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STR. SITE No. 3-289

HWY. No. 417

LOCATION Coulbourn Arterial Interchange

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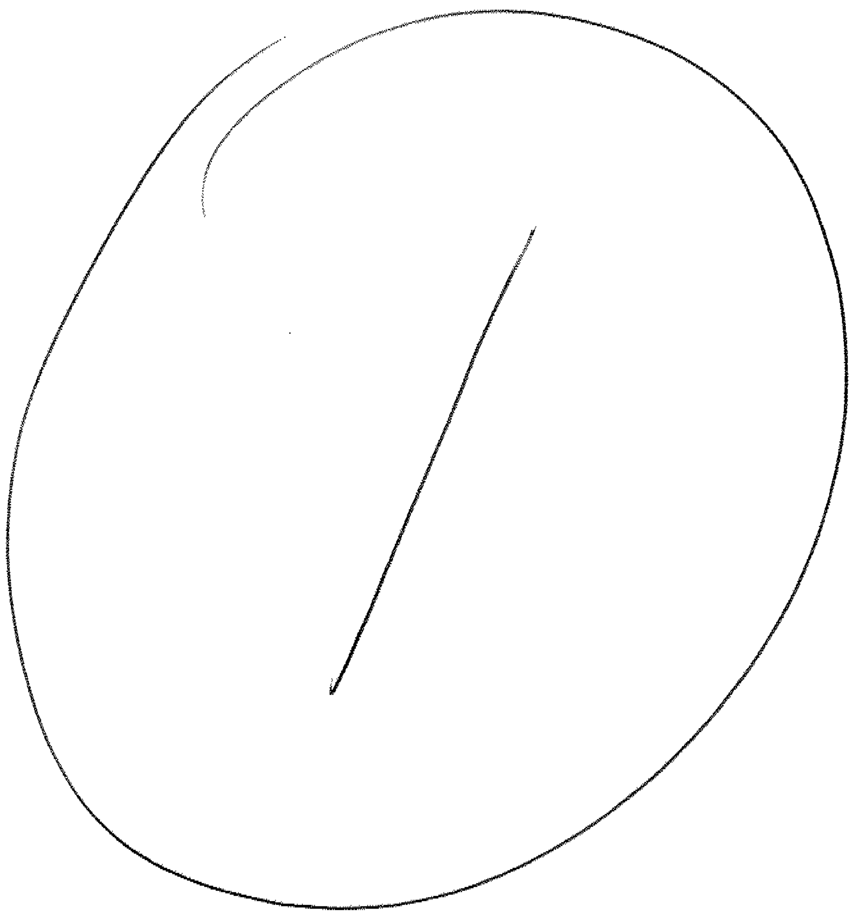
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

35MM

DRAWING



Ontario

Department of Transportation and Communications

~~DEPARTMENT OF HIGHWAYS ONTARIO~~

FOUNDATIONS

MEMORANDUM

3165-105

To: Mr. T. C. Kingsland,
Regional Bridge Planning Engr.,
Eastern Region,
KINGSTON, Ontario.

From: Foundation Section,
Design Services Branch,
Downsview, Ontario.

Attention:

Date: July 26, 1971

Our File Ref.

In reply to

AUG 3 1971

Subject:

FOUNDATION INVESTIGATION REPORT
For
Underpass Structure at the Crossing
Of Proposed Hwy. #417 and
Goulbourn Road Revision
March Township
Reg. Municipality of Ottawa-Carleton
District No. 9 (Ottawa)
W.O. 71-11050 -- W.P. ~~433-64-02~~ 434-64

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.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. T. C. Kingsland (2)
B. R. Davis
F. G. Allen
D. W. Farren
S. J. Markiewicz
J. E. Callaghan
E. R. Saint
J. Percy (2)
B. J. Giroux
B. A. Singh
Foundations Files
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Underpass Structure at the Crossing
Of Proposed Hwy. #417 and
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March Township
Reg. Municipality of Ottawa-Carlcton
District No. 9 (Ottawa)
W.O. 71-11050 -- W.P. 433-64-02

1. INTRODUCTION:

The Foundation Section was requested to carry out an investigation at the above mentioned crossing of proposed Hwy. #417. The request was contained in a memo from the Eastern Region Bridge Section (Mr. T. C. Kingsland, Regional Bridge Planning Engineer), dated April 21, 1971. An investigation was subsequently carried out by this Section to determine the subsoil, bedrock and groundwater conditions at this site.

This report contains the factual results obtained from this investigation, together with recommendations pertaining to the foundations of the proposed structure, as well as the stability and settlement considerations associated with the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located about 500 feet east of existing Goulbourn Road, approximately 1.2 miles north of the Village of Hazeldean.

The area is within pasture fields, used for general farming purposes. The surrounding terrain slopes gradually towards the west. In the immediate vicinity of the site the ground elevation ranges from 332 to 338. Near the existing Goulbourn Road, occasional bedrock outcrops are visible.

Physiographically, the site is situated in the "Ottawa Valley Clay Plains" region. The area is characterized by a stratum

2. DESCRIPTION OF THE SITE AND GEOLOGY: (cont'd.) ...

of marine clay deposited by the Champlain Sea. This is underlain by glacial till which, in turn, is followed by sandstone bedrock of the Beekmantown Groups, Potsdam Formation.

3. FIELD AND LABORATORY WORK:

Seven sampled boreholes, 6 of which were accompanied by a dynamic cone penetration test, as well as 4 additional cone tests, were put down in the course of the field investigation. The borings were advanced by means of conventional diamond drill rigs adapted for soil sampling purposes.

Samples of the cohesive stratum and the lower glacial till were obtained in a 2" O.D. split-spoon sampler, which was hammered into the ground in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. This was supplemented by obtaining 2" I.D. Shelby tubes, where possible, in the cohesive stratum. The tubes were manually pushed into the material. In situ vane tests were carried out within the clay to determine the undrained shear strength of the subsoil. Bedrock was proven in all of the borings by obtaining BX or AXT size rock core samples.

The groundwater level conditions across the site were determined by observing the water levels in the open holes during the course of the investigation.

The locations and elevations of all the borings were surveyed in the field by personnel from the Eastern Region Engineering Surveys Section. They are shown on Drawing No. W.O. 71-11050A, together with an estimated stratigraphical profile along the centre-line of realigned Goulbourn Road. All elevations are referenced to a Geodetic datum.

All the samples were subjected to a careful visual examination in the field and subsequently in the laboratory. In addition, the following laboratory tests were performed on selected samples to determine the engineering properties of the various soil types:

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

Natural Moisture Content
Grain-Size Distribution
Atterberg Limits
Undrained Shear Strength Testing
Consolidation Testing

The results of the laboratory testing are plotted on the Record of Borelog sheets and summarized on Figures No. 1 to 4 inclusive, all of which are contained in Appendix I of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The predominant overburden stratum across the site is composed of a soft to stiff silty clay. The thickness of this deposit varies from 2 to 13 feet. The clay stratum is underlain by a glacial till deposit, ranging in thickness from 1 to 7 feet. The glacial till is, in turn, underlain by sandstone bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying borelog sheets. The stratigraphical profile, shown on Drawing No. W.O. 71-11050A, is inferred from this boring data.

From ground surface downward, the various soil types encountered, are as follows:

4.2) Silty Clay:

Across the site there is a layer of cohesive topsoil about 1 foot thick. Directly beneath the topsoil is the predominant stratum across the site, which is composed of a grey silty clay. The overall thickness of the stratum varies from 2 to 13 feet. The upper 2 to 3 feet of this cohesive stratum has been desiccated. Throughout the stratum, there are random pockets and seams of sand

4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.2) Silty Clay: (cont'd.) ...

and gravel (less than 1/2" thick). Grain-size distribution curves for samples of the cohesive subsoil are shown on Figure #2, located in the Appendix of this report.

