lot 2 of the Township of Peel. Authorization to proceed with the work was received in a letter dated December 2, 1975 from Mr. W.E. Kelley P. Eng., of W.E. Kelley & Associates Limited, Consulting Engineers for the project.

The purpose of the investigation was to disclose the subsurface conditions at the site and make recommendations for the design and construction of the bridge foundations.

2.0 METHOD OF INVESTIGATION

The field work consisted of three exploratory boreholes put down at the locations shown on Drawing No. 1 of this report. The initial investigation involved two boreholes and these were advanced to the sampling depths using a continuous flight hollow stem power auger. Samples of the subsoil were recovered at 2½ and 5 foot intervals in depth to a maximum depth of 36.5 feet. Subsequent to this, BH 1 was deepened to 35 feet and a third borehole was placed on the east end of the existing bridge and was advanced to a depth of 43 feet. In addition

to Standard Penetration tests, relatively undisturbed samples of the silty clay were recovered at depth. In-situ shear vane tests were also performed in the cohesive soil.

Elevations for the boreholes were referred to a benchmark provided by the Consulting Engineers. The benchmark used was a nail in a hydro pole, 54 feet north of the existing bridge having a given elevation of 98.45 feet referenced to local datum.

3.0 THE SITE

The site of the proposed bridge is located at the crossing of the Township Road between Concession 16 & 17, Lot 2 and the Conestogo River. The river is approximately 70 feet wide at this location and the ice surface at the time of the investigation was 12.3 feet below the top of the deck of the existing bridge. The existing bridge is a steel frame and it is to be replaced on the present alignment.

The area of the crossing is located on the side of a kame moraine where the river has cut a channel into the side of the kame. East of the site is a wide flat alluvial valley with very little vegetative cover.

4.0 SUBSOIL CONDITIONS

Subsoil conditions encountered on each side of the bridge differed. Details of the subsoil conditions encountered in each borehole are given on the individual borehole logs of Enclosures 2 to 4 inclusive and may be summarized briefly as follows.

- (i) FILL - From 7 to 9.5 feet of compact to very loose black and brown fill was encountered. The upper 12 to 18 inches of fill was well-graded sand and gravel. Beneath this, compact to loose brown sand and silt fill was observed. 'N' values within the fill ranged from 3 to 11 blows per foot.
- (ii) PEAT & TOPSOIL - Beneath the fill, soft black peat and topsoil was encountered. The stratum contained pieces of wood and ranged in thickness from 3 to 5 feet extending to a maximum depth below ground surface of 14 feet in BH's 2 & 2A. The stratum was highly organic and compressible.
- (iii) SILTY - Firm to hard, brown to grey silty clay till was encountered at depth in all boreholes. This stratum extended to the maximum depth explored in BH's 1 & 2 and to a depth of 34 feet in BH 3.

Si

'N' values within the stratum ranged from 9 to 40 blows per foot and shear strengths ranged from 2500 p.s.f. to over 4000 p.s.f. Sensitivities varied from 2.4 to 3.2. The soil is very plastic and has a variable amount of silt and clay. Liquid limits vary from 28% to 51%; natural moisture contents ranged from 12% to 31% and plastic limits varied from 15% to 28%.

(iv) SILT TILL-In BH 2A, the silty clay was underlain by hard grey silt till containing some clay and embedded sand. 'N' values within this stratum ranged from 68 to 100 blows per foot and the borehole was terminated at a depth of 43 feet in the stratum.

5.0 GROUNDWATER CONDITIONS

The free surface of the groundwater table was very slow to respond in the boreholes. The levels varied from 5 feet in depth to 23 feet based on measurements taken immediately after completion of the field work. The long term water table is expected to correspond in the change in colour from brown to grey which is approximately the same level as the water level in the river.



6.0 DISCUSSION

The existing steel framed bridge at the crossing of the Conestogo River was the road between Concession 17 and 18, Lot 2. It is to be reconstructed and replaced with single span 80 foot long concrete structure. Foundation conditions varied between the east and west abutment locations and several different foundation systems may be considered.

