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DIST. 3 REGION

W.P. No. 213-77-03

CONT. No. 81-53

W. O. No.

STR. SITE No. 33-100

HWY. No. 17

LOCATION Grand River Bridge
Widening

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 213-77-03

DIST 3

HWY 7

STR SITE 33-100

Grand River Bridge
3.3 km East of
Frederick Street, Kitchener 81-53

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FOUNDATION INVESTIGATION REPORT

For

Grand River Bridge
3.3 km East of Frederick Street, Kitchener
W.P. 213-77-03, Site 33-100
Hwy. 7, District 3, Stratford

INTRODUCTION

A foundation investigation was carried out in 1971 for the proposed major reconstruction programme at the crossing of Hwy. 7 and Grand River. The proposal involved the construction of a new bridge on the existing alignment and also the erection of a temporary detour structure located some 17 m north. The actual construction work commenced in 1972 and upon completion the new bridge was opened for traffic. Since that time it became evident that an additional structure is required to cope with the increased density of traffic. The existing structure will carry the eastbound traffic and the proposed new bridge the westbound vehicles. The Soil Mechanics Section reviewed the original foundation investigation and it was concluded that no additional borings are required.

This report was prepared from the original foundation investigation report (W.P. 194-63-00, issued on 71 05 12) and contains basically the same information. It should be noted that the units of measurements were changed from the imperial system to international system (SI) also known as the metric system.

SITE DESCRIPTION

The site is located 3.3 km east of Frederick Street, Kitchener at the crossing of Hwy. 7 and Grand River. The south flowing Grand River meanders across the gently rolling terrain. The river channel, during periods of normal flow, varies from 45 m to 60 m within the vicinity of the site. The south bank of the river is relatively flat and low-lying, while the north bank has an over-all slope of about 2:1, the crest being some 10 m over the river bed.

The site is situated in the physiographic region known as the 'Waterloo Hills'. In the vicinity of the site the terrain is covered by kame moraines with outwash sands occupying the intervening hollows. The overburden is underlain by dolomite bedrock of the salina formation, Silurian period.

SUBSURFACE CONDITIONS

General

The predominant stratum across the site is composed of a competent glacial till which varies from 4 m to 10.5 m in thickness. The glacial till is overlain by a surficial spillway deposit of loose to very dense sand and gravel. The thickness of this deposit ranges from 0.5 m to 6.5 m. The overburden sequence is underlain by sandy dolomite bedrock. The fill material of the existing approaches is composed of primarily silty sand and gravel.

It is pointed out that due to the construction activity which has taken place at this site since the original field investigation, the thickness of the fill may have been changed.

The boundaries of the various deposits are shown on the appended Record of Borehole Sheets and an estimated stratigraphical profile is shown on Drawing #2137703-A.

The subsoil and bedrock encountered from ground surface downward is presented in the subsections to follow.

Fill Material

Up to 5.5 m of fill was encountered at those borings put down along the approaches to the existing structure. The fill was primarily composed of a silty sand to sand and gravel. At B.H. #9, however, the fill material is a clayey silt with some sand and gravel. Occasional seams of organic silt up to 6 mm thick, are present throughout the fill. Grain size distribution curves for samples obtained from the fill are plotted on Figure #1 in the Appendix to this report.

Standard penetration testing was carried out within the fill material; the values obtained are plotted on the Record of Borehole Sheets. The results gave 'N' values which range from 6 to 15

blows/0.3 m. Based on this testing it is estimated that the fill has been subjected to a moderate degree of compaction.

Spillway Deposit - Silty Sand and Gravel

The surficial deposit across the site is composed of a sand and gravel with a trace to some silt. The thickness of this deposit ranges from 0.3 m to 6.5 m; it is most extensive on the west bank of the river, tapering off in an easterly direction. Traces of organic silt were often encountered in the upper 1.5 m of the deposit; further, the lower 1 m is periodically composed of a uniform sand. In addition, occasional sandy silt seams, up to 0.1 m in thickness, are present throughout, as well as random clayey silt layers up to 1 m thick. Grain size distribution curves for samples obtained from the granular spillway deposit are plotted on Figure #2.

Standard penetration testing was carried out within the granular deposit. The 'N' values obtained generally range between 23 blows/0.3 m and 150 blows for 0.1 m. Based on these results, it is estimated that the relative density of the sand and gravel varies from compact to very dense. An exception to this pattern occurs along the west bank in the immediate vicinity of the river (refer to B.H.'s #6, 7 and 13). Here the 'N' values in the upper portion of the deposit range from 1 to 18 blows/0.3 m indicating a relative density which varies from very loose to compact. The topography in this area would seem to indicate that this was once part of the old river channel. If this is the case, it could be inferred that the lower relative densities would be indicative of 'reworking' of the material by the scour action of the river.

Glacial Till

The granular spillway deposit is underlain by the predominant stratum across the site which is composed of a glacial till. The thickness of the till sheet varies from 4 m to 10.5 m being most extensive in those areas where the surficial deposits are thinnest - i.e., on the east bank of the river. The upper 1 to 4.5 m of the stratum is reddish-brown in colour; below this zone the till is grey; the transition between the zones is clearly indicated on the borelog sheets. The upper reddish-brown zone is basically granular, being composed of silt, sand and gravel with a trace of clay. The lower portion, however, is primarily cohesive in

nature - i.e., it has a matrix of clayey silt binding sand and gravel. Boulders were encountered in the lower portion of the stratum (generally below elevation 287 at B.H.'s 10, 11, 12 and 15. These boulders ranged up to 0.4 m in size.

Atterberg Limit Tests were performed on samples of the glacial till; the results are plotted on the borelog sheets, as well as on the Plasticity Chart, Figure #4. The testing is summarized in the following table:

		Upper Zone (Reddish-Brown)	Lower Zone (Grey)
Liquid Limit	(W _L) %	13-17	17-24
Plastic Limit	(W _P) %	11-13	12-15
Natural Moisture Content	(W) %	7-10	9-17

Based on these results it is estimated that the upper reddish-brown zone is basically non-plastic - i.e., granular type of material. The testing carried out in the lower grey zone, however, would indicate that in this area the till is composed of an inorganic soil of low plasticity.

Standard penetration testing carried out within this stratum gave 'N' values which were consistently greater than 100 blows/0.3 m; these values are summarized on the borelog sheets. Based on this testing, it is estimated that the relative density of the upper granular portion of the glacial till is very dense. The lower cohesive zone would have a hard consistency.

Dolomite Bedrock

Grey dolomite bedrock was encountered below the glacial till. The bedrock was proven at 8 of the boring locations by obtaining up to 2.5 m of AXT size rock core samples. The surface of the bedrock varies between elevations 283.6 and 284.5, which corresponds to depths of between 8 m and 11 m below the original ground surface.

The bedrock was generally found to be in a sound condition as evidenced by the high percentage of rock recovery. At a few isolated boring locations, however, specifically B.H.'s #1 and 7, the upper 1.5 m is in a fractured condition.

Groundwater Conditions

Groundwater level observations have been carried out during the period of the investigation by recording the water levels in the open holes. The results of the measurements indicate that the piezometric groundwater level within the overburden generally varies between elevations 293.8 and 295.2 which corresponds to depths of 0.5 to 1.5 m below the original ground surface in the area. The river water level at the time of the investigation varied from elevation 293.8 (normal flow conditions) to 295.4 (spring run-off).

At B.H. #11 put down through the river bottom, an artesian water pressure was encountered. The artesian pressure occurred once the casing was advanced into a bouldery zone located near the base of the glacial till stratum (at about elevation 285). Once this zone was penetrated the water rose instantaneously in the casing eventually stabilizing itself at about elevation 294.4 which is about 0.6 m above the river level. This lower bouldery zone is more pervious than the overlying basically cohesive part of the glacial till. It is inferred that this zone is acting as a confined aquifer which is being charged with groundwater from the higher surrounding terrain. Artesian conditions were not encountered anywhere else during the drilling programme. It is believed, however, that such conditions may exist at other isolated locations where a similar stratigraphical sequence exists, particularly within the low-lying river channel.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to build an additional structure some 17 m (ϕ to ϕ) north of the existing structure to accommodate the future west-bound lanes of Hwy. #7 over Grand River. The proposed additional 5 span (27.280 m - 37.534 m - 27.534 m - 27.534 m - 27.280 m) structure will be similar to the existing one. The profile grade will be at elevation 301 some 8.5 m over the river bed.

The predominant stratum across the site is composed of a 4.3 m to 10.4 m thick competent glacial till. The glacial till is overlain by a granular spillway deposit which is primarily composed of compact to very dense sand and gravel; the thickness of the spillway deposit ranges from 0.3 m to 6.4 m being most extensive on the west bank of the Grand River. The overburden is underlain by dolomite bedrock.

The recommendations pertaining to structure foundations, as well as the stability and settlement of the associated approaches, will be discussed separately in the following sub-sections.

Structure Foundations

Abutments: The abutments, which will be perched within the approach fills, can be founded on end-bearing piles driven into the glacial till stratum. For estimating purposes, it can be assumed that the pile tips for the abutments will be as follows:

East Abutment	Elevation 287-288
West Abutment	Elevation 289-290

Piles founded at these elevations may be designed using the maximum capacity for the particular pile section chosen. For example, HP310x110 steel H piles may be designed for 845 kN/pile. In any case the piles should be driven in accordance with Standard SS3-11 (Hiley Formula). A minimum of 1.2 m of earth cover should be provided to the pile caps for frost protection purposes.

Piers: A review of the construction drawings for the existing structure indicates that the piers are founded on spread footings placed within the hard glacial till stratum at elevation 288.3.

Initially, sheet piles were driven to sufficient depths, then excavated and tremie concrete was placed to elevation 290.8. It was reported that some difficulties were encountered in driving the sheet piles through the very dense and hard portion of the subsoil.

As an alternative to sheet piling it is recommended that the overburden be excavated to the required foundation level (elev. 288.3), then a pre-fabricated box be placed (timber, steel or concrete) within this excavation. After the installation of the box, tremie concrete should be placed to a depth sufficient to balance the full hydrostatic head. From the top of the tremie concrete the construction should proceed in the dry. An allowable bearing value of up to 480 kPa is recommended. Settlement of the foundation subsoil will take place due to the imposed footing pressure. This settlement will be elastic in nature and of negligible order.

Approach Fills

Up to 8.5 m high fills will be required along the approach to the structure. Part of the fill is already in place which was required for the construction of the existing approaches. Fills of this height will be stable with respect to a deep-seated failure. 2:1 forward and side slopes are recommended. The fill will induce settlement of the underlying subsoil. This settlement will take place during or immediately following placement and should not exceed 20-30 mm.


Benching will be required between the existing and new fill and should be constructed according to Standard DD-414.

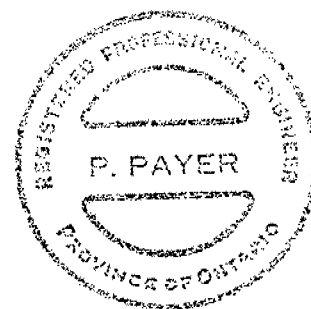
The fill material should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles have to be driven and it is recommended that this portion of the fill should not contain larger grain sizes than 75 mm.

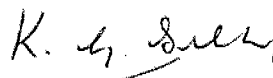
The forward slopes and the river bed in the vicinity of slopes should be protected against scour action of the river. Specific recommendations regarding this matter will be provided by the Hydrology Section.

MISCELLANEOUS

The fieldwork was carried out during the period of 71 03 01 to 71 04 14. The original report was written by Mr. B.T. Darch, Senior Engineer. The revised version was prepared by Mr. P. Payer, Senior Engineer.


