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DIST. 1 REGION SOUTHWESTERN

W.P. No. 122-65-07 & 08

CONT. No. 75-027

W. O. No. \_\_\_\_\_

STR. SITE No. 14-341

HWY. No. 402

LOCATION WAWANOSH DRAIN

(E. OF MOPELAND RD.) BRIDGE

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 1

REMARKS: 2 documents to be unfolded before

microfilming

MEMORANDUM

40J-109

GEOCRES No.

To: Mr. B. R. Davis,  
Bridge Engineer,  
Bridge Office,  
Admin. Bldg.

FROM: Foundation Section,  
Materials & Testing Office,  
Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: July 15, 1970

OUR FILE REF.

IN REPLY TO

JUL 22 1970

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For

The Proposed Wawanosh Drain Bridge  
Of Hwy. #402, 0.5 Miles East of  
Modeland Road  
District #1 (Chatham)

W.O. 70-11047 -- W.P. 122-65-07 & 08  
CONT. 74-56

40J16-41  
GEOCRES No.

Attached, we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/MdeF  
Attach.

cc: Messrs. B. R. Davis  
H. A. Tregaskes  
D. W. Farren  
W. Zonnenberg  
F. C. Brown  
A. P. Watt (2)  
J. Roy  
B. A. Singh

*A. G. Stermac*  
A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER

Foundations Files  
Gen. Files

FOUNDATION INVESTIGATION REPORT

For

The Proposed WAWANOSH DRAIN Bridge  
of Hwy. #402, 0.5 mi. east of Modeland Rd.

District #1 Chatham

W.O. 70-11047 -- W.P. 122-65-07 & 08

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1. INTRODUCTION:

In a memo dated May 22, 1970 Mr. A. P. Watt, Regional Bridge Planning Engineer, Southwestern Region, requested a Foundation Investigation at the site of the proposed bridge of Hwy. # 402 over Wawanosh Drain, some 0.5 mi. east of Modeland Rd.

Due to the thick deposit of organic material, observed during our previous investigation at Modeland Rd. along the original line "C", it was recommended that the line be shifted southward, where the organics were found to be shallower. This recommendation was subsequently adopted.

At the proposed Wawanosh drain bridge the line was shifted appr. 70 ft. south, necessitating some additional borings.

In the following paragraphs the results of these investigations together with recommendations pertaining to structure foundations are given.

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2. DESCRIPTION OF THE SITE:

Wawanosh drain, known also as Perch creek is roughly 40 ft. wide and 4-5 ft. deep at the site of the proposed crossing. The banks of the creek are built up as dykes, the heights of which are some 7-8 ft. above general ground surface. The vicinity is flat farmland occupied by crops and meadows.

Geologically the area belongs to the physiographic region known as the HURON FRINGE. At this southerly portion of the region, behind the sandy beaches of Lake Huron some marshy lagoons may be found. These marshlands are usually underlain by marl or marly silt and clay.

3. FIELD AND LABORATORY INVESTIGATIONS:

Three boreholes and five dynamic cone penetration tests, carried out during our previous investigation in Nov.-Dec. 1969 were near the revised locations of the north structure footings, therefore they were also utilized for this report. Some five additional borings were drilled recently. Continuous flight augers were used for boring the overburden, while the bedrock was proved by diamond drilling. Conventional sampling procedure was followed during the field investigations, taking split spoon and shelby tube samples at regular intervals. Split spoons were advanced by performing Standard Penetration Tests with a free falling hammer of 140 lbs. from a vertical distance of 30 inches. Shelby tubes were pushed 18 inches into the undisturbed soil manually or hydraulically. Field vane tests were carried out usually

3. FIELD AND LABORATORY INVESTIGATIONS: (cont'd.)...

18 inches below the depth of the samples and the undrained and remoulded shear strengths measured.

The locations and elevations of the boreholes as well as the estimated stratigraphical cross sections at the proposed footing locations are shown on Drawing #70-11047A in the appendix.

Soil samples were visually examined and identified in the field, right upon recovery, and again in the laboratory. Laboratory tests were performed on samples for more refined classification purposes and in order to determine the shear strengths of the layers. All the field and laboratory test results are delineated on the borelogs attached to this report.

4. SOIL CONDITIONS:

4.1) General:

Four different soil strata were recognized in the boreholes, underlain by shale bedrock. From the top of the dykes downward the soil stratigraphy is as follows: Fill material, organic silts and sands, clayey silts with traces of sand and gravel, and finally silty clays with traces of sand and gravel. Since the observed layers were very similar to the ones found at the Modeland Rd. crossing, and since these deposits were dealt with at some length in our report numbered 70-11046 only a brief summary of the soil properties is given below.