6.1 Spread Footings

6.1.1 Bearing Capacity & Settlement

The footing proposed by the Consulting Engineers places it at Elevation 77.5 which is below the depth of frost and scour expected. Conventional spread footings can be utilized and different bearing pressures are suggested for the two abutments as outlined in the following chart.

<u>Borehole No.</u>	<u>Location</u>	<u>Suggested Footing Elevation</u>	<u>Safe Net Bearing Pressure</u>	<u>Settlement</u>
1	West Abut.	77.5	5.0 T.S.F.	0.3"
2 & 2A	East Abut.	77.5	2.5 T.S.F.	1.2"

Settlement of the west abutment which will be on hard till will occur with application of the full load. Settlement of the east abutment will occur slowly after loading and the maximum differential settlement is expected to be 0.9 inches. As the structure is simply supported, it is expected that this structure can tolerate this differential and total settlement.

The footings should be designed to resist sliding and a factor of safety of 1.5 is suggested. The unit cohesion between the clay and concrete can be assumed to be 2000 p.s.f. provided that a key is placed at the heel of the footing. The key should be at least 12 inches deep. The temporary loss of shear strength at the interface can be reduced by placing the concrete on a thin layer of clean, sharp, crushed gravel particularly if the excavation is wet at the time of pouring the concrete.

The footing excavation should be done by hand for the final 4 inches to preserve the natural strength of the subsoil.

6.1.2 Excavation & Dewatering

Footings will be constructed well below the water table and seepage can be expected from the upper fill and peat layers. It is suggested that the excavation be enclosed in tight sheeting driven into the clay layer. Only slight seepage is expected from this lower clay layer and excavations in the clay should be sloped at .5 horizontal to 1 vertical to achieve stability. A small amount of seepage is expected and it can be collected in gravity sumps and pumped out to maintain stability in the trench bottom.



6.2 . Deep Foundations

If spread footings are not considered acceptable the structure can be supported on deep foundations such as driven timber or steel 'H' piles or tube piles.

Size 14 timber piles (12 inch diameter) are expected to penetrate to a depth of 35 feet in BH 1 and 40 feet near BH 2 (for estimating only) and would develop a working load of 25 tons per pile if driven to practical refusal. Negative skin friction above the base of the organic layer should be deducted from the gross pile capacity.

Steel tube or 'H' piles could be driven to achieve their full structural capacity at practical refusal and it is expected that they would penetrate an additional 5 feet deeper than the timber piles. Variations in pile driving depths are to be expected and provision should be made for this. Pile caps should be formed below the anticipated depth of frost and scour and excavation and dewatering techniques similar to those outlined in section 6.1.2 used.

Batter piles to support the upbalanced lateral pressures are suggested.

6.3 Approach Fills

It is recommended that the existing fill and organic material be removed from underneath the approach fills. The grade should be raised up by the addition of well-compacted granular fill but overcompaction against the abutments should be avoided.

6.4 Drainage

The backfill behind the abutments should consist of granular material and provision should be made to ensure that through drains properly protected by filters are provided to avoid a build up of hydrostatic pressure behind the abutments.

6.5 Statement of Limitation

The conclusion and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature which may be available for the area investigated.

Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the boreholes and conditions may be come apparent during construction which could not be anticipated or detected by the soil investigation.

We recommend that a geotechnical engineer or other designated inspector from this company should be called upon to visit

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every excavation or other type of earth-work associated with this project where the soil is required to support load. The inspector should be given ample opportunity to verify that the conditions encountered by the construction are similar to those described in the report, and to confirm that the conclusions and recommendations of the report are not invalidated by new information that may have come to light during construction. If such confirmation cannot be given, the foundation design should be reviewed with respect to the new information.

In cases where the foregoing recommendation is not followed, the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.

DOMINION SOIL INVESTIGATION LIMITED.