P. Payer, P. Eng.
Senior Engineer




K.G. Selby, P. Eng.
Supervising Engineer

December, 1978

APPENDIX

RECORD OF BOREHOLE No 1

W P 213-77-03 LOCATION Sta 10+047.3 O/S 29.0 m Lt & Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE Washboring, NX & BX Casing, Bi Cone Bit, AXT Core COMPILED BY HR
DATUM Geodetic DATE 1971 02 24 Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
300.08	Ground Level																
0.00	Fill Material						300.00										
	Sandy silt to silty sand, trace of gravel & clay, occasional organic inclusions (0.10m thick)		1	SS	8												
			2	SS	6												
	Loose to Compact		3	TW	PM												
			4	SS	15												
	Brown		5	SS	9												
294.59							295.00										
5.49	Sand & gravel. Dense.		6	SS	48												
293.98			7	SS	105/	0.18m											
6.13	Glacial Till		8	SS	50/	0.03m											
	Het. Mixture of gravel sand & silt, trace of clay		9	SS	90/	0.15m											
	Very Dense																
	Reddish Brown		10	SS	100/	0.15m											
289.72							290.00										
10.36	Glacial Till		11	SS	110/	0.10m											
	Het. mixture of clayey silt, sand & gravel		12	SS	150/	0.05m											
	Hard																
	Grey		13	SS	90/	0.15m											
			14	SS	155/	0.28m											
283.62							285.00										
16.46	Dolomite Bedrock (Fractured)		15	RC AXT	Rec 7%												
282.09																	
17.99	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

W P 213-77-03 LOCATION Sta 10+036.8 0/S 9.1 m Lt of Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX,BX Casing, Bicone Bit, Cone Test COMPILED BY HR
DATUM Geodetic DATE 1971 03 01 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					
294.74	Ground Level												
0.00	Sand & gravel, layers of sandy silt(0.15m thick)												
293.22	Very Dense Brown		1	SS	95								
1.52	Glacial Till		2	SS	155/	0.28m		100/0.10m					
	Het. mix. of gravel, silt & sand, trace of clay		3	SS	125								25 31 34 10
	Very Dense		4	SS	170/	0.28m							
290.17	Reddish Brown		5	SS	155/	0.23m	290.00						9 37 44 10
4.57	Glacial Till		6	SS	160/	0.15m							
	Het. mix. of clayey silt, sand & gravel		7	SS	150/	0.08m							
	Hard												
	Grey												
285.35			8	SS	140/	0.23m							5 20 59 16
9.39	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

W P 213-77-03 LOCATION Sta 10+020.8 O/S 7.3 m I.R. & Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bicone & Tricone Bit COMPILED BY HR
DATUM Geodetic DATE 1971 03 02 CHECKED BY HR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
294.25	Ice Level																
0.00																	
292.73	River Bottom																
1.52	Sand & Gravel		1	SS	70												
1.83	Glacial Till		2	SS	105	0.20m											
	Het. Mix. gravel, sand & silt, trace of clay		3	SS	162												
	Very Dense Reddish Brown		4	SS	180		290.00										38 25 28 9
289.07			5	SS	150	0.10m											
5.18	Glacial Till		6	SS	150	0.13m											
	Het. Mix. of clayey silt, sand & gravel Hard		7	SS	100	0.03m											
	Grey																
284.80			8	SS	167		285.00										5 22 50 23
9.45	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

W P 213-77-03 LOCATION Sta 10+027.2 O/S 28.3 m Lr 6 Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bicone Bit, AXT Core COMPILED BY BR
DATUM Geodetic DATE 1971 03 03&04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES			20	40	60	80	100					
294.25	Ice Level																
0.00																	
292.73	River Bottom																
1.54	Sand & Gravel		1	SS	69												
1.77	Glacial Till		2	SS	200/	0.28m											
	Het. Mix. of gravel, sand, silt, trace of clay		3	SS	125												
	Very Dense Reddish Brown		4	SS	185												
289.07			5	SS	130/	0.15m											
5.18	Glacial Till		6	SS	150/	0.15m											
	Het. Mix. of clayey silt, sand & gravel		7	SS	150/	0.15m											
	Hard		8	SS	135/	0.15m	285.00										
	Grey		9	SS	150/	0.00m											
283.58	Bedrock - sandy		10	RC	Rec												
282.82	dolomite Sound			AXT	75%												
11.43	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5

W P 213-77-03 LOCATION Sta 9+971.4 O/S 18.6 m Lt 7 Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bi & Tri Cone Bits, Cone Test COMPILED BY HR
DATUM Geodetic DATE 1971 03 18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
293.80	Ice Level																
0.00																	
292.90																	
0.90	Sand & gravel, trace of silt		1	SS	36												
	Compact to Very Dense Black		2	SS	12												
290.47			3	SS	77												
3.33	Sand		4	SS	88												
289.69	Very Dense Brown						290.00										0 76 (24)
4.11	Glacial Till-Het. mix. sand, silt & gravel		5	SS	166												42 46 (12)
288.34	V. Dense Reddish Brown		6	SS	126/	0.20m											
5.46	Glacial Till		7	SS	150/	0.20m											
	Het. mix. of clayey silt, sand and gravel		8	SS	125/	0.13m											9 32 49 10
	Hard		8A	SS	150/	0.08m	285.00										
284.08	Grey		9	SS	105/	0.13m											
9.72	End of Borehole Probable Bedrock																



RECORD OF BOREHOLE No 6

W P 213-77-03 LOCATION Sta 9+955.8 O/S 29.0m Lt. of Hwy 7 ORIGINATED BY HW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & Bi Cone Bits, AXT Core, Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 19 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
295.05	Ground Level																
0.00	Traces of organic silt		1	SS	18		295.00										
293.83			2	SS	14												
1.22	Sand & Gravel		2A	SS	7												
	Loose to Compact		3	SS	6												
	Brown		4	SS	8												51 45 (4)
290.48			5	SS	83		290.00										
4.57	Glacial Till-Het. mix. silt, sand & gravel		6	SS	155	0.28 m											47 42 (11)
288.95	Very Dense Brown		7	SS	156	0.20 m											
3.10	Glacial Till		8	SS	152	0.20 m											
	Het. Mix. clayey silt, sand & gravel		9	SS	135	0.20 m											5 30 55 10
	Hard		9A	SS	100	0.20 m	285.00										
284.23			10	RC	Rec												
10.82	Bedrock-Dolomite																
282.86	Pitted in upper 0.45 m Sound																
12.19	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6A

W P 213-77-03 LOCATION Sta 9+955.8 O/S 16.8 m Lt. of Hwy 7 ORIGINATED BY JW
 DIST 3 HWY 7 BOREHOLE TYPE Dynamic Cone Test COMPILED BY HR
 DATUM Geodetic DATE 1971 03 22 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
295.20	Ground Level																
0.00	Probably Sand & Gravel																
291.69																	
3.51	Probable																
290.63	Glacial Till																
4.57	End of Cone Test																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

W P 213-77-03 LOCATION Sta 9+954.9 0/S 5.8 m Rt. C Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & Bi Cone Bits, AXT Core, Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 16 CHECKED BY J

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
294.74	Ground Level																
0.00	Sandy silt, trace of shells																
293.37	Very Loose Brown		1	SS	2												0 59 35 6
1.37	Sand & gravel, trace of silt		2	SS	10												
	Compact to Very Dense Grey		3	SS	64												50 40 (10)
291.08			4	SS	112												2 81 (17)
3.66	Uniform sand		5	SS	153												
290.02	Very Dense Brown		6	SS	185												
4.72	Glacial Till-Het. mix. silt, sand & gravel		7	SS	123												
	Trace of clay		8	SS	150												
288.34	Very Dense Brown		9	SS	150												
6.40	Glacial Till																
	Het. mix. of clayey silt, sand & gravel																
	Hard																
	Grey																7 25 53 15
284.38																	
10.36	Bedrock-Pitted Dolomite		10	RC	Rec												
283.16	Fractured Grey																
11.58	Shaley Dolomite		11	RC	Rec												
281.94	Fractured Grey																
12.80	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

W P 213-77-03 LOCATION Sta 9+925.2 O/S 18.6 m Lt of Hwy 7 ORIGINATED BY JW
 DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing Tri & Bi Cone, Core COMPILED BY HR
 DATUM Geodetic DATE 1971 03 22 CHECKED BY /

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
293.83	Ground Level																GR SA SI CL
0.00	Traces of organic silt																
292.00	Compact Black		1	SS	23												54 39 (7)
1.83			2	SS	76												
	Sand & gravel		3	SS	79	0.23m											
	Very Dense		4	SS	79												
288.95	Brown		5	SS	135		290.00										50 39 (11)
4.88	Het. mix. silt, sand & gravel		6	SS	150	0.10m											
288.04	Very Dense Brown		7	AXT	-												
5.79	Glacial Till		8	SS	160	0.15m											13 35 41 11
	Het. mix. of clayey silt, sand & gravel																
	Hard Grey						285.00										
284.23			9	SS	100	0.15m											
9.60	End of Borehole Probable Bedrock																



RECORD OF BOREHOLE No 9

W P 213-77-03 LOCATION Sta 9+907.6 0/5 0.6 m Lt & Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing Tri & Bi Cone Bits, Dynamic Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 15 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
293.92	Ice Level													
293.46	River Bottom													
0.46	Fill Material-clayey silt with sand & gravel Very Dense Grey		1	SS	70									
292.39														
1.53	Sand & gravel		2	SS	52									
	Very Dense Brown		3	SS	82									
290.41														
3.51	Layers of clayey silt up to 0.10m thick		4	SS	170/	0.28m	290.00							66 27 (7)
289.20														
4.72	Glacial Till-Het mix. silt, sand & gravel, trace of clay		5	SS	150									
	Very Dense Reddish Brown		6	SS	185/	0.20m								8 39 41 12
287.67														
6.25	Glacial Till Het mix. of clayey silt sand & gravel		7	SS	135/	0.18m								
	Hard Grey		8	SS	153/	0.28m								7 20 53 20
284.53														
9.39	End of Borehole Probable Bedrock		9	SS	145/	0.25m	285.00							

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10

W P 213-77-03 LOCATION Sta 9+897.6 O/S 28.3 m. Lt. 7 Hwy 7 ORIGINATED BY JW
 DIST 3 HWY 7 BOREHOLE TYPE NX Casing, Tri & B1 Cone Bits, BXT Core, Cone COMPILED BY HR
 DATUM Geodetic DATE 1971 03 23 CHECKED BY HR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
295.35	Ground Level																
0.00	Traces of organic silt																
294.13			1	SS	24												
1.22			2	SS	69												
	Sand & Gravel		3	SS	84												50 38 (12)
	Some silt		4	SS	130												56 37 (7)
290.32			5	SS	60												
5.03	Layers of uniform sand up to 0.20m thick		6	SS	154												
288.95	Glacial Till-Het. mix. silt, sand & gravel		7	SS	140	0.10m											
6.40	Very Dense Brown		8	SS	150	0.23m											
287.58	Glacial Till Het. mix. clayey silt, sand & gravel occasional boulders up to 0.30m in size throughout		9	SS	100	0.18m											
7.77			10	EX	50%												
			11	EX	17%												
284.07	Hard Grey Bedrock Dolomite		12	EX													
283.77																	
11.58	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 11

W P 213-77-03 LOCATION Sta 10+017.2 O/S 18.8 m Lt of Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-Washboring & Cone Test COMPILED BY WH
DATUM Geodetic DATE 1971 03 31 & 04 01 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
293.83	Water Level																
0.00																	
292.30	River Bottom																
1.53	Sand & gravel		1	SS	161												
291.54	Very Dense Brown																
2.29	Glacial Till-Het. mix. silt, sand & gravel, trace of clay Very Dense Reddish Brown		2	SS	83												
289.72			3	SS	150												
4.11			4	SS	130/	0.20m											
	Het. mix. clayey silt, sand & gravel		5	SS	150/	0.10m											
			6	SS	150/	0.13m											
	Occ. boulders up to 0.40 m in size below el. 943		7A	RC BX	-												
			7	SS	125/	0.13m											
			8	BX	5%												
	Hard Brown		9	RC BX	-												
284.53	End of Borehole Probable Bedrock						Encountered										
9.30																	