The engineering properties of the stratum, as determined by field and laboratory testing, are presented in tabular form below:

Identity Tests		Range	(Average)
Bulk Density (p.c.f.)	(γ)	106 - 118	(110)
Liquid Limit (%)	(W_L)	36 - 45	(41)
Plastic Limit (%)	(W_P)	19 - 29	(24)
Natural Moisture Content (%)	(W)	32 - 57	(44)

Consolidation Characteristics					
Initial Void Ratio	(e_o)	1.45	and	1.44	Two Tests
Compression Index	(C_c)	0.52	and	0.82	Two Tests
Degree of Preconsolidation (t.s.f.)	(P_c-P'_o)	3.0	and	3.5	Two Tests

Undrained Shear Strength (C_u) (p.s.f.)	
1) Field Tests	> 2,000
2) Lab. Tests	500 - 2,000

Standard Penetration Tests ('N') (Blows/ft.)	5 - 16

The Atterberg limit tests are also plotted on the Plasticity Chart, Figure #1. These results indicate that the material is essentially inorganic with a plasticity in the intermediate range. The natural water content generally exceeds the liquid limit; this is indicative of a sensitive material.

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.2) Silty Clay: (cont'd.) ...

The consistency of the stratum varies from firm to stiff.

The consolidation characteristics of the stratum were determined by carrying out two laboratory tests, the results of which are shown as Void Ratio vs. Pressure plots on Figure #4. The results of these tests indicate that the cohesive stratum is preconsolidated by about 3 to 3.5 t.s.f. in excess of existing overburden pressure.

4.3) Heterogeneous Mixture of Clayey Silt, Sand and Gravel - (Glacial Till):

The cohesive stratum is generally underlain by a thin deposit of glacial till from 1 to 2 feet in thickness. In B. H. #2 no glacial till deposit was encountered, while in B.H. #4 the till deposit was 7 feet thick.

The till, which is basically cohesive in nature, consists of clayey silt, binding sand and gravel and rock fragments. Grain-size distribution curves for samples of this deposit are shown on Figure #3, in the Appendix of the report.

The Standard Penetration Tests, carried out within the glacial till deposit, are plotted on the Record of Borelog sheets. This testing gave 'N' values which range from 4 to 27 blows/ft. The lower values were obtained in the thin deposits of glacial till; it is inferred that these zones have been 'reworked' - i.e., it was once exposed to the atmosphere and weathered by the elements. Based on the 'N' values, the consistency of the glacial till ranges from firm to very stiff.

Atterberg limit tests were carried out on representative samples of the glacial till and these are plotted on the Plasticity Chart, Figure #1. The results indicate that the matrix of the glacial till is inorganic with a low plasticity.

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.4) Sandstone Bedrock:

The glacial till is directly underlain by bedrock which was proven in six boreholes, by obtaining from 2 to 10 feet of BX or AXT size rock core samples. Over the site the bedrock surface was generally found to vary randomly between elevations 320 and 326. However, in B.H. #2, where bedrock directly underlies the silty clay stratum, the bedrock surface was encountered at elevation 330.5.

The bedrock is sandstone with occasional irregular shaley seams and interbeds up to 1/2 inch in thickness. The bedrock is sound as evidenced by the high rock recovery.

5. GROUNDWATER CONDITIONS:

During the period of the investigation, groundwater level observations were carried out in all of the boreholes. The groundwater level in the overburden is at a depth of 2 to 4 feet below the existing ground surface. This depth corresponds to elevations between 328 and 335, with the phreatic surface generally corresponding to the slope of the ground.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a two-span underpass structure at the crossing of Hwy. #417 and the proposed Goulbourn Road Relocation in the Township of March, Reg. Municipality of Ottawa-Carleton. The structure will be about 55 feet wide and approximately 271 feet long.

The profile grade of the Goulbourn Road Relocation, at the crossing, will be between elevations 352 (west approach) and 357 (east approach). Hwy. #417 is to be in a shallow cut section (1 to 3 feet) with the profile grade of the WBL and EBL being about elevation 332. The associated approach fills will, therefore, have a maximum height of approximately 21 and 25 feet in the transverse and longitudinal directions, respectively.

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6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.1) General: (cont'd.) ...

The predominant stratum across the site is composed of a firm to stiff, marine clay which varies from 2 to 13 feet in thickness. This stratum is underlain by a thin glacial till deposit which, in turn, is followed by sound sandstone bedrock, the surface of which was encountered between elevations of 320 and 330.

The presence of the cohesive stratum at a shallow depth below ground surface, is the governing factor from a foundation point of view, since it will be necessary to ensure that it is not overstressed by either the embankment or the structure foundation surcharge loadings. Thus it will be necessary to found the structure elements on spread footings located directly on the sound bedrock or, alternatively, on end-bearing piles driven to the bedrock surface.

6.2) The Embankments:

6.2.1) Stability of Approach Fill Sections:

The critical condition for stability of an embankment on slightly overconsolidated cohesive subsoils as is the case at this site, generally occurs during or immediately after construction. This being the case, a total stress analysis ($\phi = 0$) provides a suitable means of assessing the stability of the embankment sections. In this method of analysis, stability is governed by the applied loads and by the stress-strain and undrained shear strength characteristics of the foundation and embankment soils.

Analyses have been carried out, therefore, in terms of total stresses, both by hand as well as with the use of the electronic computer, to determine the stability of the approaches.

The geometrics of the approaches, and the soil properties for the fill and natural subsoil, assumed for computational purposes, are presented as follows:

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6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) The Embankments: (cont'd.) ...

6.2.1) Stability of Approach Fill Sections: (cont'd.) ...

Longitudinal Section - South Approach (Critical Case) -

Existing Ground Level .... Elev. 336

Profile Grade - Goulbourn Road Revision .... Elev. 357

- Hwy. #417 .... Elev. 332

Height of Approach - 25' (Longitudinal Direction) } - (2:1 Slopes)
- 21' (Transverse Direction)

Soil Properties

Soil Type	Elevation (Ft.)	Undrained Shear Strength Cu (p.s.f.)	Angle of Shearing Resistance Ø	Bulk Density (p.c.f.)
Fill	-	0	30°	120
Silty Clay	336 - 330	1,500	0	110
	330 - 325	1,000	0	110
	325 - 320	500	0	110
Bedrock	320			

The results of the analyses indicate that the proposed south approach will be stable in all directions, provided standard 2:1 slopes are employed. This being the case, the lower north approach will be inherently stable.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) The Embankments: (cont'd.) ...

6.2.2) Settlement Considerations:

The clay stratum will undergo settlements over a period of time, due to the applied load of the approach fills. Since the applied load will not exceed the preconsolidation pressure of the stratum (refer to Sub-section 4.2), this settlement will be of a recompression nature. Computations carried out indicate that the settlement will be of the order of 2 to 3 inches, the major portion of which should occur within a period of 18 to 24 months.

6.3) Structure Foundations:

6.3.1) Centre Pier Foundation: (refer to B.H.'s #3 & 4)

At the proposed location of the pier, sound bedrock is located at a shallow depth below the surface. For this reason, it is recommended that the pier be founded on a spread footing located directly on or within the bedrock. Because of the sloping nature of the bedrock at the proposed pier location, it may be necessary to step the footing up in a northerly direction, as follows:

Elev. 324.5 (South end) -- Stepping up to -- Elev. 326 (North end)

Such a footing could be designed using an allowable bearing pressure of up to 20.0 t.s.f.

At the location of the pier foundation, the groundwater level is about 3.5 feet below ground surface (i.e., about 6 feet above the bedrock surface). Any groundwater seepage or surface run-off into the excavation, however, could be handled by conventional techniques (such as pumping from sumps).