4. SOIL CONDITIONS: (cont'd.)...

4.2) Fill material:

The depth of the fill material is roughly 7-9 ft., consisting of clayey silts with some coarse sand and gravel. The fill was found to be somewhat unevenly compacted as indicated by penetration "N" values of 9 blows per ft. to 24 blows per ft. corresponding to firm to very stiff consistencies. The natural moisture contents are just above the plastic limits averaging 14%. The liquid limits of the samples were 24-25%, the plasticity indices being 10-11%. The bulk density of the fill may be taken to be 135 PCF.

4.3) Organic Deposit:

The fill was found to be underlain by a thin layer of organic material which is the actual topsoil around the entire vicinity. The black and dark brown fibrous textured peat is only one ft. deep or so, followed by some organic silts and seams of sand. The thickness of this recent geological deposit is estimated to be 4-5 ft. The non-cohesive portion of the stratum has relative densities of loose to compact, with fairly high moisture contents. The black peat and organic silts are unacceptable engineering materials.

4.4) Clayey silt with traces of sand and gravel:

The overall thickness of the grey clayey silt is around 41-48 ft. Very few coarse sand and gravel particles were found in the deposit, the largest gravel recovered in the samples being around 2" in diameter.

4. SOIL CONDITIONS: (cont'd.)...

4.4) Clayey silt with traces of sand and gravel: (cont'd.)...

Penetration resistances varied between 8 blows per ft. and 53 blows per ft. undrained shear strength values between 500 PSF and over 2,000 PSF. The average value of undrained shear strength was estimated to be 1200 PSF. The layer has slight plasticity, the mean plasticity index being 10-11%, with plastic limits of 13-21% and liquid limits of 23-33%. The bulk density of the clayey silt is roughly 133 PCF.

4.5) Silty clay with traces of sand and gravel:

Around el. 540 ft. the clayey silt was followed by silty clay with traces of sand and gravel. The layer at this location is 54-61 ft. thick, having stiff consistency, the undrained shear strength values ranging from 800 PSF to above 2000 PSF. According to the Atterberg limit tests the deposit has intermediate plasticity, typical plastic limits being 21-23% and liquid limits 39-40%. The bulk density is estimated to be 120 PCF.

4.6) Bedrock:

Bedrock was proved in two locations by diamond drilling, using AXT size core barrels. Some 5 ft. of bedrock was drilled at each location, yielding 100% recovery. Further four boreholes were augered down to the probably bedrock surface, which was assumed to be at the depth of refusal of penetration and the grinding of the auger on rock. The



4. SOIL CONDITIONS: (cont'd.)...

4.6) Bedrock: (cont'd.)...

bedrock surface was found to vary between el. 479 ft. and 487 ft. Bedrock was identified to be a relatively sound black shale of the Kettle Point formation.

4.7) Groundwater conditions:

The groundwater level was found to lie at el. 587-588 ft. in the boreholes. This elevation is some 7-8 ft. below the top of dykes and only a few inches beneath the general ground surface. Since the open water level of Wawanosh Drain is deeper than the surrounding groundwater it is assumed that a constant seepage pressure exists towards the creek.

5. DISCUSSION & RECOMMENDATIONS:

5.1) General:

It is proposed to build a three span twin structure at the crossing of Hwy. #402 and Wawanosh Drain. The grade of Hwy. #402 at the crossing is designed to be around el. 600.5 ft., some 3-4 ft. above the top of the existing banks and 11-12 ft. above general ground level.

The appr. 100-110 ft. deep overburden was observed to consist of a thin organic deposit, followed by clayey silts with silty clays, the latter two containing traces of sand and gravel.

5. DISCUSSION & RECOMMENDATIONS: (cont'd.)...

5.2) Structure Foundation:

In view of the subsoil conditions it appears that both abutments and piers of the proposed bridge can be supported either on friction piles or end bearing piles driven to bedrock.

As friction piles No. 14 timber piles may be used. It is assumed that the piles will be entirely below the groundwater level, nevertheless if any length of the piles remains above groundwater, these piles should be treated to prevent decay. The No. 14 timber piles should have embedded lengths of 45 ft. in original soil, in which case 20 Ton/pile design loads may be employed.

Steel H piles will probably be the most suitable and most economical, if end bearing piles are selected. H piles should be driven to refusal on bedrock, which is anticipated to be reached between el. 479 ft. and 487 ft. Appr. 100-110 ft. long H piles will be required. Loads equal to the maximum allowable design loads on the particular H section, may be used on piles supported on sound rock.

Pile caps should have a minimum cover of four ft. for frost protection. The depth of pier footings should also be governed by hydrological requirements, as suggested by the hydrology section.

The abutments may also be supported on spread footings at el. 585 ft. just below the thin organic and sand layers.