RECORD OF BOREHOLE No 12

W P 213-77-03 LOCATION Sta 9+986.3 O/S 29.0 m Lt. Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-Washboring & Cone Test COMPILED BY WH
DATUM Geodetic DATE 1971 03 30&31 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
293.83	Water Level																
0.00																	
292.82	River Bottom																
1.01			1	SS	60												
	Sand & Gravel		2	SS	36												
	Some silt		3	SS	32												
	Dense to Very Dense		4	WS	-												
	Brown		5	SS	142												
289.01			6	SS	190/	0.23m											
4.82	Glacial Till		7	SS	150/	0.08m											
	Het. mix. of clayey silt, sand & gravel		8	RC BX	Rec 25%												
	Occ. boulders up to 0.10m in size		9	SS	-												
284.68	Hard Grey		10A	SS	152/	0.13m	285.00										
284.35	Bedrock Dolomite		10	BX	80%												
9.48	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 13

W P 213-77-03 LOCATION Sta 9+929.6 O/S 6.4 m Rt 7 Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-Washboring & Cone Test COMPILED BY WH
DATUM Geodetic DATE 1971 04 05&06 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
295.05	Ground Level													
0.00	Sandy silt. Traces of organic silt													
294.13														
0.92	Sand & gravel		1	SS	12									
	Trace of White Shells		2	SS	1									
			3	SS	16									
	Very Loose to Compact Brown		4	SS										
290.63			5	SS	115									
4.42	Uniform Sand		6	SS	108									
	Trace of gravel													
288.65	Very Dense Brown		7	SS	150/	0.10m								
6.40	Glacial Till-Het. mix. silt, sand, gravel. Trace of clay Very Dense													
287.43			8	SS	150/	0.15m								
7.62	Het. mix. of clayey silt, sand & gravel													
285.91	Hard Grey		9	SS	130/	0.15m								
9.14	End of Borehole													



RECORD OF BOREHOLE No 14

W P 213-77-03 LOCATION Sta 10+053.7 O/S 7.6 m Rt. of Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bi & Tricone Bit, AXT Core, Cone COMPILED BY JHR
DATUM Geodetic DATE 1971 03 04, 05, 08 & 09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
300.62	Ground Level																
0.00	Fill Material		1	SS	14		300.00										
	Sand & gravel		2	SS	11												
	Some silt		3	SS	15												
	Compact to Dense		4	SS	15												
	Brown																41 40 18 1
296.05	Sand & gravel		5	SS	42												
4.57	Dense to Very Dense		6A	SS	107		295.00										
294.22	Brown		6	SS	56												
6.40	Glacial Till		7	SS	174	0.25m											
	Het. mix. of silt, sand & gravel, trace of clay		8	SS	151												
	Very Dense																
289.80	Reddish Brown		9	SS	250	0.25m	290.00										
10.82	Glacial Till		10	SS	200	0.10m											
	Het. mix. of clayey silt, sand & gravel		11A	SS	200	0.13m											
	Hard		11	SS	155	0.15m											
	Grey		12	SS	220	0.28m											
284.83	Bedrock-Dolomite		13	RC	67	0.03m	285.00										
15.79	chertified layers up to 0.05m thick		14	RC	100												
	Sound Grey		15	RC	100												
282.73	End of Borehole		16	RC	80												
17.89																	



RECORD OF BOREHOLE No 15

W P 213-77-03 LOCATION Sta 9+889.5 O/S 7.9 m L.E. of Hwy 7 ORIGINATED BY WJI
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & Bi Cone Bits, AXT Core, Cone COMPILED BY WJI
DATUM Geodetic DATE 1971 03 10, 11 & 12 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L		
300.72 0.00	Ground Level													
	Fill Material		1	SS	16		300.00							
	Sand & gravel		2	SS	8									37 50 (13)
	Trace of silt		3	SS	15									
	Loose to Compact		4	SS	14									
	Brown to Grey		5	SS	11									45 46 (9)
295.23 5.49	Sand & gravel		6	SS	39		295.00							57 33 9 1
	Trace of silt		7	SS	145/	0.28m								
	Dense to Very Dense		8	SS	107									46 40 13 1
292.19 8.53	Clayey silt, traces of sand and gravel		9	SS	46									
	Reddish Brown Hard		10	SS	141/	0.23m	290.00							17 48 31 4
289.44 11.28	Glacial Till		11	SS	200									
288.53 12.19	Very Dense		12	SS	205/	0.25m								9 35 40 16
	Glacial Till		13	RC	28%									
	Het. mix. of clayey silt, sand & gravel		14	SS	197/	0.23m								
	Grey Hard		15	SS	150/	0.15m								
	Boulders 0.15m in size at el. 943		16	SS	195/	0.28m								5 32 49 14
284.87 15.85	Bedrock Dolomite			RC	Rec		285.00							
283.49 17.23	Sound Grey		17	AXT	85%									
	End of Borehole													

RECORD OF BOREHOLE No 16

W P 213-77-03 LOCATION Sta 9+930.6 O/S 29.9 m I.E. Hwy 7 ORIGINATED BY JDW
 DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
 DATUM Geodetic DATE 1971 04 07&08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L		
295.96	Ground Level													GR SA SI CL
0.00	Silty sand to sand													
	Brown		1	SS	7		295.00							
	Occ. grey sandy silt pockets Loose		2	SS	7									
292.91			3	SS	23									
3.05	Sand and gravel Trace of silt		4	SS	47									
	Brown		5	SS	55									
290.47	Compact to Very Dense		6	SS	81									
5.49	Glacial Till- Het. mix. of gravel, sand, silt and clay		7	SS	145		290.00							
288.19	Brownish Very Dense		8	SS	160	0.20m								
7.77	Glacial Till		9	SS	140	0.20m								
	Het. mix. of clayey silt, sand and gravel		10	SS	170	0.18m								
	Grey		11	SS	125		285.00							
284.07	Hard													
11.89	End of Borehole Probable Bedrock													

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 17

W P 213-77-03 LOCATION Sta 9+983.0 O/S 5.8 m I.R. of Hwy 7 ORIGINATED BY JDW
 DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
 DATUM Geodetic DATE 1971 04 12&13 CHECKED BY J

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
295.05	Water Level															
0.00																
291.39	River Bottom															
291.08	Sand & gravel		1	SS	52											
3.97	Silty sand to sand with gravel		2	SS	89											
	Red to Brown		3	SS	111											
289.26	Dense to Very Dense		4	SS	1507	0.18m										
5.79	Glacial Till		5	SS	1507	0.15m										
	Het. mix. clayey silt, sand & gravel		6	SS	1507	0.08m										
286.73	Hard Grey															
8.32	End of Borehole															

+3, x5: Numbers refer to
Sensitivity.

20
15-5 (%) STRAIN AT FAILURE
10



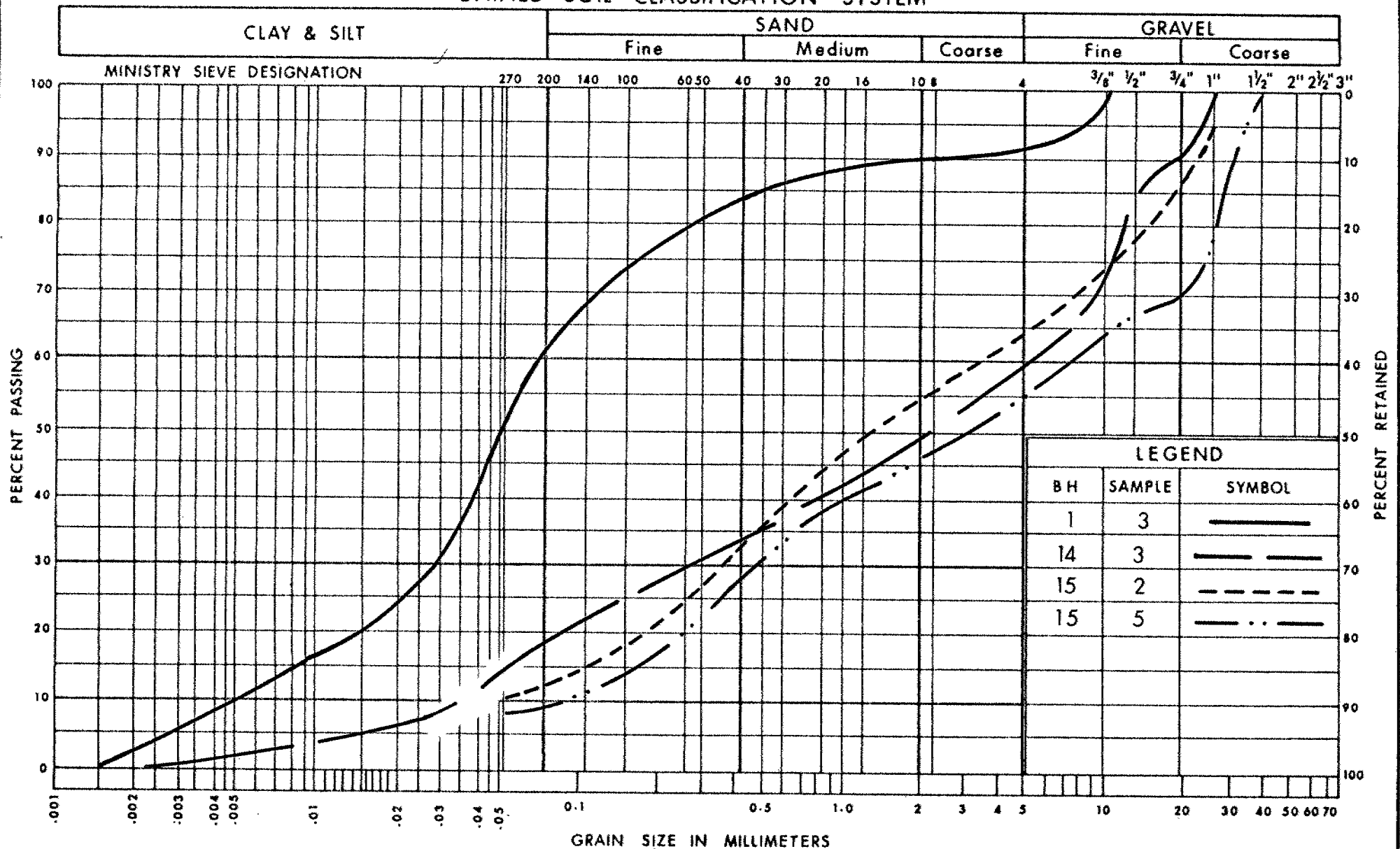
RECORD OF BOREHOLE No 18

W P 213-7/-03 LOCATION Sta 10+010.8 O/S 5.8 m Lt & Hwy 7 ORIGINATED BY JDW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
DATUM Geodetic DATE 1971 04 13&14 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
295.35	Water Level																
0.00																	
290.78	River Bottom																
290.47	Sand & gravel		1	SS	56												
4.88			2	SS	304												
	Glacial Till		3	SS	140												
288.95	Very Dense																
6.40			4	SS	1507	0.23m											
	Glacial Till		5	SS	1507	0.10m											
	Het. mix. clayey silt, sand & gravel		6	SS	1507	0.13m											
286.02	Hard Grey		7	SS	1507	0.18m											
9.33	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