..... 10

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Structure Foundations: (cont'd.) ...

6.3.2) Abutment Foundations: (refer to B.H.'s #1, 2, 5, 6, 9, 10, and 11) -

The abutments for the structure may be founded within the approach fills and supported on end-bearing piles driven to bedrock. The approximate tip elevations would vary between elevations 322 to 330.5 at the north abutment (refer to Section A-A, Drawing No. W.O. 71-11050A), and between elevations 320 and 321.5 at the south abutment. The allowable pile load would be dependent on the section chosen - for example, 12 BP 74 steel H-piles may be designed for 95 tons/pile.

No bouldery or rock fill should be used in areas in which piles are to be driven.

As an alternative, the abutments may be founded directly upon the sound bedrock at the elevations mentioned above. A safe bearing pressure of up to 20 t.s.f. may be used for design purposes.

7. MISCELLANEOUS:

The field work, performed during the period of June 18 and June 22, 1971, was supervised by Mr. M. Logan, Student Technician (Field). The equipment used was owned and operated by Dominion Soil Investigation Ltd.

The preparation of this report was undertaken by Mr. W. G. Hutton, Project Foundation Engineer.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who reviewed this report.

July, 1971.

APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11050 LOCATION Sta. 99 + 37 ℄ Goulbourn Rd. Rev'n O/S 18' rt. ORIGINATED BY M.L.

W.P. 434-64-00 BORING DATE June 18 - 21, 1971 COMPILED BY W.H.

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100); SHEAR STRENGTH P.S.F. (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE; 400 800 1200 1600 2000)	LIQUID LIMIT — w_L, PLASTIC LIMIT — w_P, WATER CONTENT — w; WATER CONTENT % (15 30 45)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT					
332.1	Ground level.									
0.0	Topsoil.		1	SS	8					
1.0	Silty clay.		2	SS	9	330				▽328.5
	Firm to stiff.		3	SS	5					
324.1 0.0							+>2000			
322.1	Glacial Till - v.stiff		4	TW	PM					8 36 48 8
10.0	Bedrock Sandstone		5	BX	93%	320				
317.1	Sound. Light grey.			R.C.	Rec					
15.0	End of borehole.									
						310				

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11050
LOCATION Sta. 99 + 39 ℄ Goulbourn Rd. Rev'n O/S 38' lt.
ORIGINATED BY M.L.

W.P. 434-64-00
BORING DATE June 21, 1971
COMPILED BY W.H.

DATUM Geodetic
BOREHOLE TYPE Diamond Drill - Washboring
CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100); SHEAR STRENGTH P.S.F. (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB. VANE)	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W; WATER CONTENT % (15, 30, 45)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
333.5	Ground level.									
0.0	Topsoil.		1	SS	16					
330.5	Silty clay.					330				▽ 330.0
3.0	Bedrock. Sandstone.		2	BX R.C.	83% Rec					
	Sound.		3	BX R.C.	80% Rec					
320.7	Light grey.									
12.8	End of borehole.					320				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11050

W.P. 434-64-00

DATUM Geodetic

LOCATION Sta. 100 + 74 ℄ Goulbourn Rd. Rev'n O/S 27' rt.

BORING DATE June 21, 1971

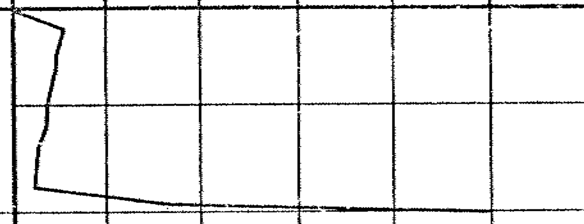
BOREHOLE TYPE Dynamic Cone Penetration Test

ORIGINATED BY M.L.

COMPILED BY W.H.

CHECKED BY [illegible]

SOIL PROFILE: ELEV. DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100); SHEAR STRENGTH P.S.F. (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB. VANE)	LIQUID LIMIT — w_L; PLASTIC LIMIT — w_P; WATER CONTENT — w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
335.0	Ground level.									
0.0						330				
324.6 10.4	End of borehole. Probable bedrock.					320				



FORM OS-MT - 126 (REV. 1969)

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11050 LOCATION Sta. 100 + 74 ¢ Goulbourn Rd. Rev'n. O/S 29' Lt. ORIGINATED BY M.L.

W.P. 434-64-00 BORING DATE June 21, 1971 COMPILED BY W.H.

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY [illegible]

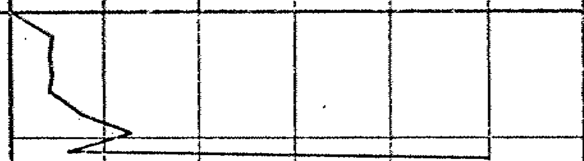
SOIL PROFILE: ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL
336.2	Ground level.							
0.0	Topsoil		1	SS	15			∇ 332.4
1.0	Silty clay, stiff. Grey.							5 45 40 1?
333.2 / 3.0	Glacial till. Clayey silt with sand, Trace of gravel, very stiff. Grey.		2	SS	19			
			3	SS	27	330		
326.4 / 9.8	Bedrock. Sandstone. Sound. Light grey.		4	BX R.C	84% Rec			
322.2 / 14.0	End of borehole.					320		

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE

LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w

WATER CONTENT % 15 30 45



FORM OD-MT-120 (REV. 1969)

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

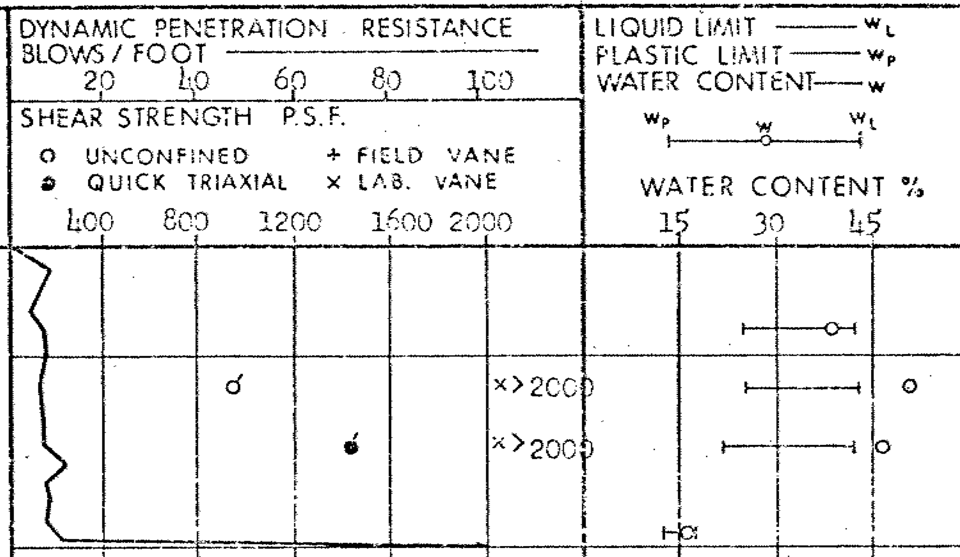
FOUNDATION SECTION

JOB 71-11050
W.P. 434-64-00
DATUM Geodetic

LOCATION Sta. 102 + 12 ℄ Goulbourn Rd. Rev'n O/S 36' rt.
BORING DATE June 21-22, 1971
BOREHOLE TYPE Diamond Drill - Washboring

ORIGINATED BY M.L.
COMPILED BY W.H.
CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
335.7	Ground level.								
0.0	Topsoil.		1	SS	9				▽
1.0	Silty clay with some sand.		2	SS	10	330			
	Firm to stiff.		3	TW	PM		×>2000	106	
	Grey.		4	TW	PM		×>2000	108	0 17 43 41
322.2	soft		5	SS	2				
320.2	Glacial Till. Firm.		6	SS	4	320			7 43 45 5
15.5	Bedrock. Sandstone.		7	BX R.C.	96% Rec				
314.7	Sound. Light grey.		8	BXRC	100%				
21.0	End of borehole.					310			



6

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTIO

JOB 71-11050

LOCATION Sta. 102 + 12 ℄ Goulbourn Rd. Rev'n O/S 20' lt.