J. B. England
J. Byron England, P. Eng.,
Kitchener-Waterloo Branch Manager

JBE*di

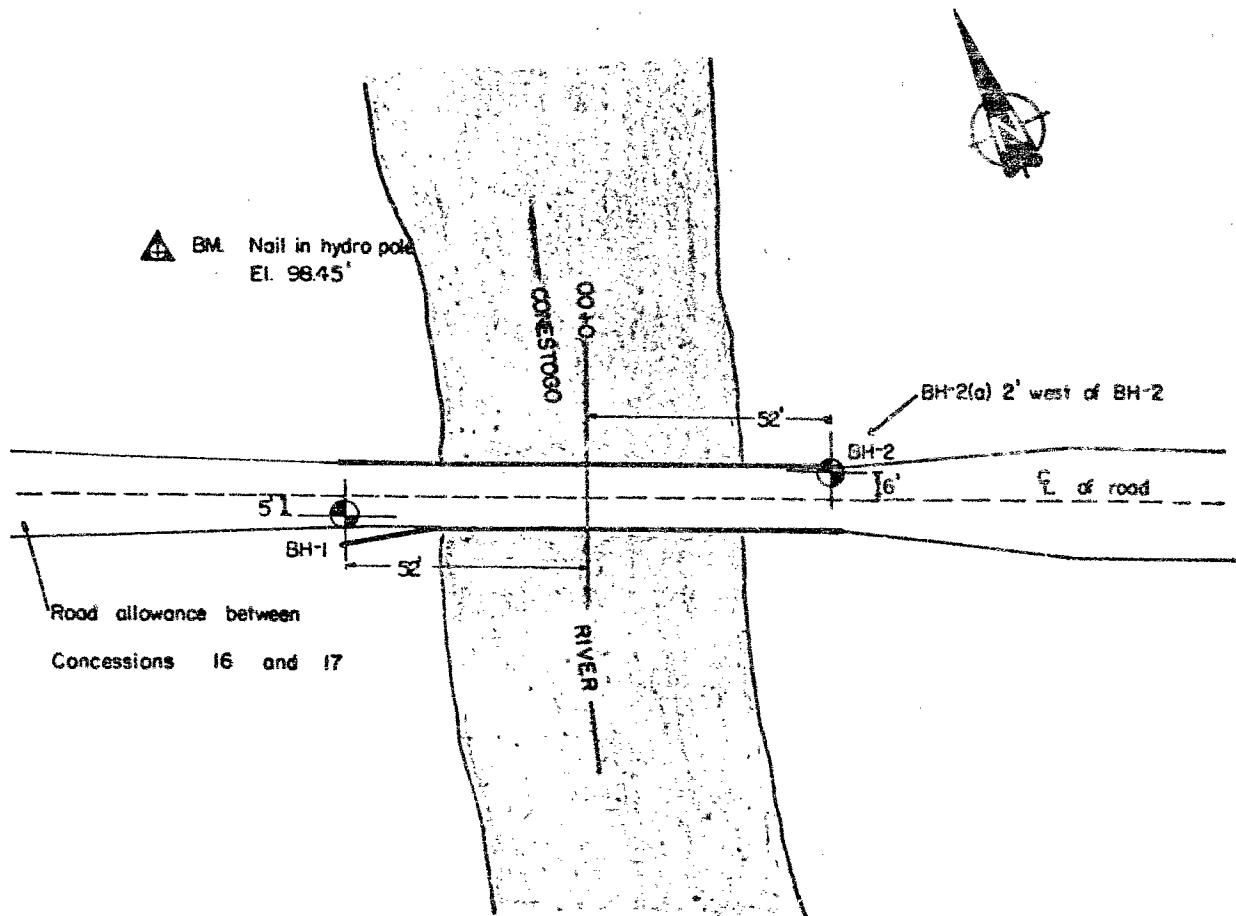


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Our Ref. No. 75-12-K4

Drawn No. 1

Prep. By K.M.