5. DISCUSSION & RECOMMENDATIONS: (cont'd.)...

5.2) Structure Foundation: (cont'd.)...

At this elevation a slightly desiccated crust exists, upon which design loads of 2 TSF can be utilized.

Naturally the most economical foundations should be chosen from the preceding alternatives.

5.3) Approach Embankments:

Approach fills of roughly 12 ft. height will be necessary for the crossing. No stability problems are foreseen for such embankments, provided they are built with 2 horizontal to 1 vertical slopes. The organic deposit should be removed under the fills in accordance with D.H.O. Standards. Forward slopes should be protected against scour as recommended by the hydrology section.

Based on past experience with the clays and clayey tills of the St. Clair region, negligible differential settlements are anticipated under the structure and approach fills.

6. MISCELLANEOUS:

The recent fieldwork, carried out during the period June 4-30, 1970 was supervised by Messrs. A. K. Barsvary Senior Foundation Engineer and T. Preston, Student Technician. Equipment used was owned and operated by P.V.K. drilling Co. Burford, Ontario.

This report was written by Mr. A. K. Barsvary and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

July 1970

APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-11047 LOCATION Sta. 86 + 41 o/s 40' Lt.  
W.P. 122-65-07 & 08 BORING DATE November 26, 1969  
DATUM Geodetic BOREHOLE TYPE Dynamic Cone TestORIGINATED BY GA  
COMPILED BY GA  
CHECKED BY SL

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % $w_p$ — $w$ — $w_L$			
597.6	Top of Fill														
580.0	End of Cone Test														

## FOUNDATION SECTION

ORIGINATED BY GA

COMPILED BY GA

CHECKED BY

[illegible]

15  $\frac{20}{10}$  5 % STRAIN AT FAILURE

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 70-11047 LOCATION Sta. 87 + 61 o/s 35' Lt.ORIGINATED BY GAW.P. 122-65-07 & 08 BORING DATE November 26, 1969COMPILED BY GADATUM Geodetic BOREHOLE TYPE Dynamic Cone TestCHECKED BY GA

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$		BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	20	40	60	80	100	PLASTIC LIMIT — $w_p$		
597.2	Top of Fill						SHEAR STRENGTH P.S.F.					WATER CONTENT %		P.C.F.	GR. SA. SI. CL.
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					$w_p$ — $w$ — $w_L$			
581.2	End of Cone Test					590									
160						580									

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 70-11047 LOCATION Sta. 87 + 36 o/s 6' Rt.

ORIGINATED BY GA

W.P. 122-65-07 &amp; 08 BORING DATE Nov. 27 &amp; 28, 1969

COMPILED BY GA

DATUM Geodetic BOREHOLE TYPE Cont. Flight Auger

CHECKED BY *SL*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20 40 60 80 100	SHEAR STRENGTH P.S.F.	WATER CONTENT % $w_p$ — $w$ — $w_L$				
597.5	Top of Fill												
0.0	Fill												
	Clayey silt with some sand & traces gravel		1	SS	20								
	Very Stiff												
588.0													
9.5			2	SS	15								
			3	SS	40								
			4	SS	27								
	Clayey silt with some sand & traces gravel		5	SS	24								
			6	SS	17								
	Hard to Firm		7	TW	PH								
			8	SS	11								
			9	TW	PH								
			10	SS	25								
			11	TW	PH								
			12	SS	12								
540.0			13	TW	PH								
57.5													
	Silty clay with traces of sand and gravel												
	Firm to Hard												
480.0	Auger grinding												
117.5	Probably Bedrock												
	End of Borehole												



DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 70-11047

LOCATION Sta. 86 + 75 o/s 100' Lt.