ORIGINATED BY M.L.

W.P. 434-64-00

BORING DATE June 21, 1971

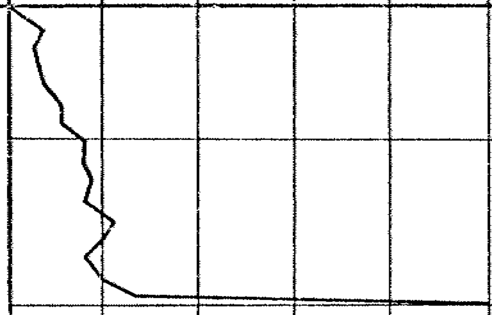
COMPILED BY W.H.

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test.

CHECKED BY [illegible]

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100); SHEAR STRENGTH P.S.F. (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB. VANE)	LIQUID LIMIT — w_L, PLASTIC LIMIT — w_P, WATER CONTENT — w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.C
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
337.0	Ground level.									
0.0						330				
321.6 / 15.4	End of conehole. Probable bedrock					320				
						310				



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

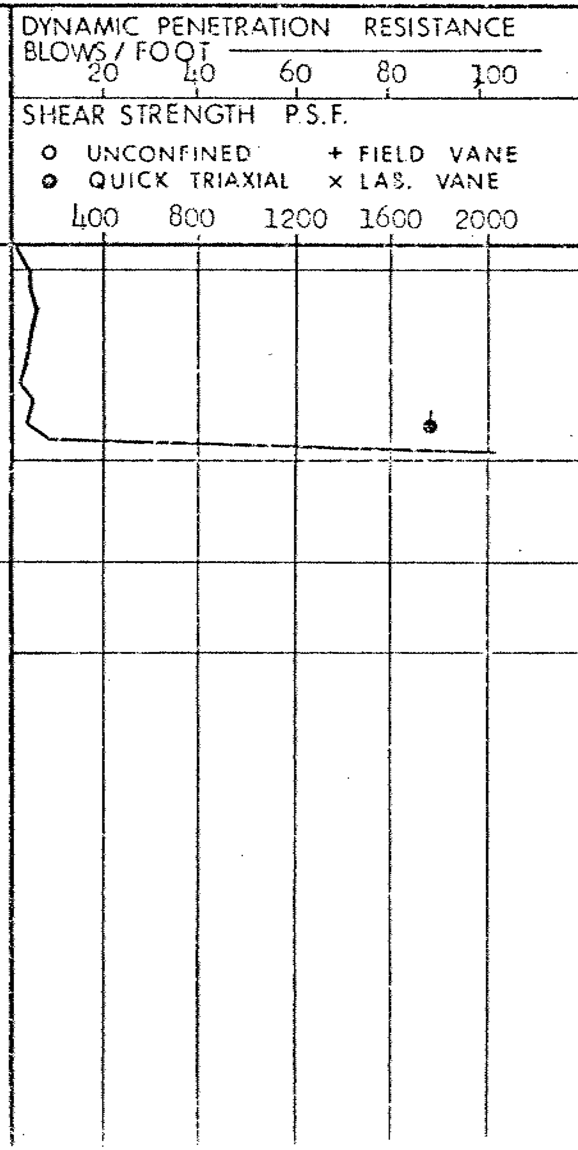
FOUNDATION SECTIO

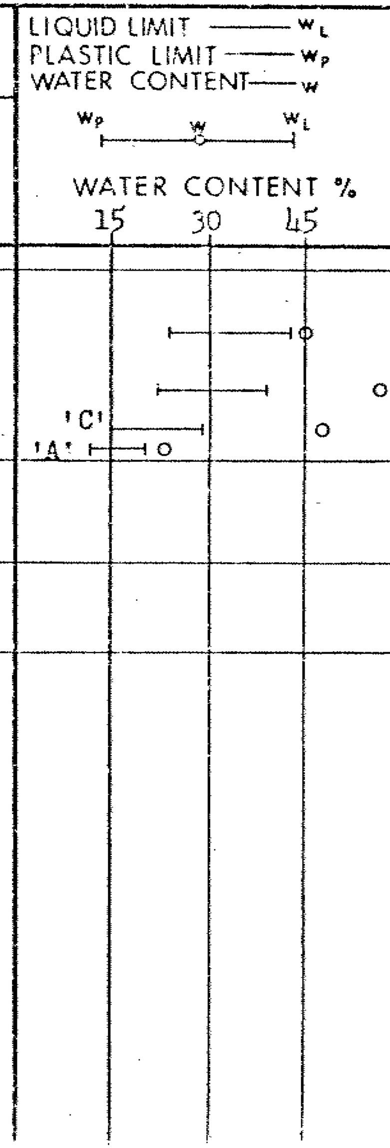
JOB 71-11050 LOCATION Sta. 98 + 88 ¢ Goulbourn Rd. Rev'n O/S 13' lt. ORIGINATED BY M.L.

W.P. 434-64-00 BORING DATE June 22, 1971 COMPILED BY W.H.

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY

ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	BULK DENSITY P.C.F.	REMARKS GR. SA. SI. CL
331.0	Ground level.						
0.0	Topsoil.	1	SS	6	330		
1.0	Silty clay with some sand. Stiff. Grey.	2	SS	16			328.2
		3	SS	8			
		4	TW	PM			
319.8	Glacial Till - Firm.				320	110	0 11 49 40
11.2	Bedrock. Sandstone. Sound. Light grey.	5	BX R.C.	88% Rec			
314.8 16.2	End of borehole.				310		





DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTIO[N]

JOB 71-11050 LOCATION Sta. 102 + 62 ℄ Goulbourn Rd. Rev'n O/S 12' rt. ORIGINATED BY M.L.

W.P. 434-64-00 BORING DATE June 22, 1971 COMPILED BY W.H.

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY [signature]

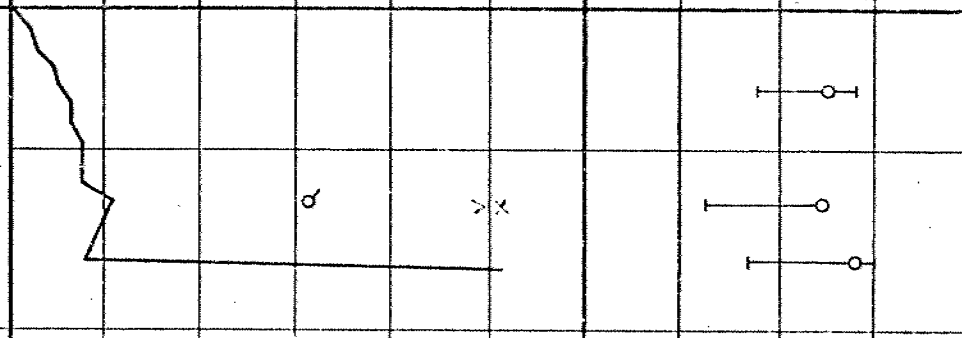
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
337.3	Ground level.							
0.0	Topsoil.		1	SS	8			
1.0	Silty clay with some sand.							▽ 334.7
			2	SS	12			
	Firm to stiff.		3	SS	8	330		
			4	TW	PM		118	
	Grey.							
323.8			5	SS	6			
322.8	Glacial Till.							
14.5	Bedrock - Sandstone.		6	BX	100%			
320.8	Sound.		7	BX	75%	320		
16.5	End of borehole.							