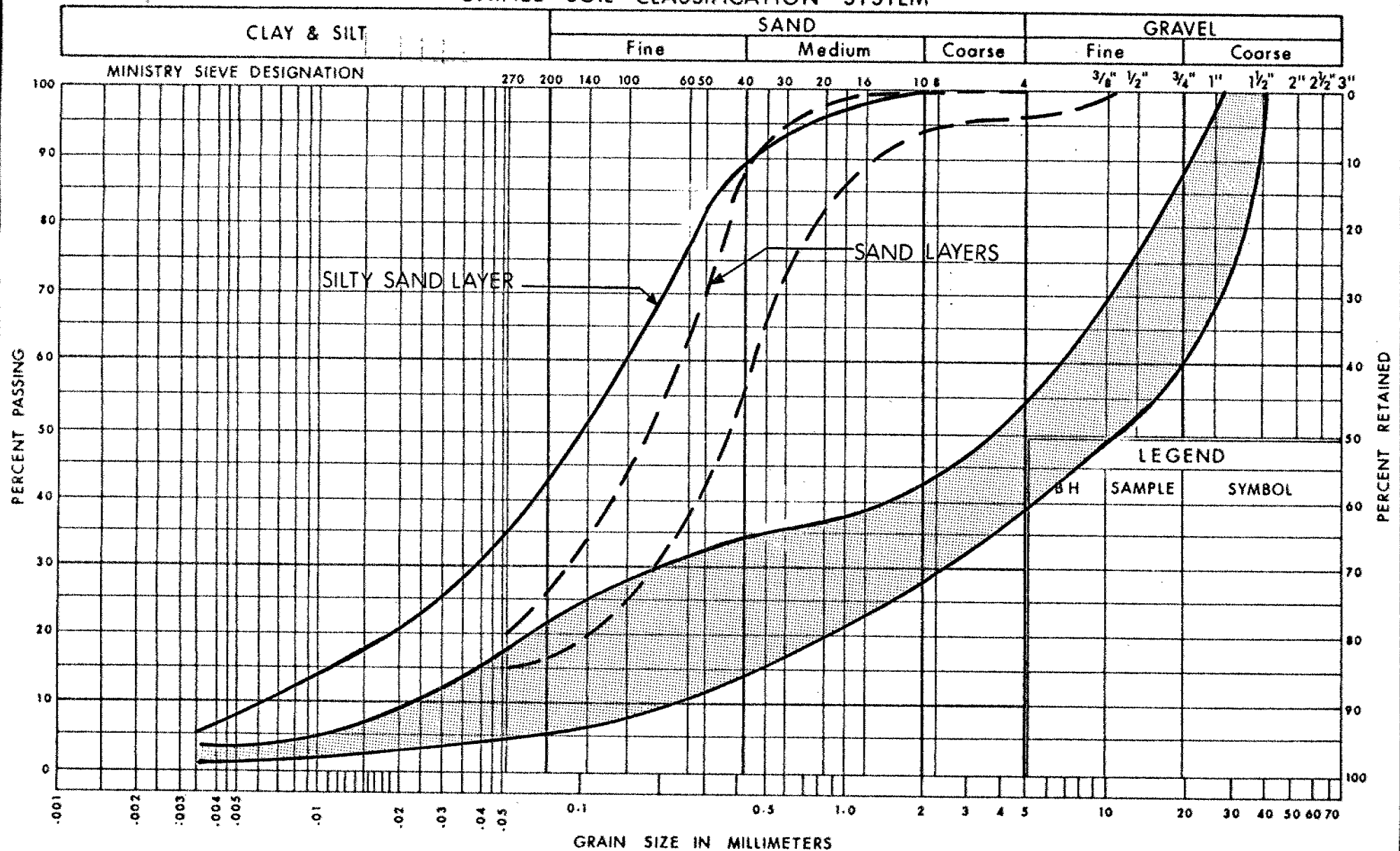
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL MATERIAL
SANDY SILT TO SILTY SAND

FIG No 1

W P 213-77-03

UNIFIED SOIL CLASSIFICATION SYSTEM



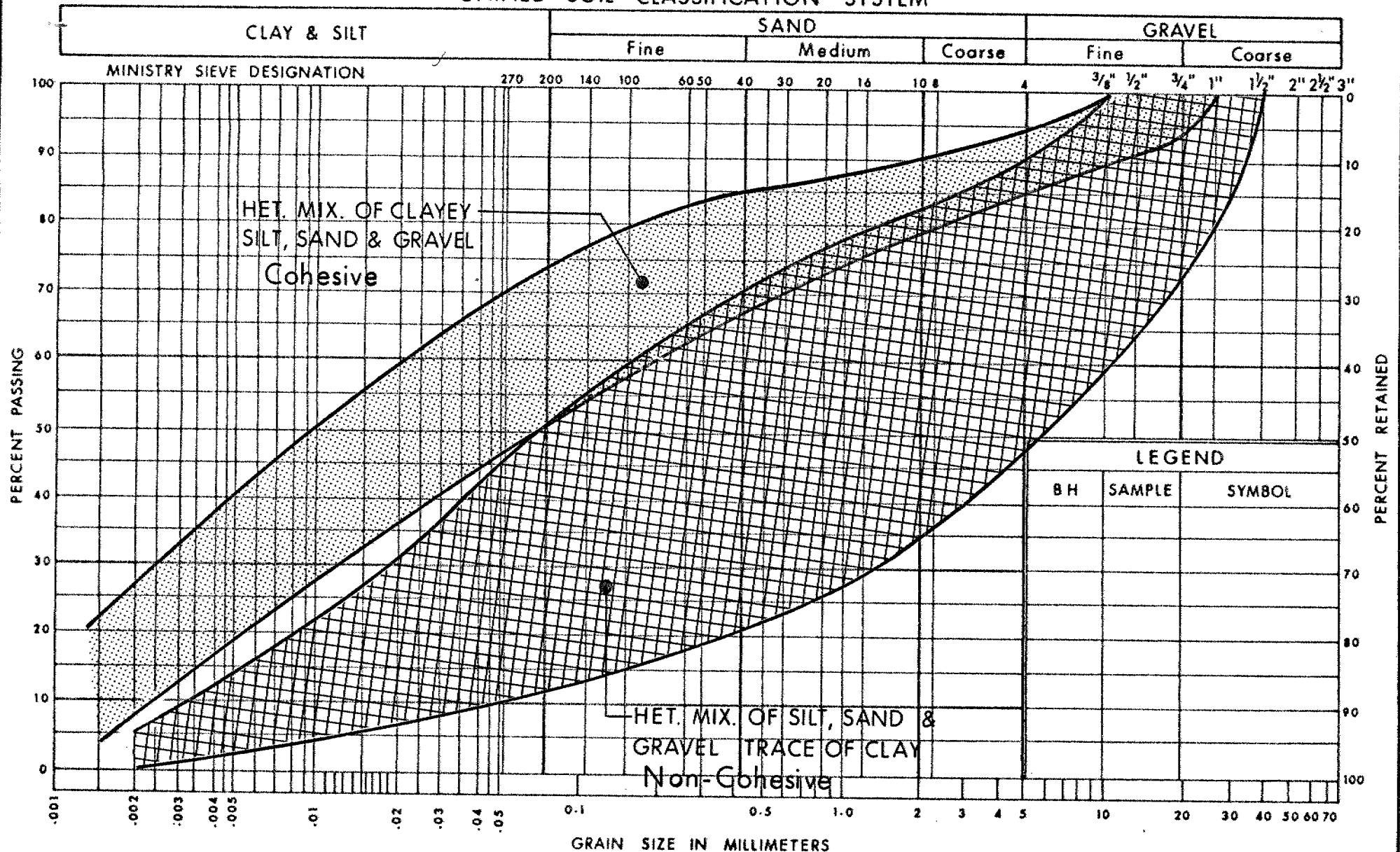
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION SAND & GRAVEL

FIG No 2

W P 213-77-03

UNIFIED SOIL CLASSIFICATION SYSTEM

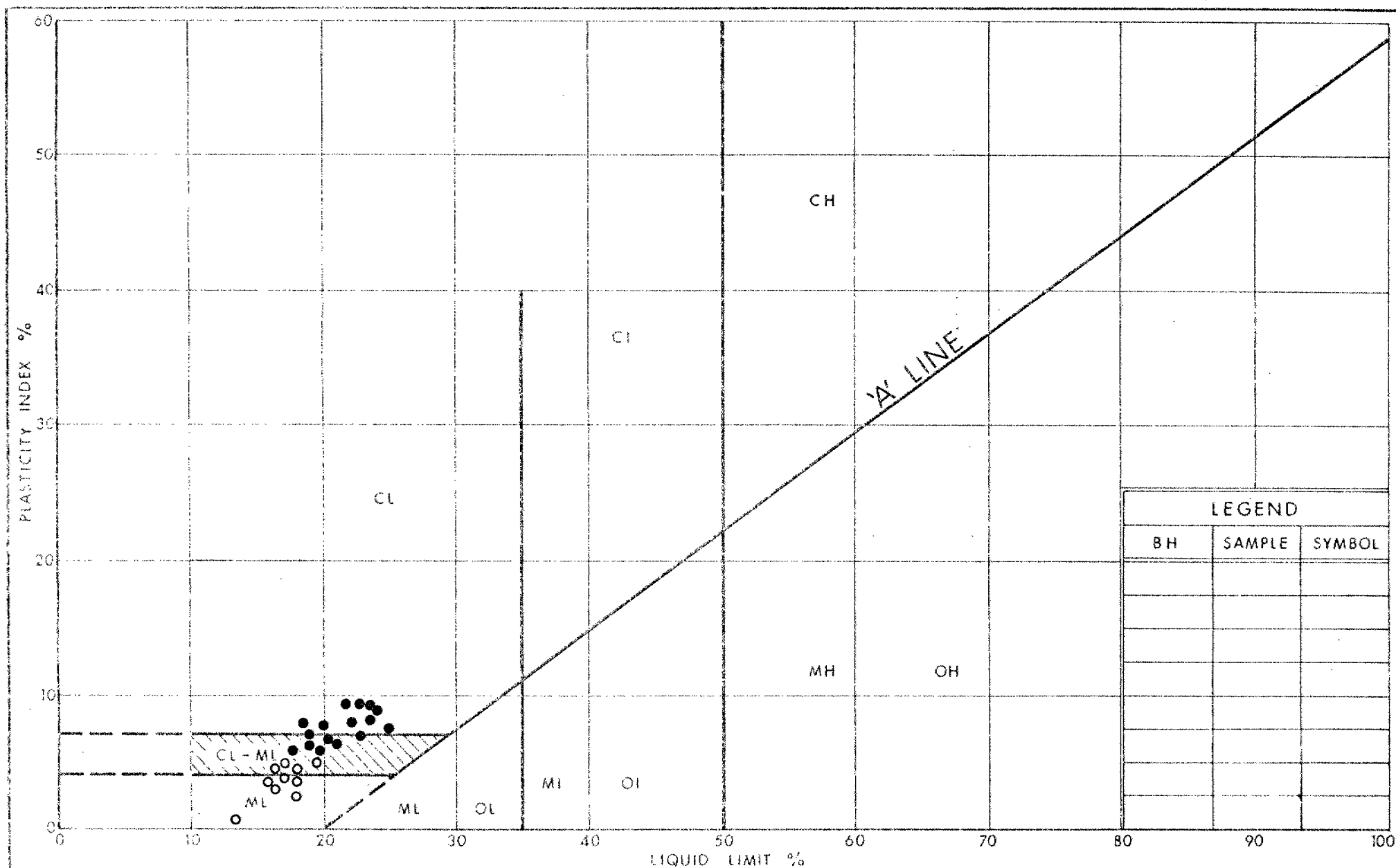


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GLACIAL TILL

FIG No 3

W P 213-77-03



Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART GLACIAL TILL

● COHESIVE

○ NON-COHESIVE

FIG No 4

W P 213-77-03

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS SPLIT SPOON	TP THINWALL PISTON
WS WASH SAMPLE	OS OSTERBERG SAMPLE
ST SLOTTED TUBE SAMPLE	RC ROCK CORE
BS BLOCK SAMPLE	PH TW ADVANCED HYDRAULICALLY
CS CHUNK SAMPLE	PM TW ADVANCED MANUALLY
TW THINWALL OPEN	FS FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