ORIGINATED BY GA

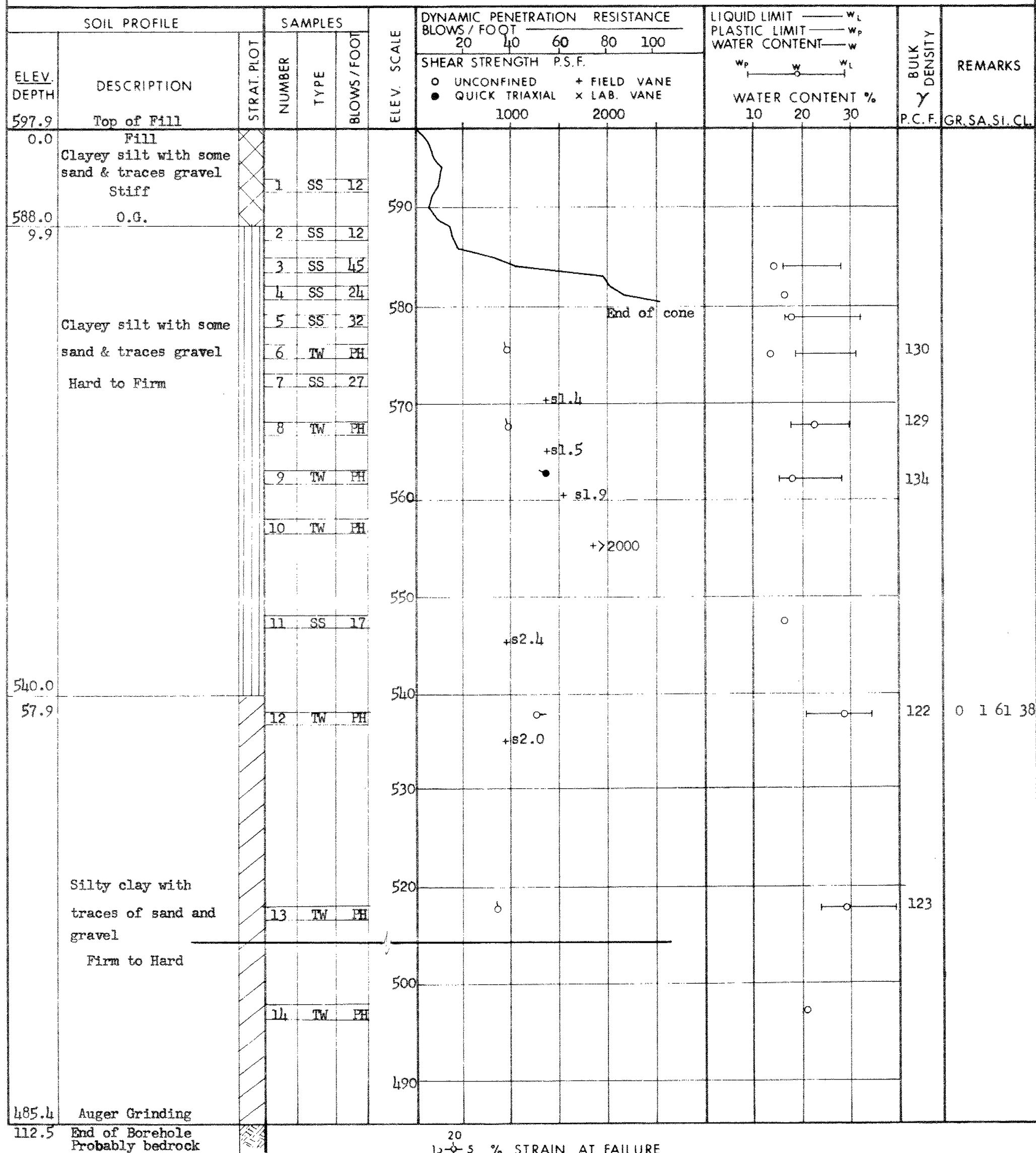
W.P. 122-65-07 &amp; 08

BORING DATE Nov. 25 &amp; 26, 1969

COMPILED BY GA

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY *SR*

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 70-11047

LOCATION Sta. 87 + 86 o/s 86' Lt.

ORIGINATED BY AKB

W.P. 122-65-07 &amp; 08

BORING DATE June 24 - 25, 1970

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %				
							1000		2000		$w_p$ — $w$ — $w_L$				
596.3	Ground Level														
0.0	Clayey silt Fill. Brown Very Stiff		1	SS	19										
589.3						590									
7.0	Organic silt & sand. Stiff		2	SS	10										
585.3															
11.0			3	SS	60										
			4	SS	12										
	Clayey silt with traces of sand and gravel														
			5	TW	PM										
	Hard to Firm		6	SS	8										
			7	TW	PM										
	Grey														
			8	SS	8										
541.3															
55.0															
			9	TW	PM										
	Silty clay with traces of sand and gravel														
			10	SS	11										
	Stiff to Very Stiff														
	Grey														
			11	TW	PM										
486.3	Probable Bedrock														
110.0	End of Borehole														

20  
10-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No.7

FOUNDATION SECTION

JOB 70-110/47

LOCATION Sta. 86 + 86, 71 Ft. Rt. of  $\phi$ 

ORIGINATED BY T.P.