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB. VANE 400 800 1200 1600 2000

LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w

WATER CONTENT % 15 30 45



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 71-11050 LOCATION Sta. 99 + 38, 10' lt. ORIGINATED BY M.L.
W.P. 434-64-00 BORING DATE July 20 - 21, 1971 COMPILED BY W.H.
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY [signature]

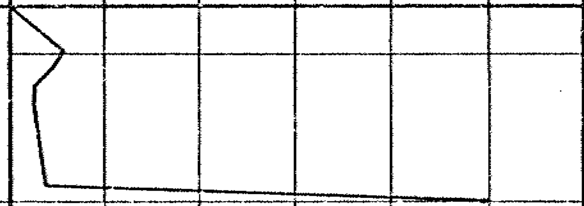
SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100); SHEAR STRENGTH P.S.F. (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE)	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				GR.SA.SI.CL
332.1										
0.0	Topsoil									
1.0	Silty clay, some sand		1	SS	13	330				
	Stiff. Grey.		2	SS	15					∇ - 329.0
327.1			3	SS	12					
5.0	Glacial Till, v. stiff		4	SS	20					
6.0	Bedrock. Sandstone.		5	AXT RC	64% Rec					
	Sound.		6	AXT RC	95%	320				
316.1	Light grey.									
16.0	End of borehole.					310				

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 71-11050 LOCATION Sta. 99 + 37, 4' rt. ORIGINATED BY M.L.
W.P. 434-64-00 BORING DATE July 20, 1971 COMPILED BY W.H.
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY [signature]

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100; SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ⊗ QUICK TRIAXIAL × LAB. VANE	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
332.1	Ground level.									
0.0						330				
322.1 10.0	End of cone hole. Probable bedrock.					320				

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11

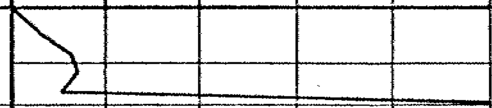
FOUNDATION SECTION

JOB 71-11050 LOCATION Sta. 99 + 38, 24' lt. ORIGINATED BY M.L.

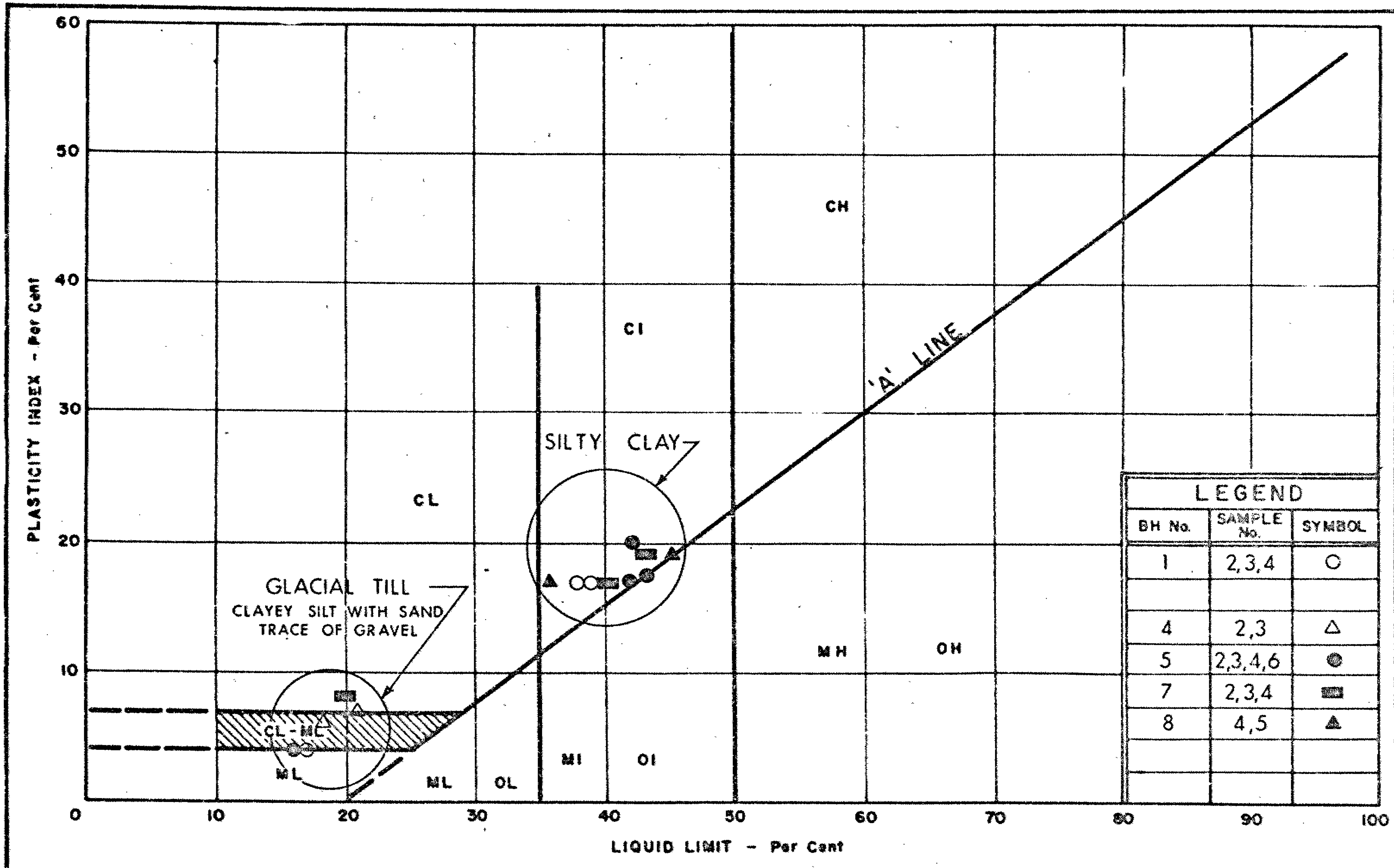
W.P. 434-64-00 BORING DATE July 20, 1971 COMPILED BY W.H.

DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test. CHECKED BY [signature]

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w / WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
332.5	Ground level.									
0.0						330				
327.7 4.8	End of cone hole. Probable bedrock.									
						320				