PHYSICAL PROPERTIES OF SOIL

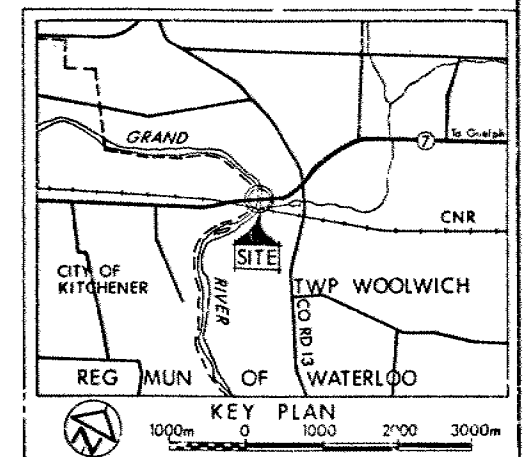
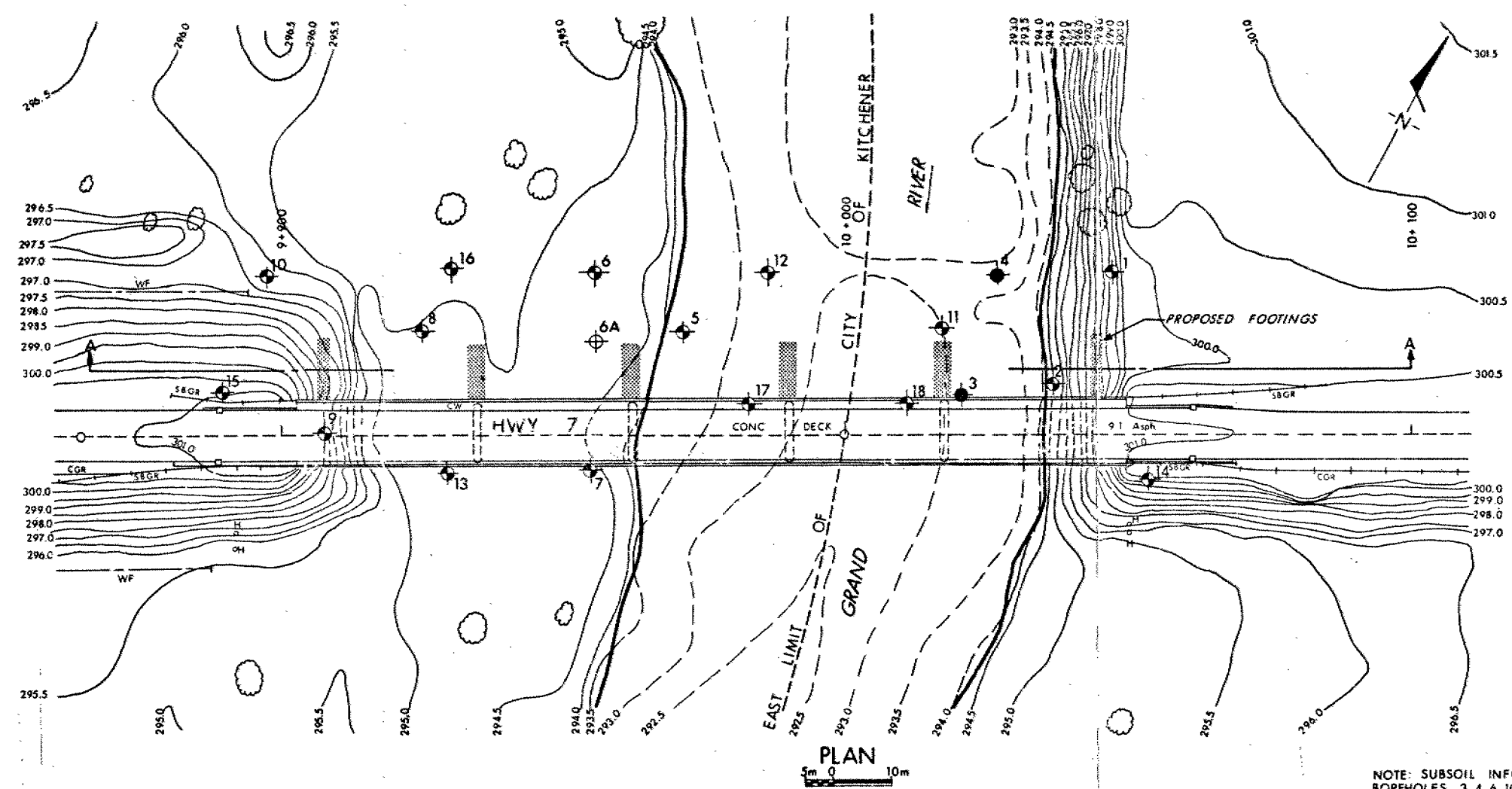
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC

CONT No
WP No 213-77-03

GRAND RIVER BRIDGE
(3.3 km East of Frederick St, Kitchener)
BORE HOLE LOCATIONS & SOIL STRATA

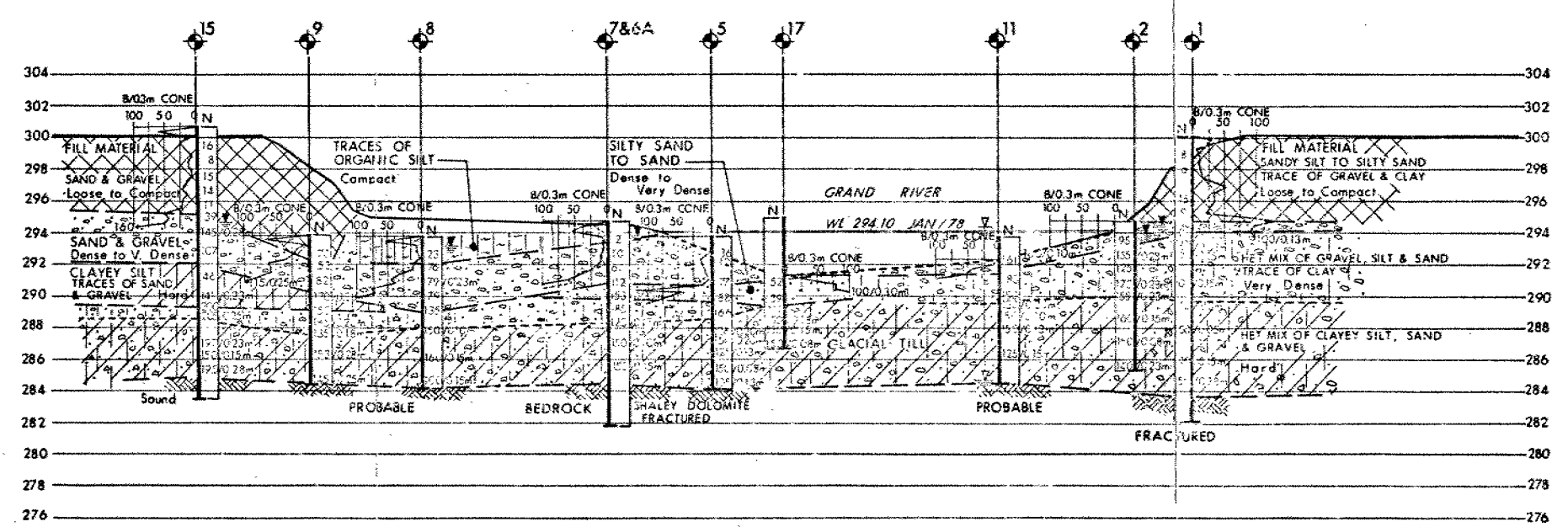
SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1971 03 & 04
- Head ARTESIAN WATER
- Encountered

NOTE: SUBSOIL INFORMATION FOR BOREHOLES 3, 4, 6, 10, 12, 13, 14, 16 & 18 SEE RECORD OF BOREHOLES



No	ELEVATION	STATION	OFFSET
1	300.08	10+047.3	29.0m LT
2	294.74	10+036.8	9.1m LT
3	294.25	10+020.8	7.3m LT
4	294.25	10+027.2	28.3m LT
5	293.80	9+971.4	18.6m LT
6	295.05	9+955.8	29.0m LT
6A	293.20	9+955.8	16.8m LT
7	294.74	9+954.9	5.8m RT
8	293.83	9+925.2	18.6m LT
9	293.92	9+907.6	0.6m LT
10	295.35	9+897.6	28.3m LT
11	293.83	10+017.2	18.8m LT
12	293.83	9+986.3	29.0m LT
13	295.05	9+929.6	6.4m RT
14	300.62	10+053.7	7.6m RT
15	300.72	9+889.5	7.9m LT
16	295.96	9+930.6	29.9m LT
17	295.05	9+983.0	5.8m LT
18	295.35	10+010.8	5.8m 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.

REVISIONS	DATE	BY	DESCRIPTION

1

INDEX

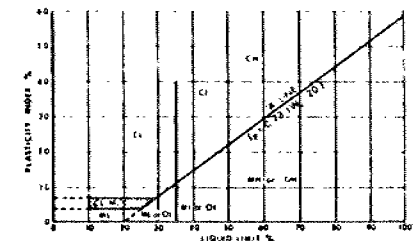
<u>Page No.</u>	<u>Description</u>
1	Index
2	Soil Classification System
3	Abbreviations and Symbols
4-32	Foundation Investigation Report
	Grand River Bridge
	Site 33-100
	W.P. 213-77-03

NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

M.T.C. SOIL CLASSIFICATION

M.T.C. SOIL CLASSIFICATION														
FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75mm AND BASING FRACTIONS ON ESTIMATED MASS)						GRP SYMP	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA					
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75µm VISIBLE TO THE NAKED EYE	GRAVELS	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE			GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESES	DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 µm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SM, SP MORE THAN 12% GM, GC, SM, SC 5% TO 12% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS					
			PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES							
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES							
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES							
	SANDS	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES			SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES	FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.	$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4 $C_c = \frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 6 ABOVE A-LINE WITH I_p BETWEEN 6 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 $C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6 $C_c = \frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 6 ABOVE A-LINE WITH I_p BETWEEN 6 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7					
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			SP	POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES							
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES							
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES							
							IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 µm							
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75µm (75µm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE)	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			GIVE TYPE, NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES.	FOR UNDISTURBED SOILS AND INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS					
			NONE	QUICK	NONE	ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR							
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM	CL	SILTY CLAYS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS							
			SLIGHT TO MEDIUM	SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS							
			LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MH						INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS	
				HIGH	NONE	MEDIUM TO HIGH	CS						SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY	
		SLIGHT TO MEDIUM		VERY SLOW	SLIGHT	CI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY							
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS							
			HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS							
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY							
			HIGHLY ORGANIC SOILS											
			READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE											
						PE	PEAT & OTHER HIGHLY ORGANIC SOILS							

USE GRAIN SIZE CURVE IN IDENTIFYING THE FUNCTIONS AS GIVEN UNDER FIELD IDENTIFICATION



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GM/GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

EXPLANATION OF TERMS USED IN REPORT

3

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w_p - w_s}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

For

Grand River Bridge
3.3 km East of Frederick Street, Kitchener
W.P. 213-77-03, Site 33-100
Hwy. 7, District 3, Stratford

INTRODUCTION

A foundation investigation was carried out in 1971 for the proposed major reconstruction programme at the crossing of Hwy. 7 and Grand River. The proposal involved the construction of a new bridge on the existing alignment and also the erection of a temporary detour structure located some 17 m north. The actual construction work commenced in 1972 and upon completion the new bridge was opened for traffic. Since that time it became evident that an additional structure is required to cope with the increased density of traffic. The existing structure will carry the eastbound traffic and the proposed new bridge the westbound vehicles. The Soil Mechanics Section reviewed the original foundation investigation and it was concluded that no additional borings are required.