BOREHOLE LOCATION PLAN

SCALE: 1" = 40'

DOMINION SOIL INVESTIGATION LIMITED

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE

SOIL COMPONENTS AND GROUND WATER CONDITIONS

											Ground Water Level	
BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANIC	BEDROCK		Depth of Cave-in
		coarse	fine	coarse	medium	fine						
Ø	8"	4"	3/4"	4.75mm	2.0	0.42	0.074	0.002	no size limit			

SAMPLE TYPES

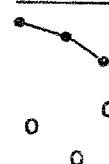
AS	Auger Sample	SS	Split Spoon Sample
RC	Rock Core	TP	Piston, thin walled tube sample
%	Recovery	TW	Open, thin walled tube sample

PENETRATION RESISTANCES

DYNAMIC PENETRATION RESISTANCE: to drive a 2" Ø, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot

STANDARD PENETRATION RESISTANCE - N: to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot, using a 140 lb hammer falling 30 inches

SYMBOL



SOIL PROPERTIES

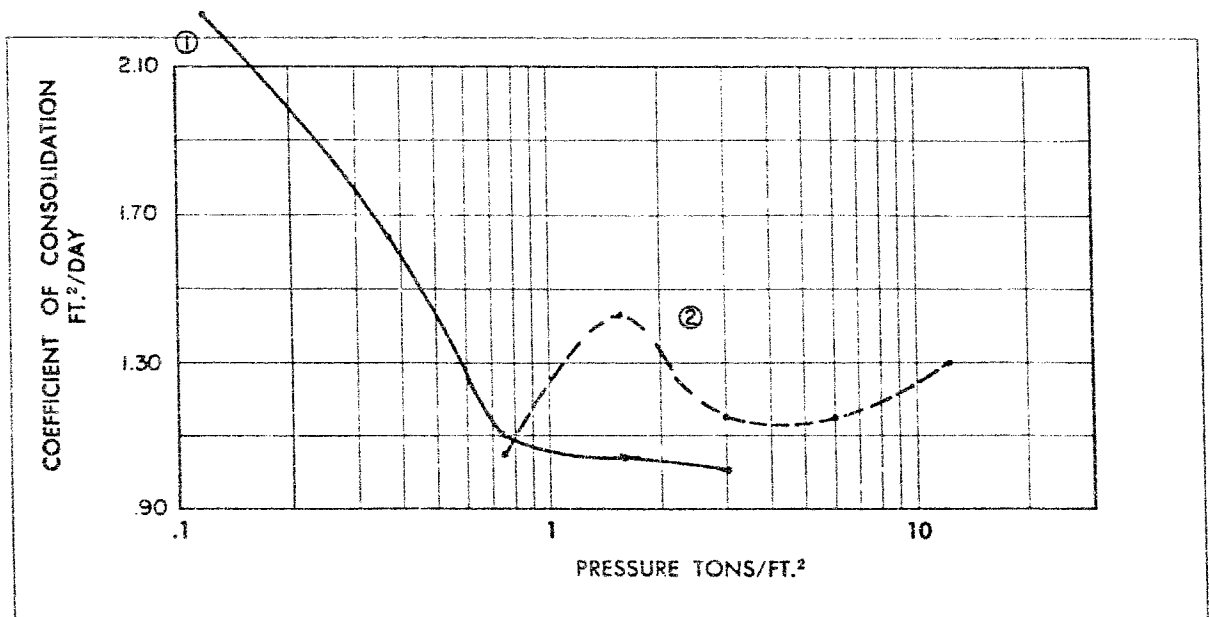
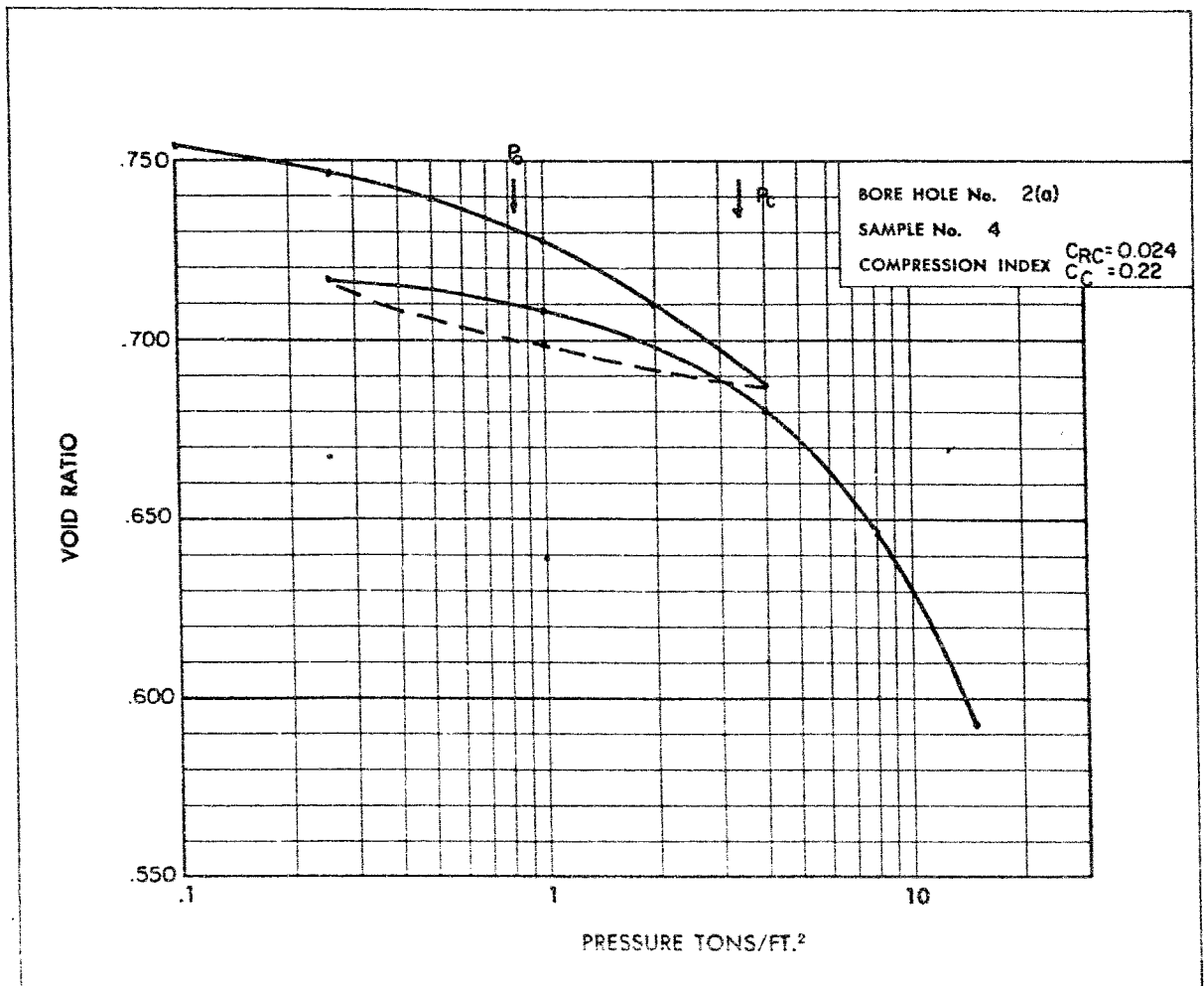
W%	Water content	k	Coeff. of permeability
LL %	Liquid limit	C	Shear strength
PL %	Plastic limit	φ	Angle of int. friction
γ	Natural bulk density (unit wt.)	C'	Cohesion
Cv	Coeff. of consolidation	φ'	Angle of int. friction

in terms of total stress
in terms of effective stress

UNDRAINED SHEAR STRENGTH

TRIAXIAL	UNCONFINED	LABORATORY	FIELD	POCKET PENETROMETER TEST
COMPRESSION TEST		VANE TEST		
Strain at failure is represented by direction of stem	St 20% 15% 5% 10%	St	St	St
		St = sensitivity =	shear strength in undisturbed state shear strength in remoulded state	

DOMINION SOIL INVESTIGATION LIMITED
CONSOLIDATION TEST



LOG OF BOREHOLE1.....