FORM OB-MT-252
REVISED JUL 966



BH No.	SAMPLE No.	SYMBOL
1	2,3,4	○
4	2,3	△
5	2,3,4,6	●
7	2,3,4	▬
8	4,5	▲

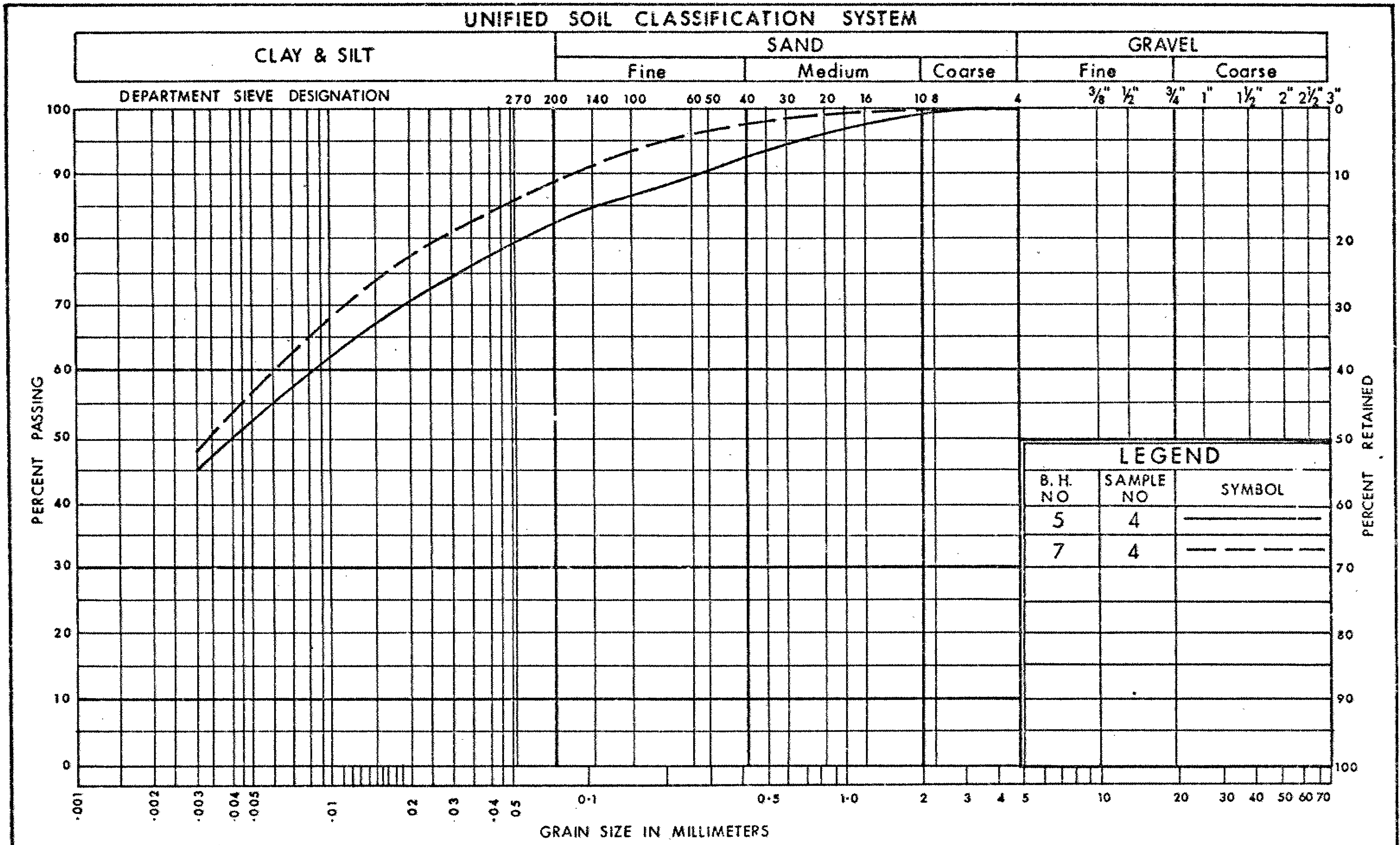
DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

W.P. No.	434-64-00
JOB No.	71-11050

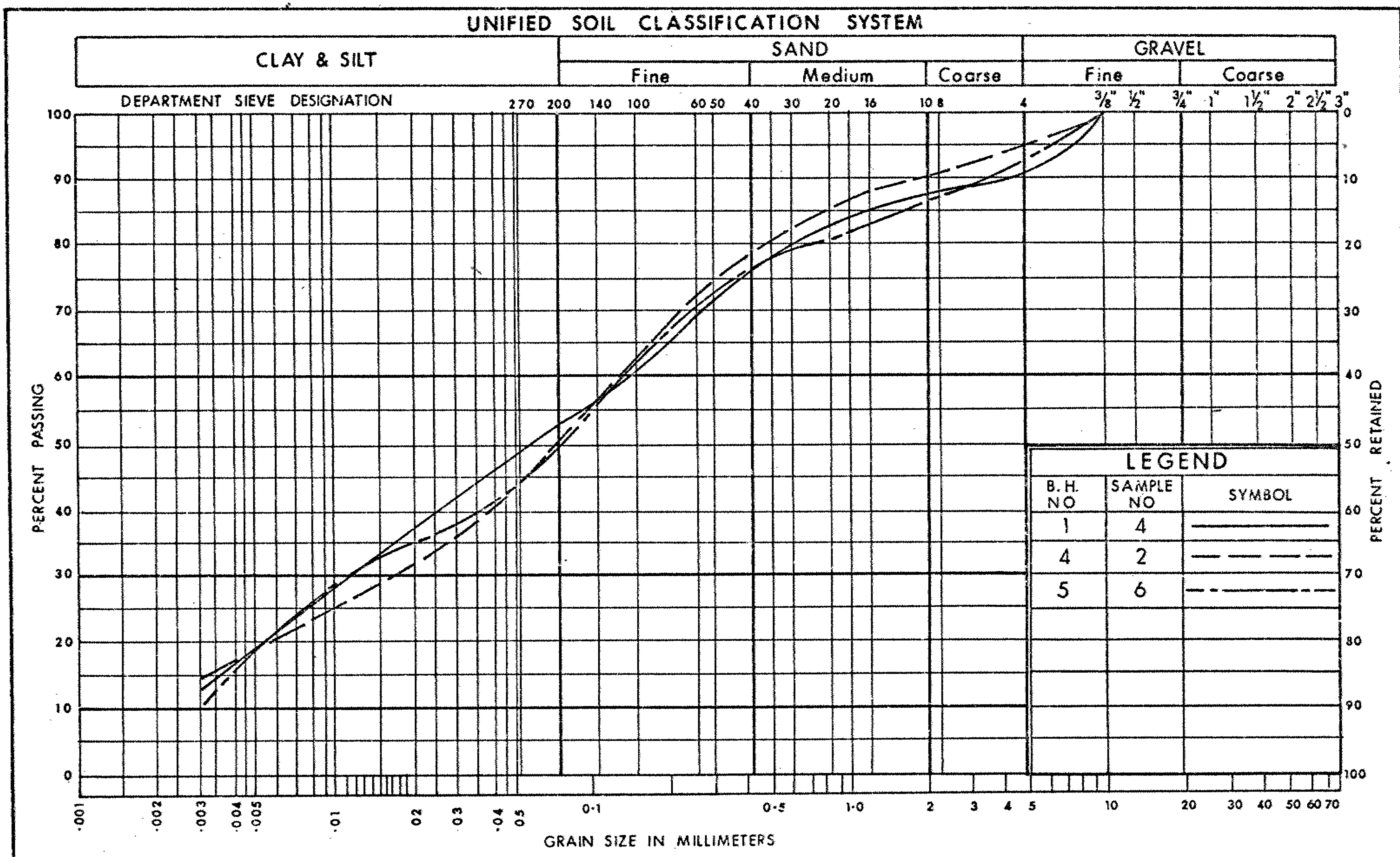
FIG. Nº 1

FORM OB MT-17
REV. APR. 1965



DEPARTMENT OF HIGHWAYS MATERIALS and TESTING DIVISION	GRAIN SIZE DISTRIBUTION SILTY CLAY WITH SOME SAND	W.P. No. 434 - 64 - 00 JOB No. 71 - 11050 FIG. Nº 2

FORM OB MT-17
REV. APR. 1965



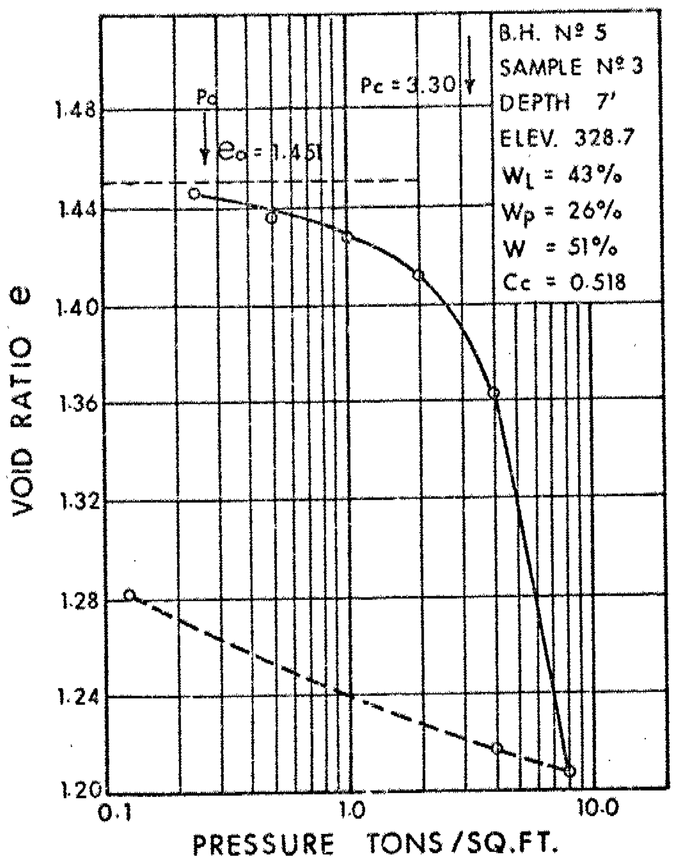
DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