W.P. 122-65-07 &amp; 08

BORING DATE June 4-9, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger &amp; Diamond Drilling

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		WATER CONTENT %				
							1000	2000	10	20	30		
							SHEAR STRENGTH P.S.F.						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE						
597.1	Ground Level												
0.0	Clayey silt fill. Brown Stiff		1	SS	13							135	
589.6			2	TW	PM	590							
7.5	Organic silt & sand loose		3	SS	5	585.6							
11.5	Clayey silt with traces of sand & gr. hard to firm grey		4	TW	PH							141	
			5	SS	27	580						140	
			6	TW	PM								
			7	SS	9	570							
			8	TW	PM							129	
			9	SS	20	560							
			10	TW	PM	550						136.5	
541.1			11	SS	8	540							
56.0	Silty clay with traces of sand & gravel stiff grey		12	TW	PM	530						124	
487.0			13	RC	Rec. 100%	490							
110.1	shale bedrock												
482.0													
115.1	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 70-11047 LOCATION Sta. 85 + 70 73' Rt. of ¢  
W.P. 122-65-07 & 08 BORING DATE June 25 - 29, 1970  
DATUM Geodetic BOREHOLE TYPE AugerORIGINATED BY TP  
COMPILED BY AKB  
CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	WATER CONTENT %				
596.1	Ground Level						<div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div> <div><div>+ FIELD VANE</div><div>x LAB. VANE</div></div>	1000	2000	102030		
0.0	Clayey Silt Fill											
589.1	Firm		1	SS	9	590						
7.0	Black Peat		2	SS	15							
584.1	Organic silt & sand		3	SS	20							
12.0			4	SS	45	580						
	Clayey silt with traces of sand and gravel		5	TW	PM							
			6	SS	28	570						
	Very stiff to stiff		7	TW	PM	560						
			8	SS	22	550						
543.1			9	TW	PM	540						
53.0			10	SS	12	530						
	Silty clay with traces of sand and gravel		11	TW	PM	520						
	Firm to Stiff		12	TW	PM	510						
			13	TW	PM	500						
487.4	Probable Bedrock					490						
108.7	End of Borehole											

20  
10-5 % STRAIN AT FAILURE  
10

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 70-11047 LOCATION Sta. 88 + 00 ORIGINATED BY T.P.  
W.P. 122-65-07-08 BORING DATE June 30, 1970 COMPILED BY A.K.B.  
DATUM Geodetic BOREHOLE TYPE C.M.E. Auger CHECKED BY ML

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
588.8	Ground Level						<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><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DEPARTMENT OF HIGHWAYS- ONTARIO

## RECORD OF BOREHOLE No.10

FOUNDATION SECTION

MATERIALS &amp; TESTING OFFICE

JOB 70-11047

LOCATION Sta. 85 + 80 0

ORIGINATED BY TP

W.P. 122-65-07 &amp; 08

BORING DATE June 30, 1970

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
							1000	2000	10	20	30		
589.8	Ground Level												
0.0	Black Organics		1	SS	10								
2.0			2	SS	37								
			3	SS	21								
	Clayey silt with traces of sand and gravel		4	TW	PM								
	Stiff		5	SS	14								
	Grey		6	TW	PM								
541.8													
48.0	Silty clay, traces of sand & gravel		7	SS	9								
536.8	Firm												
53.0	End of Borehole												

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - 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>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

## ABBREVIATIONS 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
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
$\log_e a$ 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
$\sigma$	NORMAL STRESS
$\sigma'$	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