This report was prepared from the original foundation investigation report (W.P. 194-63-00, issued on 71 05 12) and contains basically the same information. It should be noted that the units of measurements were changed from the imperial system to international system (SI) also known as the metric system.

SITE DESCRIPTION

The site is located 3.3 km east of Frederick Street, Kitchener at the crossing of Hwy. 7 and Grand River. The south flowing Grand River meanders across the gently rolling terrain. The river channel, during periods of normal flow, varies from 45 m to 60 m within the vicinity of the site. The south bank of the river is relatively flat and low-lying, while the north bank has an over-all slope of about 2:1, the crest being some 10 m over the river bed.

The site is situated in the physiographic region known as the 'Waterloo Hills'. In the vicinity of the site the terrain is covered by kame moraines with outwash sands occupying the intervening hollows. The overburden is underlain by dolomite bedrock of the salina formation, Silurian period.

SUBSURFACE CONDITIONS

General

The predominant stratum across the site is composed of a competent glacial till which varies from 4 m to 10.5 m in thickness. The glacial till is overlain by a surficial spillway deposit of loose to very dense sand and gravel. The thickness of this deposit ranges from 0.5 m to 6.5 m. The overburden sequence is underlain by sandy dolomite bedrock. The fill material of the existing approaches is composed of primarily silty sand and gravel.

It is pointed out that due to the construction activity which has taken place at this site since the original field investigation, the thickness of the fill may have been changed.

The boundaries of the various deposits are shown on the appended Record of Borehole Sheets and an estimated stratigraphical profile is shown on Drawing #2 of the contract drawings.

The subsoil and bedrock encountered from ground surface downward is presented in the subsections to follow.

Fill Material

Up to 5.5 m of fill was encountered at those borings put down along the approaches to the existing structure. The fill was primarily composed of a silty sand to sand and gravel. At B.H. #9, however, the fill material is a clayey silt with some sand and gravel. Occasional seams of organic silt up to 6 mm thick, are present throughout the fill. Grain size distribution curves for samples obtained from the fill are plotted on Figure #1 in the Appendix to this report.

Standard penetration testing was carried out within the fill material; the values obtained are plotted on the Record of Borehole Sheets. The results gave 'N' values which range from 6 to 15

blows/0.3 m. Based on this testing it is estimated that the fill has been subjected to a moderate degree of compaction.

Spillway Deposit - Silty Sand and Gravel

The surficial deposit across the site is composed of a sand and gravel with a trace to some silt. The thickness of this deposit ranges from 0.3 m to 6.5 m; it is most extensive on the west bank of the river, tapering off in an easterly direction. Traces of organic silt were often encountered in the upper 1.5 m of the deposit; further, the lower 1 m is periodically composed of a uniform sand. In addition, occasional sandy silt seams, up to 0.1 m in thickness, are present throughout, as well as random clayey silt layers up to 1 m thick. Grain size distribution curves for samples obtained from the granular spillway deposit are plotted on Figure #2.

Standard penetration testing was carried out within the granular deposit. The 'N' values obtained generally range between 23 blows/0.3 m and 150 blows for 0.1 m. Based on these results, it is estimated that the relative density of the sand and gravel varies from compact to very dense. An exception to this pattern occurs along the west bank in the immediate vicinity of the river (refer to B.H.'s #6, 7 and 13). Here the 'N' values in the upper portion of the deposit range from 1 to 18 blows/0.3 m indicating a relative density which varies from very loose to compact. The topography in this area would seem to indicate that this was once part of the old river channel. If this is the case, it could be inferred that the lower relative densities would be indicative of 'reworking' of the material by the scour action of the river.

Glacial Till

The granular spillway deposit is underlain by the predominant stratum across the site which is composed of a glacial till. The thickness of the till sheet varies from 4 m to 10.5 m being most extensive in those areas where the surficial deposits are thinnest - i.e., on the east bank of the river. The upper 1 to 4.5 m of the stratum is reddish-brown in colour; below this zone the till is grey; the transition between the zones is clearly indicated on the borelog sheets. The upper reddish-brown zone is basically granular, being composed of silt, sand and gravel with a trace of clay. The lower portion, however, is primarily cohesive in

nature - i.e., it has a matrix of clayey silt binding sand and gravel. Boulders were encountered in the lower portion of the stratum (generally below elevation 287 at B.H.'s 10, 11, 12 and 15. These boulders ranged up to 0.4 m in size.

Atterberg Limit Tests were performed on samples of the glacial till; the results are plotted on the borelog sheets, as well as on the Plasticity Chart, Figure #4. The testing is summarized in the following table:

		Upper Zone (Reddish-Brown)	Lower Zone (Grey)
Liquid Limit	(W _L) %	13-17	17-24
Plastic Limit	(W _p) %	11-13	12-15
Natural Moisture Content	(W) %	7-10	9-17

Based on these results it is estimated that the upper reddish-brown zone is basically non-plastic - i.e., granular type of material. The testing carried out in the lower grey zone, however, would indicate that in this area the till is composed of an inorganic soil of low plasticity.

Standard penetration testing carried out within this stratum gave 'N' values which were consistently greater than 100 blows/0.3 m; these values are summarized on the borelog sheets. Based on this testing, it is estimated that the relative density of the upper granular portion of the glacial till is very dense. The lower cohesive zone would have a hard consistency.

Dolomite Bedrock

Grey dolomite bedrock was encountered below the glacial till. The bedrock was proven at 8 of the boring locations by obtaining up to 2.5 m of AXT size rock core samples. The surface of the bedrock varies between elevations 283.6 and 284.5, which corresponds to depths of between 8 m and 11 m below the original ground surface.

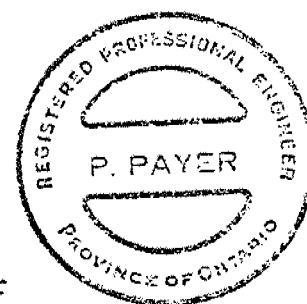
The bedrock was generally found to be in a sound condition as evidenced by the high percentage of rock recovery. At a few isolated boring locations, however, specifically B.H.'s #1 and 7, the upper 1.5 m is in a fractured condition.

Groundwater Conditions

Groundwater level observations have been carried out during the period of the investigation by recording the water levels in the open holes. The results of the measurements indicate that the piezometric groundwater level within the overburden generally varies between elevations 293.8 and 295.2 which corresponds to depths of 0.5 to 1.5 m below the original ground surface in the area. The river water level at the time of the investigation varied from elevation 293.8 (normal flow conditions) to 295.4 (spring run-off).

At B.H. #11 put down through the river bottom, an artesian water pressure was encountered. The artesian pressure occurred once the casing was advanced into a bouldery zone located near the base of the glacial till stratum (at about elevation 285). Once this zone was penetrated the water rose instantaneously in the casing eventually stabilizing itself at about elevation 294.4 which is about 0.6 m above the river level. This lower bouldery zone is more pervious than the overlying basically cohesive part of the glacial till. It is inferred that this zone is acting as a confined aquifer which is being charged with groundwater from the higher surrounding terrain. Artesian conditions were not encountered anywhere else during the drilling programme. It is believed, however, that such conditions may exist at other isolated locations where a similar stratigraphical sequence exists, particularly within the low-lying river channel.

P. Payer, P. Eng.
Foundations Engineer



K.G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX



RECORD OF BOREHOLE No 1

METRIC

W P 213-77-03 LOCATION Sta 10+047.3 O/S 29.0 m Lt 6 Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE Washboring, NX & BX Casing, Bi Cone Bit, AXT Core COMPILED BY HR
DATUM Geodetic DATE 1971 02 24 Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
300.08	Ground Level															
0.00	Fill Material															
	Sandy silt to silty sand, trace of gravel & clay, occasional organic inclusions (0.10m thick)		1	SS	8											
			2	SS	6											
	Loose to Compact		3	TW	PM											
			4	SS	15											
	Brown		5	SS	9											
294.59																
5.49																
293.98	Sand & gravel, Dense.		6	SS	48											
			7	SS	106/	0.18m										
6.10	Glacial Till		8	SS	50/	0.03m										
	Het. Mixture of gravel sand & silt, trace of clay		9	SS	90/	0.15m										
	Very Dense															
	Reddish Brown		10	SS	100/	0.15m										
289.72																
10.36	Glacial Till		11	SS	110/	0.10m										
	Het. mixture of clayey silt, sand & gravel		12	SS	150/	0.05m										
	Hard															
	Grey		13	SS	90/	0.15m										
			14	SS	155/	0.28m										
283.62																
16.46	Dolomite Bedrock (Fractured)		15	RC AXT	Rec 7%											
282.09																
17.99	End of Borehole															

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC

W P 213-77-03 LOCATION Sta 10+036.8 O/S 9.1 m Lt of Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX, BX Casing, Bicone Bit, Cone Test COMPILED BY HR
DATUM Geodetic DATE 1971 03 01 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
294.74	Ground Level													
0.00	Sand & gravel, layers of sandy silt(0.15m thick)		1	SS	95		0.28m		100/0.10m				25 31 34 10	
293.22	Very Dense Brown		2	SS	155/									
1.52	Glacial Till Het. mix. of gravel, silt & sand, trace of clay		3	SS	125									
	Very Dense Reddish Brown		4	SS	170/									
290.17			5	SS	155/	0.23m	290.00						9 37 44 10	
4.57	Glacial Till Het. mix. of clayey silt, sand & gravel		6	SS	160/	0.15m								
	Bard		7	SS	130/	0.08m								
	Grey		8	SS	140/	0.23m							5 20 59 16	
285.35														
9.39	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3

METRIC

W P 213-77-03 LOCATION Sta 10+020.8 O/S 7.3 m Lt. 2 Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bicone & Tricone Bit COMPILED BY HR
DATUM Geodetic DATE 1971 03 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
294.25	Ice Level																
0.00																	
292.73	River Bottom																
1.52	Sand & Gravel		1	SS	70												
1.83	Glacial Till		2	SS	105	0.20m											
	Het. Mix. gravel, sand & silt, trace of clay		3	SS	162												
	Very Dense		4	SS	180												
289.07	Reddish Brown						290.00										
5.18	Glacial Till		5	SS	150	0.10m											
	Het. Mix. of clayey silt, sand & gravel		6	SS	150	0.13m											
	Hard		7	SS	100	0.03m											
	Grey																
284.80			8	SS	167		285.00										
9.45	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
0
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

W P 213-77-03 LOCATION Sta 10+027.2 O/S 28.3 m L.R. Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bicone Bit, AXT Core COMPILED BY HR
DATUM Geodetic DATE 1971 03 03&04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
294.25	Ice Level																
0.00																	
292.73	River Bottom																
1.24	Sand & Gravel		1	SS	69												
1.77	Glacial Till		2	SS	200/	0.28m											
	Het. Mix. of gravel, sand, silt, trace of clay		3	SS	125												
	Very Dense		4	SS	185												
289.07	Reddish Brown		5	SS	130/	0.15m											
5.18	Glacial Till		6	SS	150/	0.15m											
	Het. Mix. of clayey silt, sand & gravel		7	SS	150/	0.15m											
	Hard		8	SS	135/	0.15m											
	Grey		9	SS	150/	0.00m											
283.58	Bedrock - sandy		10	RC	Rec												
10.67	dolomite Sound			AXT	75%												
282.82																	
11.43	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