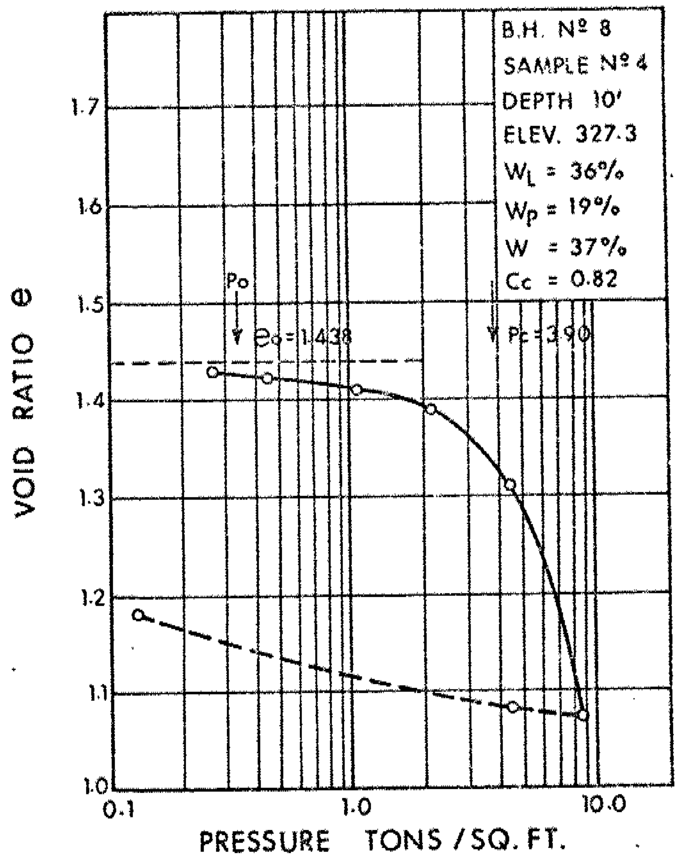
GRAIN SIZE DISTRIBUTION
GLACIAL TILL
CLAYEY SILT WITH SAND, TRACE OF GRAVEL

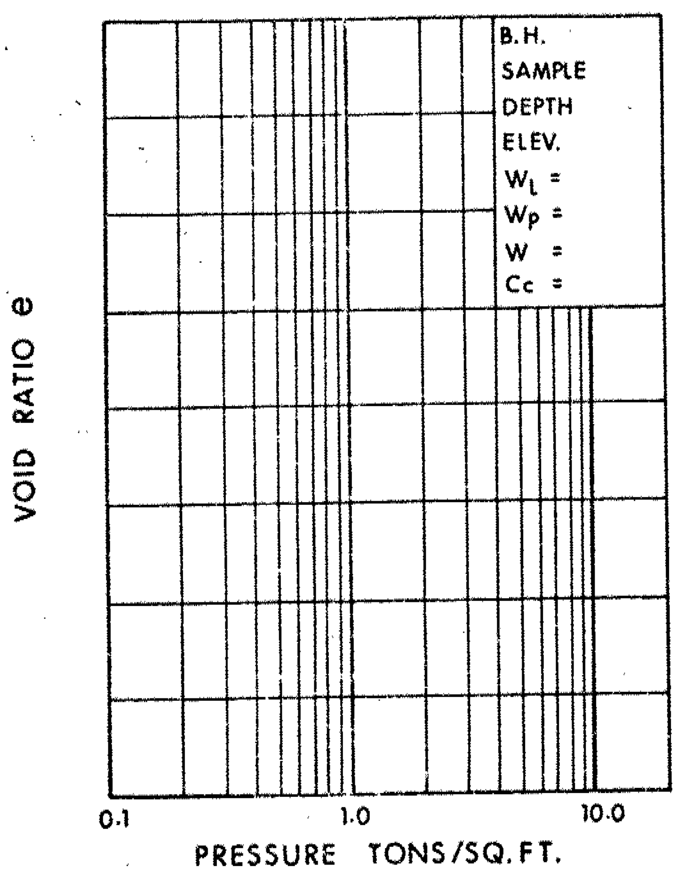
W.P. No. 434-64-00
JOB No. 71-11050
FIG. Nº 3

VOID RATIO – PRESSURE CURVES

JOB NO. 71-11050







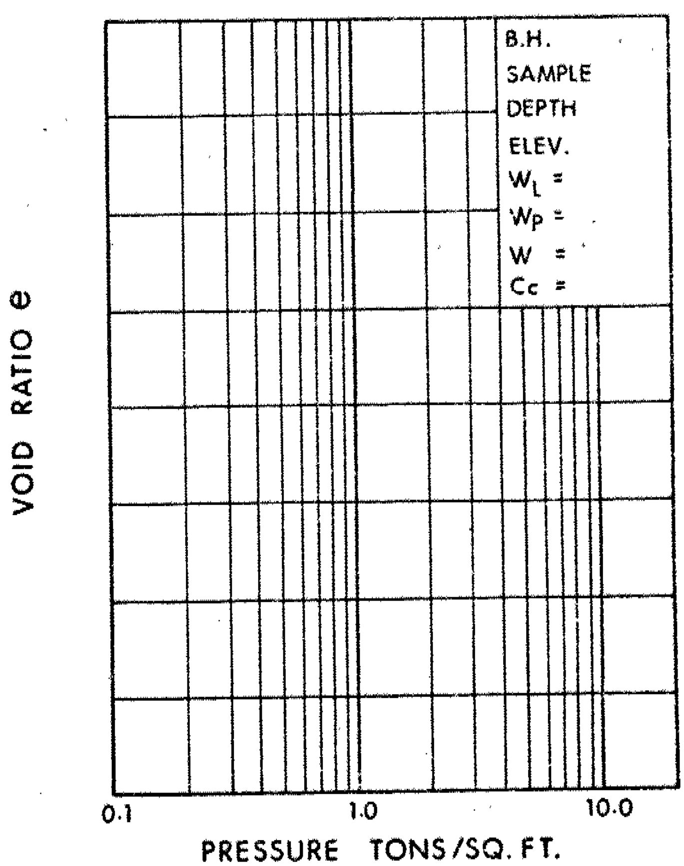


FIG. 4

ABBREVIATIONS 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
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' and ϕ') IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u APPARENT COHESION
ϕ_u APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
(c_u and ϕ_u) IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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_o 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