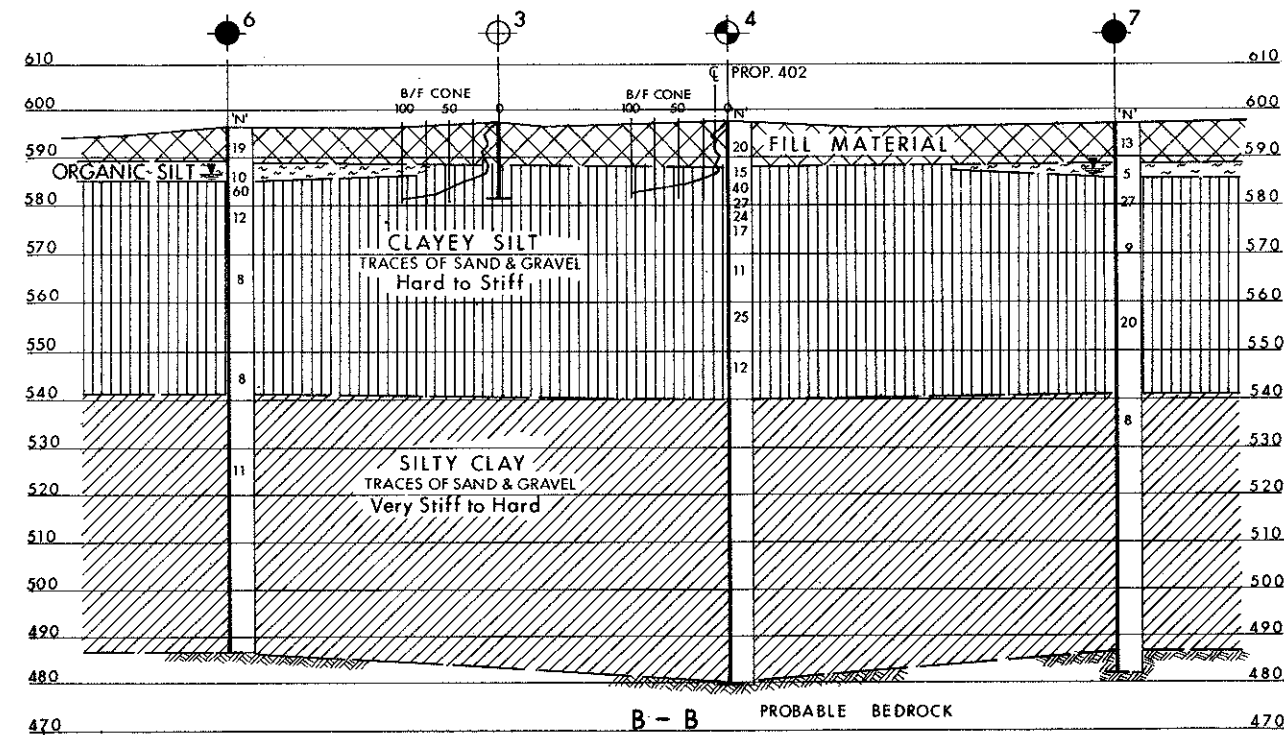
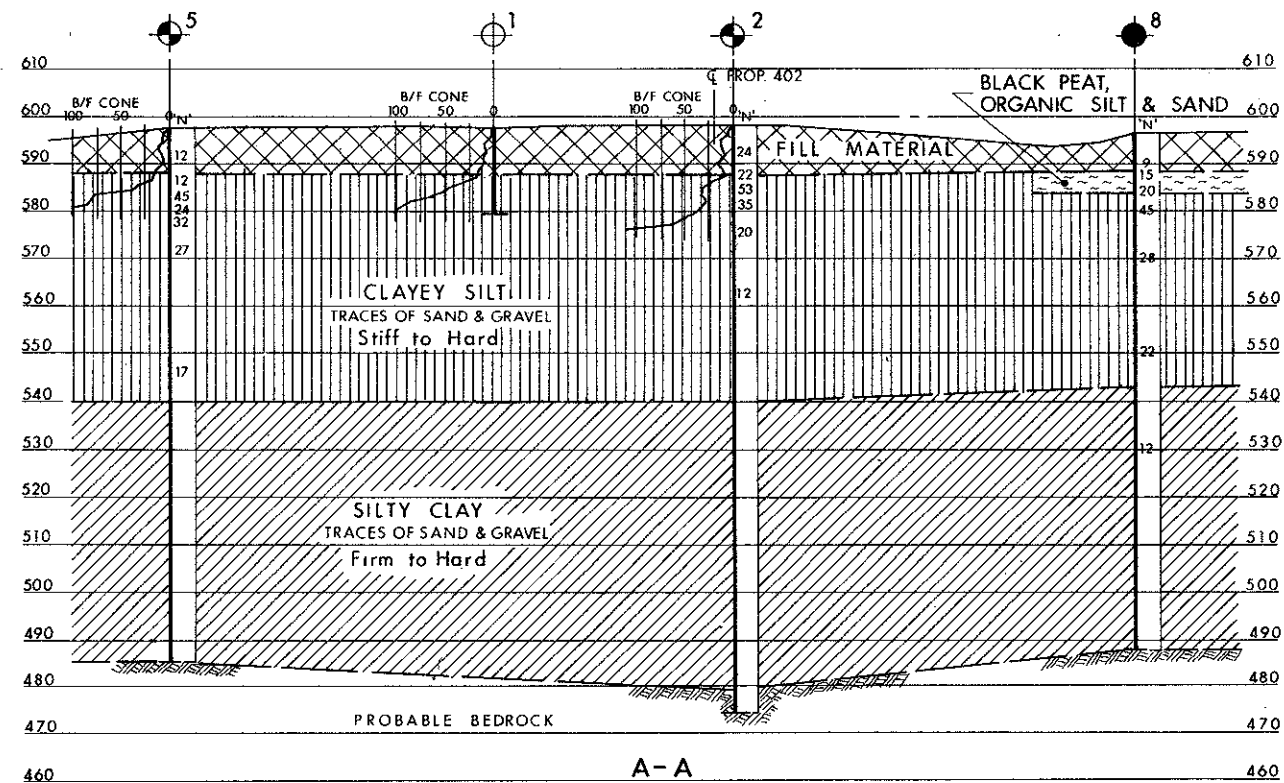
### FOUNDATIONS