Our Reference No 75-12-K4

CLIENT: Township of Peel

PROJECT: Conestogo Bridge Replacement

LOCATION: Conc 16 & 17, Twp. of Peel

DATUM ELEVATION: Local

DRILLING DATA











Method: Augering

Diameter: 6 1/2"

Date: ⁰² December 10, 1975.

Enclosure № 2

December 10, 1975.

SUBSURFACE PROFILE					SAMPLES			PENETRATION RESISTANCE					WATER CONTENT					REMARKS
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					%					
								20	40	60	80	100	PLASTIC LIMIT	NATURAL	LIQUID LIMIT			
								UNDRAINED SHEAR STRENGTH										
								+ FIELD VANE TEST					COMPRESSION TEST					
101.9	0	GROUND SURFACE																
100.4	1.5	Granular Fill																
	5	Dense to loose brown SAND & SILT (FILL)																
94.9	7.0				1	SS	35											
					2	SS	7	0										
					3	SS	4	0										
		Soft black PEAT, wood																
91.9	10.0				4	SS	17	0										
		Very stiff to hard																
	15	brown grey silty CLAY TILL																
					5	SS	40	0										
					6	SS	37	0										
	20	more clay																
					7	SS	35	0										
	25																	
					8	SS	33	0										
	30																	
					9	SS	>100											
																		
67.4	34.5	END OF BOREHOLE																
					10	SS	>100											

LOG OF BOREHOLE..2.....

Our Reference No. 75-12-K4

CLIENT: Township of Peel
PROJECT: Conestogo Bridge Replacement
LOCATION: Conc 16 & 17, Twp. of Peel
DATUM ELEVATION: Local

Enclosure No. 3

DRILLING DATA

Method: Augering

Diameter: 6½"

Date: December 10, 1975.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %			REMARKS	
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					PLASTIC LIMIT	NATURAL		LIQUID LIMIT
								20	40	60	80	100				
								UNDRAINED SHEAR STRENGTH								
+ FIELD VANE TEST					COMPRESSION TEST											
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LOG OF BOREHOLE 2(a)

Our Reference No. 75-12-K4

Enclosure No. 4

CLIENT: Township of Peel
PROJECT: Conestogo Bridge Replacement
LOCATION: Conc 16 & 17, Twp. of Peel
DATUM ELEVATION: Local

DRILLING DATA

Method: Augering
Diameter: 6 1/2"
Date: December 29, 1975.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %			REMARKS		
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft.	Blows/Ft.					PLASTIC LIMIT W _p	NATURAL W		LIQUID LIMIT W _L	
								20	40	60	80	100					
								UNDRAINED SHEAR STRENGTH p.s.f.									
+ FIELD VANE TEST					@ COMPRESSION TEST												
								1000	2000	3000	4000	5000	10	20	30	40	50

100.0	0	GROUND SURFACE																
99.0	1.0	Granular Fill																
95.5	4.5	Compact brown SAND & SILT (FILL)																
	5	Very loose brown & black SILT (FILL)																
90.5	9.5	Black TOPSOIL PEAT, wood																
	10																	
86.0	14.0	Very stiff grey silty CLAY																
	15					1	SS	26	0					0				
	20					2	SS	14	0									
	25					3	TW											
	30					4	TW											
66.0	34.0	Hard grey SILT TILL, some clay				5	SS	68						0				
	35																	
	40					6	SS	31						0				
37.0	43.0	END OF BOREHOLE				7	SS	2100						0				

El. 77.0 Dec 29, 1975