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 :-

CONSISTENCY	'N' BLOWS/FT.	c LB./SQ.FT.	DENSENESS	'N' BLOWS/FT.
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

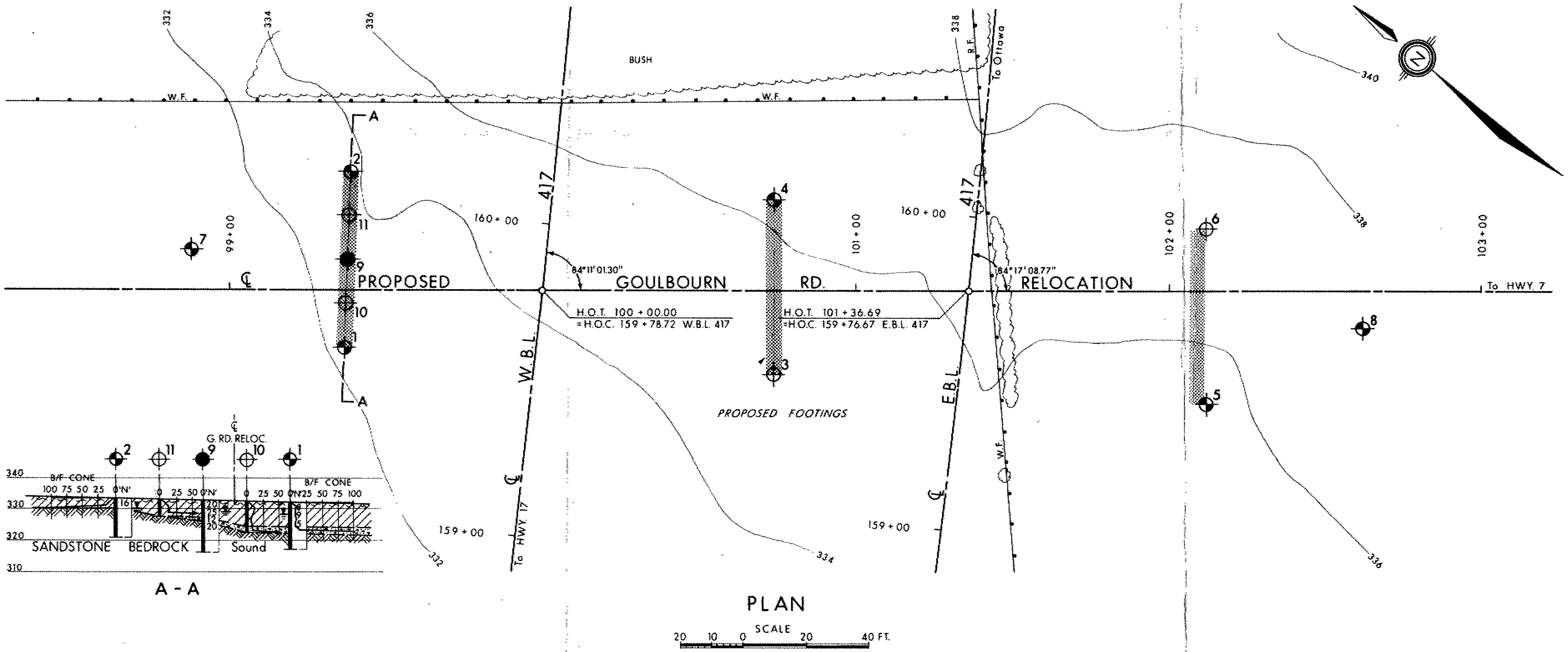
S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		

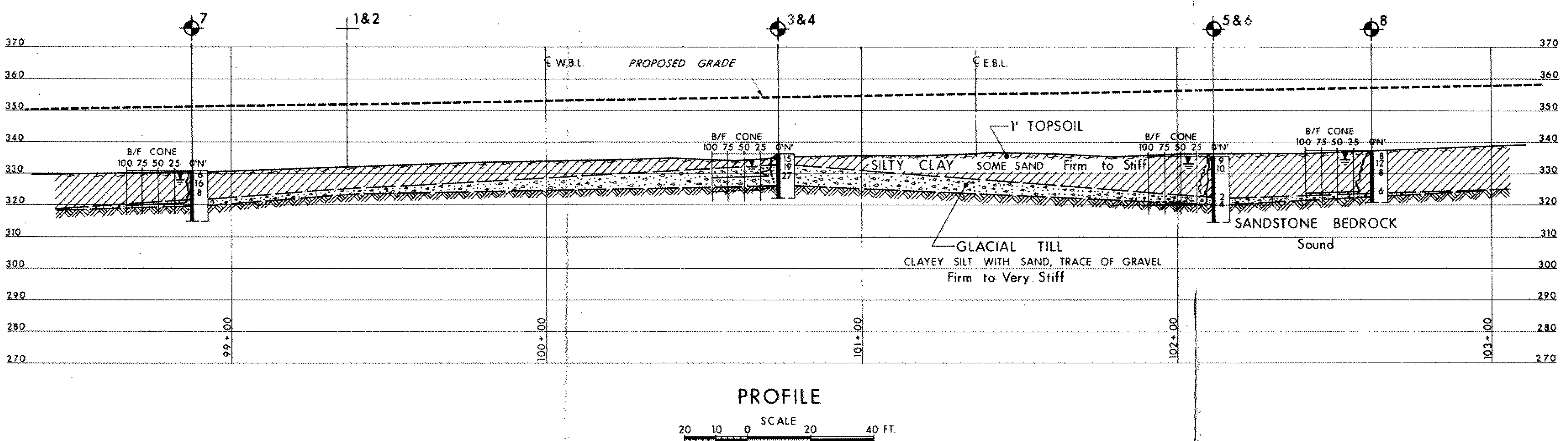
P.H. SAMPLE ADVANCED HYDRAULICALLY

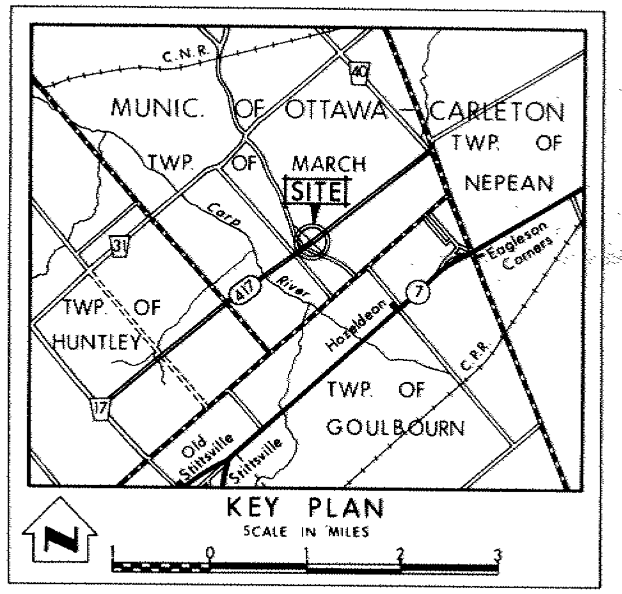
P.M. SAMPLE ADVANCED MANUALLY

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







LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation. JUNE 1971

NO.	ELEVATION	STATION	OFFSET
1	332.1	99 + 37	18' RT.
2	333.5	99 + 39	38' LT.
3	335.0	100 + 74	27' RT.
4	336.2	100 + 74	29' LT.
5	335.7	102 + 12	36' RT.
6	337.0	102 + 12	20' LT.
7	331.0	98 + 88	13' LT.
8	337.3	102 + 62	12' RT.
9	332.1	99 + 38	10' LT.
10	332.1	99 + 37	4' RT.
11	332.5	99 + 38	24' LT.

— 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.

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION SECTION

GOULBOURN ROAD RELOCATION

HIGHWAY NO. 417 DIST. NO. 9
CO. MUNIC. OF OTTAWA - CARLETON
TWP. MARCH LOT 2 CON. 2

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. M.L.	CHECKED	W.P. NO. 434-64-00	DRAWING NO. 71-11050A
DRAWN A.N.	CHECKED	JOB NO. 71-11050	
DATE 23 JULY 1971		SITE NO.	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

REF. Nº E-5213-1