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

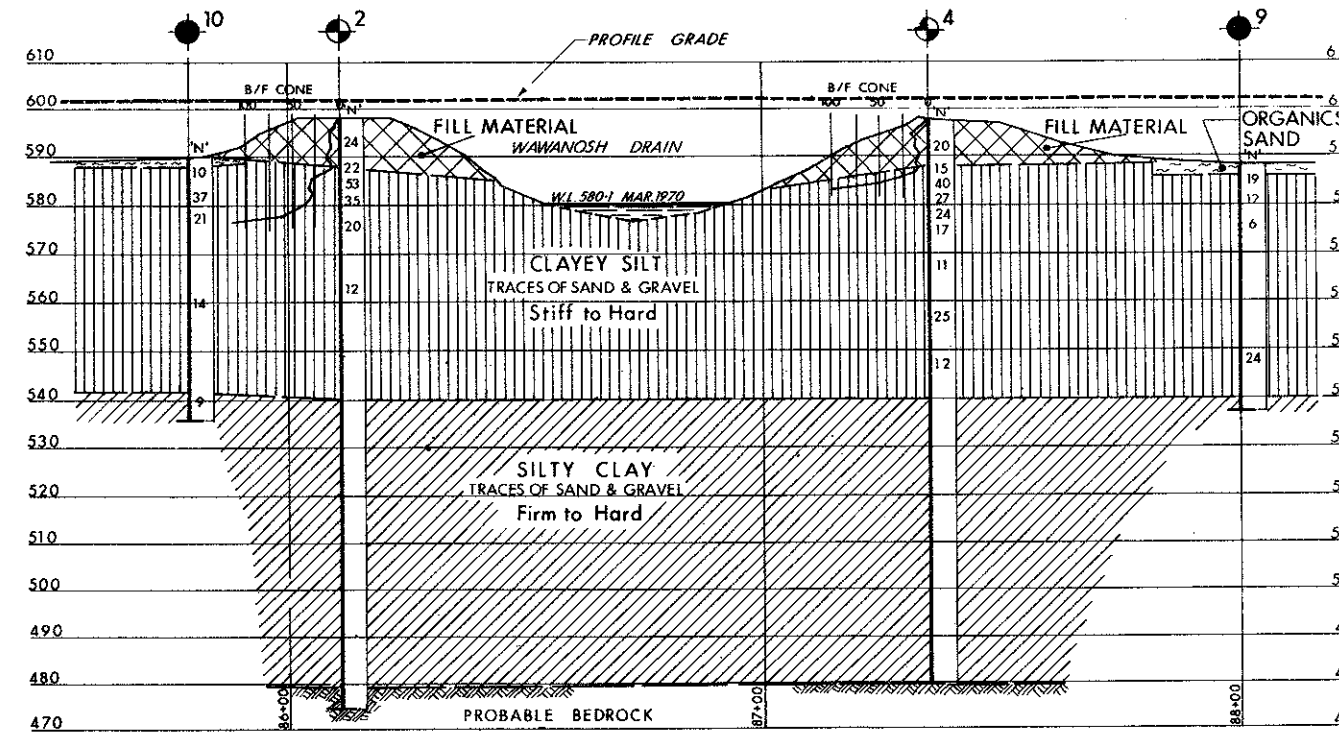
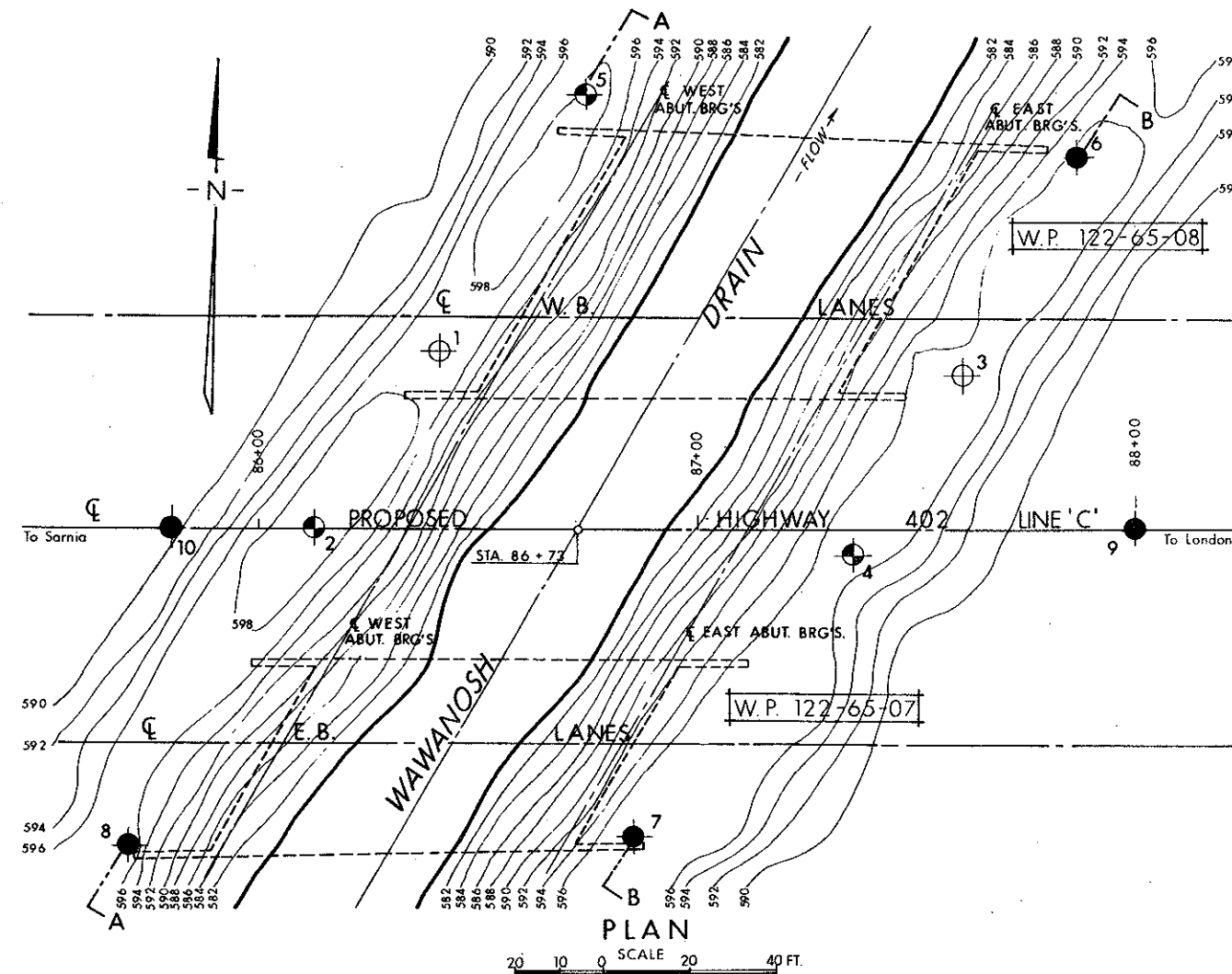
### SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL





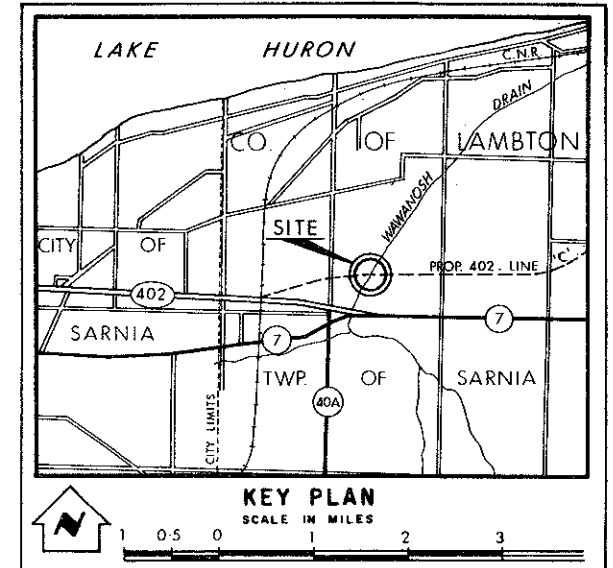
SECTIONS



PROFILE

NOTE: The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the CHATHAM District Office.

REF. NO. E-4853-1



# LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, JUNE 1970
- WATER LEVELS NOT ESTABLISHED FOR BORE HOLES 2,4,5,8,9&10

NO.	ELEVATION	STATION	OFFSET
1	597.6	86+41	40' LT.
2	598.3	86+13	4'
3	597.2	87+61	35' LT.
4	597.5	87+36	6' RT.
5	597.9	86+75	100' LT.
6	596.3	87+86	86' LT.
7	597.1	86+86	71' RT.
8	596.1	85+70	73' RT.
9	588.8	88+00	4'
10	589.8	85+80	4'

# NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
 MATERIALS & TESTING OFFICE - FOUNDATION SECTION

**WAWANOSH DRAIN**

KING'S HIGHWAY NO. 402 LINE 'C' DIST. NO. 1  
 CO. LAMBTON  
 TWP. SARNIA LOT 14 CON. 7

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBWD. A.B.	CHECKED <input checked="" type="checkbox"/>	W.P. NO. 122-65-07&08	M.B.T. DRAWING NO.
DRAWN S.O.	CHECKED <input checked="" type="checkbox"/>	JOB NO. 70-11047	70-11047A
DATE 17 JULY 1970	SITE NO. 14-341	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO. 75-27	14-341-2	