METRIC

W P 213-77-03 LOCATION Sta 9+971.4 O/S 18.6 m Lt of Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bi & Tri Cone Bits, Cone Test COMPILED BY HR
DATUM Geodetic DATE 1971 03 18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
293.80	Ice Level													
0.00														
292.90														
0.90	Sand & gravel, trace of silt		1	SS	36									
			2	SS	12									
	Compact to Very Dense Black		3	SS	77									
290.47														
3.33	Sand													
289.63	Very Dense Brown		4	SS	88									0 76 (24)
4.13	Glacial Till-Het. mix. sand, silt & gravel		5	SS	166									42 46 (12)
288.34	V. Dense Reddish Brown													
5.46	Glacial Till		6	SS	126	0.20m								
	Het. mix. of clayey silt, sand and gravel		7	SS	150	0.20m								9 32 49 10
	Hard		8	SS	125	0.13m								
			8A	SS	150	0.08m								
284.08	Grey													
			9	SS	105	0.13m								
9.72	End of Borehole Probable Bedrock													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 6

METRIC

W P 213-77-03 LOCATION Sta 9+955.8 O/S 29.0m Yr 7 Hwy 7 ORIGINATED BY HW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & Bi Cone Bits, AXT Core, Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 19 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
295.05	Ground Level													
0.00	Traces of organic silt		1	SS	18									
293.83														
1.22	Sand & Gravel		2	SS	14									
	Loose to Compact		2A	SS	7									
			3	SS	6									
	Brown		4	SS	8									51 45 (4)
290.48														
4.57	Glacial Till-Het. mix. silt, sand & gravel		5	SS	83									
288.95	Very Dense Brown		6	SS	155/0.28 m									47 42 (11)
6.10	Glacial Till		7	SS	156/0.20 m									
	Het. Mix. clayey silt, sand & gravel		8	SS	152/0.20 m									
	Hard		9	SS	153/0.20 m									5 30 55 10
	Grey													
284.23			9A	SS	100/0.20 m									
10.82	Bedrock-Dolomite													
282.86	Pitted in upper 0.45 m Sound		10	AXT	Rec 80%									
12.19	End of Borehole													

+3, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6A

METRIC

W P 213-77-03 LOCATION Sta 9+955.8 O/S 16.8 m Lt. of Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE Dynamic Cone Test COMPILED BY HR
DATUM Geodetic DATE 1971 03 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
295.20	Ground Level												
0.00	Probably Sand & Gravel												
291.69													
3.51	Probable												
290.63	Glacial Till												
4.57	End of Cone Test												

+3, x⁵: Numbers refer to
Sensitivity


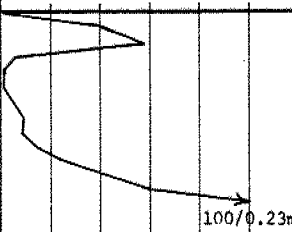
20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 7

METRIC

W P 213-77-03 LOCATION Sta 9+954.9 0/S 5.8 m Rt # Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & B1 Cone Bits, AXT Core, Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 16 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
294.74	Ground Level												GR SA SI CL
0.00	Sandy silt, trace of shells												0 59 35 6
293.37	Very Loose Brown		1	SS	2								
1.37	Sand & gravel, trace of silt		2	SS	10								
	Compact to Very Dense Grey		3	SS	64								
291.08			4	SS	112								
3.66	Uniform sand		5	SS	153	0.25m							
290.02	Very Dense Brown		6	SS	185								
4.72	Glacial Till-Het. mix. silt, sand & gravel		7	SS	123	0.13m							
288.34	Trace of clay		8	SS	150	0.15m							
6.40	Very Dense Brown		9	SS	150	0.15m							
	Glacial Till											7 25 53 15	
	Het. mix. of clayey silt, sand & gravel												
	Hard												
	Grey												
284.38													
10.36	Bedrock-Pitted Dolomite			RC	Rec								
283.16	Fractured Grey		10	AXT	35%								
11.58	Shaley Dolomite			RC	Rec								
281.94	Fractured Grey		11	AXT	35%								
12.80	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 8

METRIC

W P 213-77-03 LOCATION Sta 9+925.2 O/S 18.6 m I.t. @ Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing Tri & Bi Cone, Core COMPILED BY HR
DATUM Geodetic DATE 1971 03 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	WATER CONTENT (%)
								SHEAR STRENGTH										
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE																		
293.83	Ground Level													GR SA SI CL				
0.00	Traces of organic silt																	
	Compact		1	SS	23									54 39 (7)				
292.00	Black		2	SS	76													
1.83	Sand & gravel		3	SS	79	0.23m												
	Very Dense		4	SS	79													
288.95	Brown		5	SS	135									50 39 (11)				
4.88	Het. mix. silt, sand & gravel		6	SS	150	0.10m												
288.04	Very Dense Brown		7	RC	Rec													
5.79	Glacial Till		8	SS	160	0.15m								13 35 41 11				
	Het. mix. of clayey silt, sand & gravel		9	SS	100	0.15m												
	Hard Grey																	
284.23	End of Borehole																	
9.60	Probable Bedrock																	

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 9

METRIC -

W P 213-77-03 LOCATION Sta 9+907.6 O/S 0.6 m Lt 0 Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing Tri & Bi Cone Bits, Dynamic Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 15 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
293.92	Ice Level													
293.46	River Bottom													
0.46	Fill Material-clayey silt with sand & gravel		1	SS	70									
292.39	Very Dense Grey		2	SS	52									
1.53	Sand & gravel		3	SS	82									
290.41	Very Dense Brown		4	SS	170	0.28m	290.00							66 27 (7)
3.51	Layers of clayey silt up to 0.10m thick		5	SS	150									
289.20	Glacial Till-Het mix. silt, sand & gravel, trace of clay		6	SS	185	0.20m								8 39 41 12
4.72	Very Dense Reddish Brown		7	SS	135	0.18m								
287.67	Glacial Till Het mix. of clayey silt sand & gravel		8	SS	153	0.28m								7 20 53 20
6.25	Hard Grey		9	SS	145	0.25m	285.00							
284.53	End of Borehole Probable Bedrock													
9.39														

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 10

METRIC

W P 213-77-03 LOCATION Sta 9+897.6 O/S 28.3 m Lt. Hwy 7 ORIGINATED BY JW
 DIST 3 HWY 7 BOREHOLE TYPE NX Casing, Tri & Bi Cone Bits, BXT Core, Cone COMPILED BY HR
 DATUM Geodetic DATE 1971 03 23 CHECKED BY HR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES			20	40	60	80	100					
295.35	Ground Level																
0.00	Traces of organic silt		1	SS	24		295.00										
294.13			2	SS	69												50 38 (12)
1.22	Sand & Gravel		3	SS	84												
	Some silt		4	SS	130												56 37 (7)
290.32			5	SS	60												
5.03	Layers of uniform sand up to 0.20m thick		6	SS	154		290.00										
288.95	Glacial Till-Het. mix. silt, sand & gravel Very Dense Brown		7	SS	140	0.10m											
6.40			8	SS	150	0.23m											9 39 40 12
287.58			9	SS	100	0.18m											
7.77	Glacial Till Het. mix. clayey silt, sand & gravel occasional boulders up to 0.30m in size throughout		10	BX	50%												
			11	BX	17%												
284.07	Hard Grey Bedrock Dolomite		12	BX			285.00										
283.77																	
11.58	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 11										METRIC	
W P 213-77-03		LOCATION Sta 10+017.2 O/S 18.8 m Lt of Hwy 7				ORIGINATED BY JW					
DIST 3 HWY 7		BOREHOLE TYPE Diamond Drill-Washboring & Cone Test				COMPILED BY WH					
DATUM Geodetic		DATE 1971 03 31 & 04 01				CHECKED BY					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
293.83	Water Level										
0.00											
292.30	River Bottom										
1.53	Sand & gravel		1	SS	161						
291.54	Very Dense Brown										
2.29	Glacial Till-Het. mix. silt, sand & gravel, trace of clay		2	SS	83						
	Very Dense Reddish Brown										
289.72			3	SS	150						
4.11			4	SS	1307						
	Het. mix. clayey silt, sand & gravel		5	SS	1507						
			6	SS	1507						
	Occ. boulders up to 0.40 m in size below el. 943		7A	RC	-						
			7	SS	1257						
			8	BX	5%						
284.53	Hard Brown		9	RC	-						
9.30	End of Borehole Probable Bedrock					Encountered					

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 12										METRIC		
W P 213-77-03		LOCATION Sta 9+986.3 O/S 29.0 m Lt of Hwy 7				ORIGINATED BY JW						
DIST 3 HWY 7		BOREHOLE TYPE Diamond Drill-Washboring & Cone Test				COMPILED BY WH						
DATUM Geodetic		DATE 1971 03 30&31				CHECKED BY						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
293.83	Water Level											
0.00												
292.82	River Bottom											
1.01												
	Sand & Gravel		1	SS	60							
			2	SS	36							
	Some silt		3	SS	32							
	Dense to Very Dense		4	WS	-							
			5	SS	142							
	Brown											
289.01			6	SS	190/	0.23m						
4.82	Glacial Till		7	SS	150/	0.08m						
	Het. mix. of clayey silt, sand & gravel											
	Occ. boulders up to 0.10m in size		8	RC BX	Rec 25%							
			9	SS	-							
284.68	Hard Grey		10A	SS	159/	0.13m						
284.35	Bedrock Dolomite		10	BX	80%							
9.48	End of Borehole											

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 13

METRIC

W P 213-77-03 LOCATION Sta 9+929.6 O/S 6.4 m Rt of Hwy 7 ORIGINATED BY JW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-Washboring & Cone Test COMPILED BY WH
DATUM Geodetic DATE 1971 04 05&06 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)		
295.05	Ground Level													
0.00	Sandy silt. Traces of organic silt													
294.13														
0.92	Sand & gravel		1	SS	12									
	Trace of White Shells		2	SS	1									
			3	SS	16									
	Very Loose to Compact Brown		4	SS										
290.63			5	SS	115									
4.42	Uniform Sand		6	SS	108									
	Trace of gravel													
288.65	Very Dense Brown		7	SS	150/	0.10m								
6.40	Glacial Till-Met. mix. silt, sand, gravel. Trace of clay Very Dense													
287.43			8	SS	150/	0.15m								
7.62	Met. mix. of clayey silt, sand & gravel													
285.91	Hard Grey		9	SS	130/	0.15m								
9.14	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14

METRIC

W P 213-77-03 LOCATION Sta 10+053.7 O/S 7.6 m Rt. Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Bi & Tricone Bit, AXT Core, Cone COMPILED BY JHR
DATUM Geodetic DATE 1971 03 04,05,08&09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
300.62	Ground Level												
0.00	Fill Material		1	SS	14		300.00						
	Sand & gravel		2	SS	11								
	Some silt		3	SS	15								
	Compact to Dense		4	SS	15								41 40 18 1
	Brown		5	SS	42								
296.05	Sand & gravel		6A	SS	107		295.00						
4.57	Dense to Very Dense		6	SS	56								
294.22	Brown							100/0.20m	ONP				
6.40	Glacial Till		7	SS	174/	0.25m							33 29 30 8
	Het. mix. of silt, sand & gravel, trace of clay		8	SS	151								
	Very Dense		9	SS	250/	0.25m	290.00						7 32 49 12
289.80	Reddish Brown		10	SS	200/	0.10m							
10.82	Glacial Till		11	SS	155/	0.15m							26 16 47 11
	Het. mix. of clayey silt, sand & gravel		12	SS	220/	0.28m							
	Hard		13	RC	100/	0.03m	285.00						
	Grey		14	RC	100%								
284.83	Bedrock-Dolomite chertified layers up to 0.05m thick		15	RC	100%								
15.79	Sound Grey		16	RC	80%								
282.73	End of Borehole												
17.89													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15

METRIC

W P 213-77-03 LOCATION Sta 9+889.5 O/S 7.9 m Lt 6 Hwy 7 ORIGINATED BY WH
DIST 3 HWY 7 BOREHOLE TYPE NX & BX Casing, Tri & Bi Cone Bits, AXT Core, Cone COMPILED BY HR
DATUM Geodetic DATE 1971 03 10,11&12 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
300.72	Ground Level													GR SA SI CL
0.00	Fill Material		1	SS	16		300.00							
	Sand & gravel		2	SS	8									37 50 (13)
	Trace of silt		3	SS	15									
	Loose to Compact		4	SS	14									
	Brown to Grey		5	SS	11									45 46 (9)
295.23							295.00							57 33 9 1
5.49	Sand & gravel		6	SS	39									
	Trace of silt		7	SS	145	0.28m								
	Dense to Very Dense		8	SS	107									46 40 13 1
292.19														
8.53	Clayey silt, traces of sand and gravel		9	SS	46									
	Reddish Brown Hard		10	SS	141	0.23m	290.00							17 48 31 4
289.44	Glacial Till		11	SS	200									
11.28	Very Dense		12	SS	205	0.25m								9 35 40 16
288.53			13	RC	28									
12.19	Glacial Till		14	SS	197	0.23m								
	Net. mix. of clayey silt, sand & gravel		15	SS	150	0.15m								
	Grey Hard		16	SS	195	0.28m								5 32 49 14
284.87	Boulders 0.15m in size at el. 943						285.00							
15.85	Bedrock Dolomite			RC	Rec									
283.49	Sound Grey		17	AXT	85									
17.23	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 16

METRIC

W P 213-77-03 LOCATION Sta 9+930.6 O/S 29.9 m Lt of Hwy 7 ORIGINATED BY JDW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
DATUM Geodetic DATE 1971 04 07/08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
295.96	Ground Level													GR SA SI CL
0.00	Silty sand to sand		1	SS	7		295.00							
	Brown		2	SS	7									
292.91	Occ. grey sandy silt pockets Loose		3	SS	23									
3.05	Sand and gravel		4	SS	47									
	Trace of silt		5	SS	55									
290.47	Brown Compact to Very Dense		6	SS	81		290.00							
3.49	Glacial Till- Het. mix. of gravel, sand, silt and clay		7	SS	145									
288.19	Brownish Very Dense		8	SS	160/	0.20m								
7.77	Glacial Till		9	SS	140/	0.20m								
	Het. mix. of clayey silt, sand and gravel		10	SS	170/	0.18m								
	Grey		11	SS	125		285.00							
284.07	End of Borehole Probable Bedrock													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 17

METRIC

W P 213-77-03 LOCATION Sta 9+983.0 O/S 5.8 m Lr of Hwy 7 ORIGINATED BY JDW
 DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
 DATUM Geodetic DATE 1971 04 12&13 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
295.05 0.00	Water Level															GR SA SI CL
291.39	River Bottom															
291.08	Sand & gravel		1	SS	52											
3.97	Silty sand to sand with gravel		2	SS	89											
	Red to Brown		3	SS	111											
289.26	Dense to Very Dense		4	SS	150	0.18m										
5.79	Glacial Till		5	SS	150	0.15m										
	Het. mix. clayey silt, sand & gravel		6	SS	150	0.08m										
286.73	Hard Grey															
8.32	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity.

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18

METRIC

W P 213-77-03 LOCATION Sta 10+010.8 O/S 5.8 m Lt & Hwy 7 ORIGINATED BY JDW
DIST 3 HWY 7 BOREHOLE TYPE Diamond Drill-BX Washboring & Cone Test COMPILED BY JDW
DATUM Geodetic DATE 1971 04 13&14 CHECKED BY

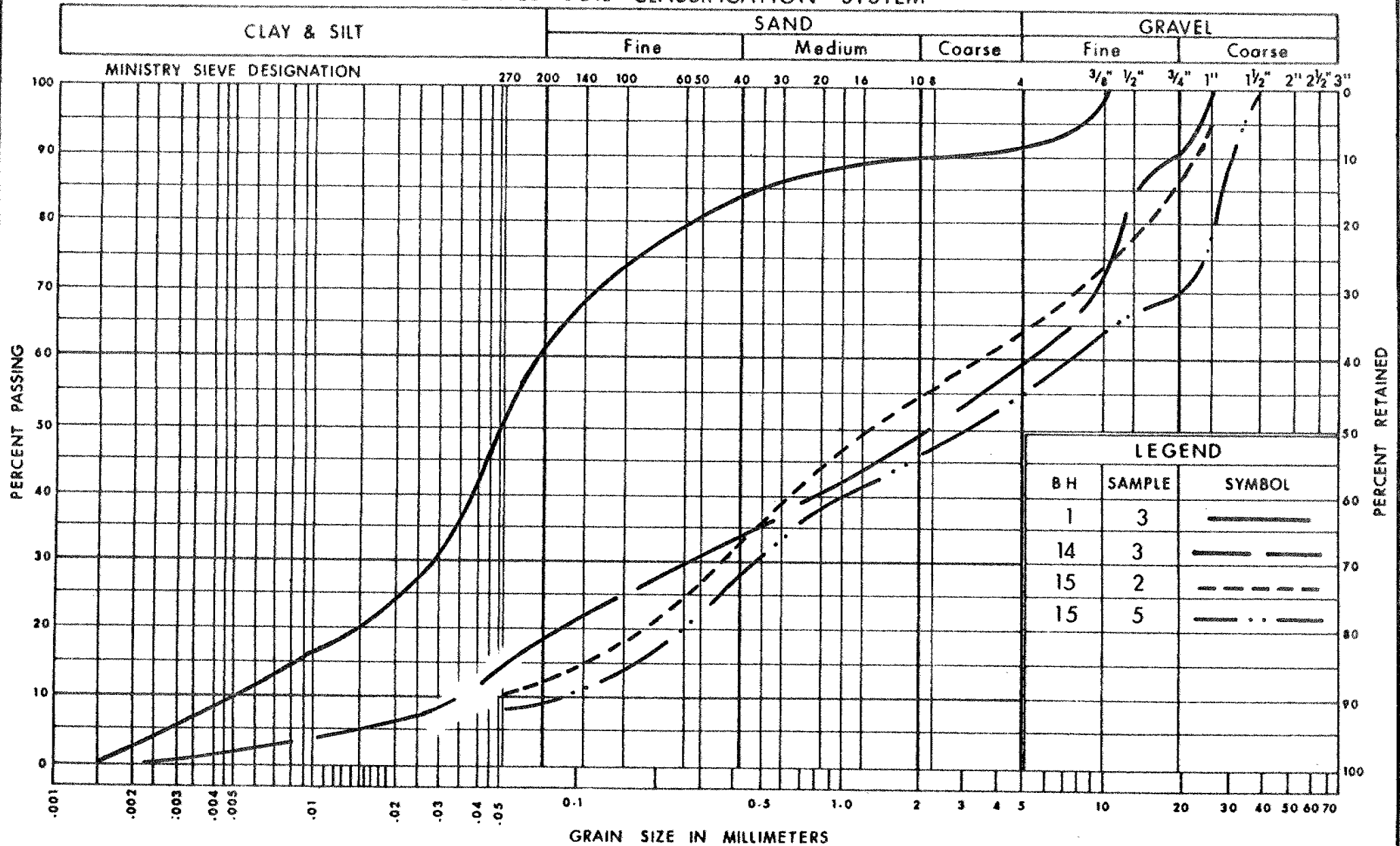
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
295.35	Water Level																
0.00							295.00										
290.78	River Bottom																
290.47	Sand & gravel		1	SS	56												
4.88	Glacial Till		2	BX1	140		290.00										
288.95	Very Dense		3	SS	140												
6.40	Glacial Till		4	SS	150	0.23m											
	Het. mix. clayey silt, sand & gravel		5	SS	150	0.10m											
			6	SS	150	0.13m											
286.02	Hard Grey		7	SS	150	0.18m											
9.33	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



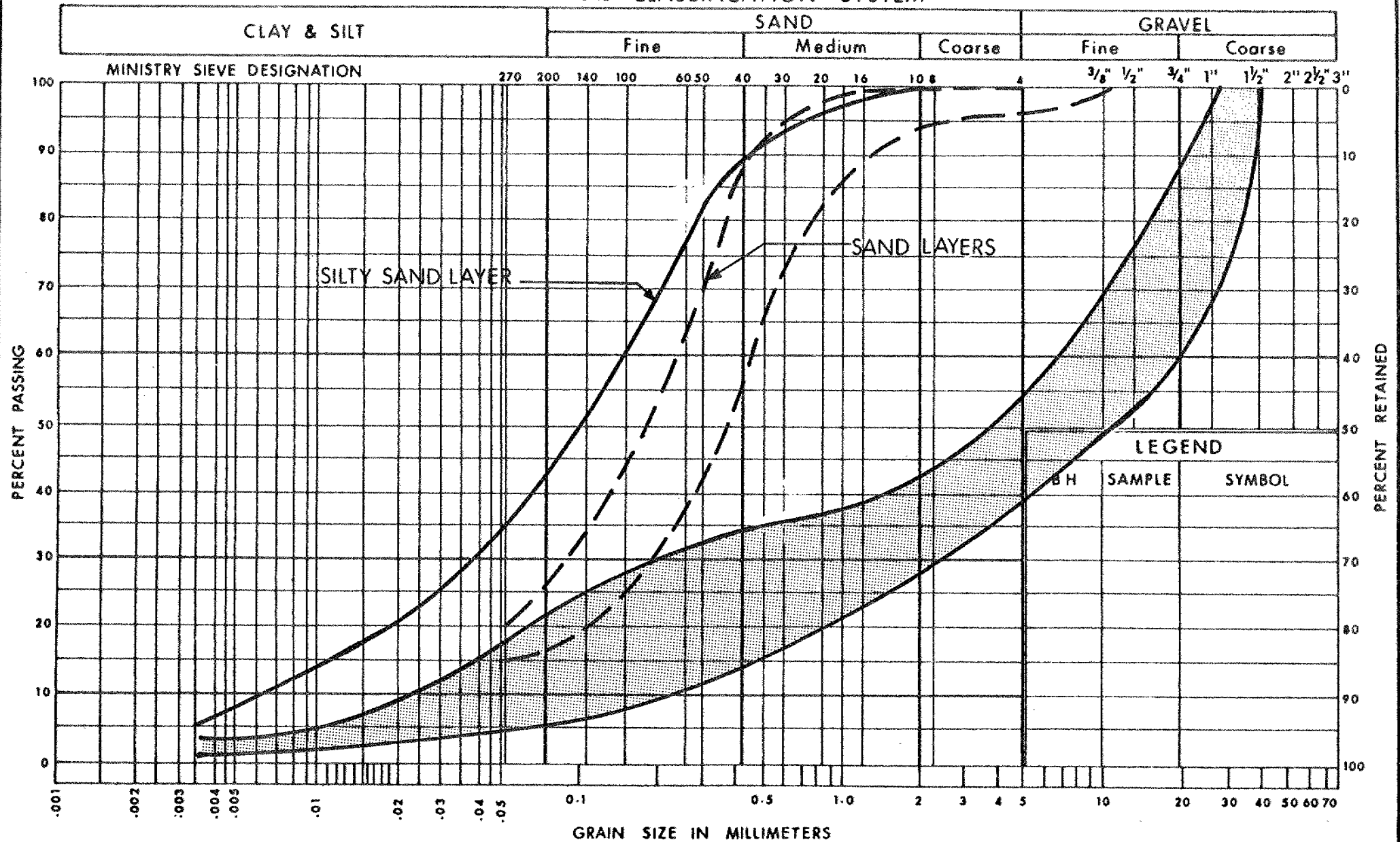
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL MATERIAL
SANDY SILT TO SILTY SAND

FIG No 1

W P 213-77-03

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION SAND & GRAVEL

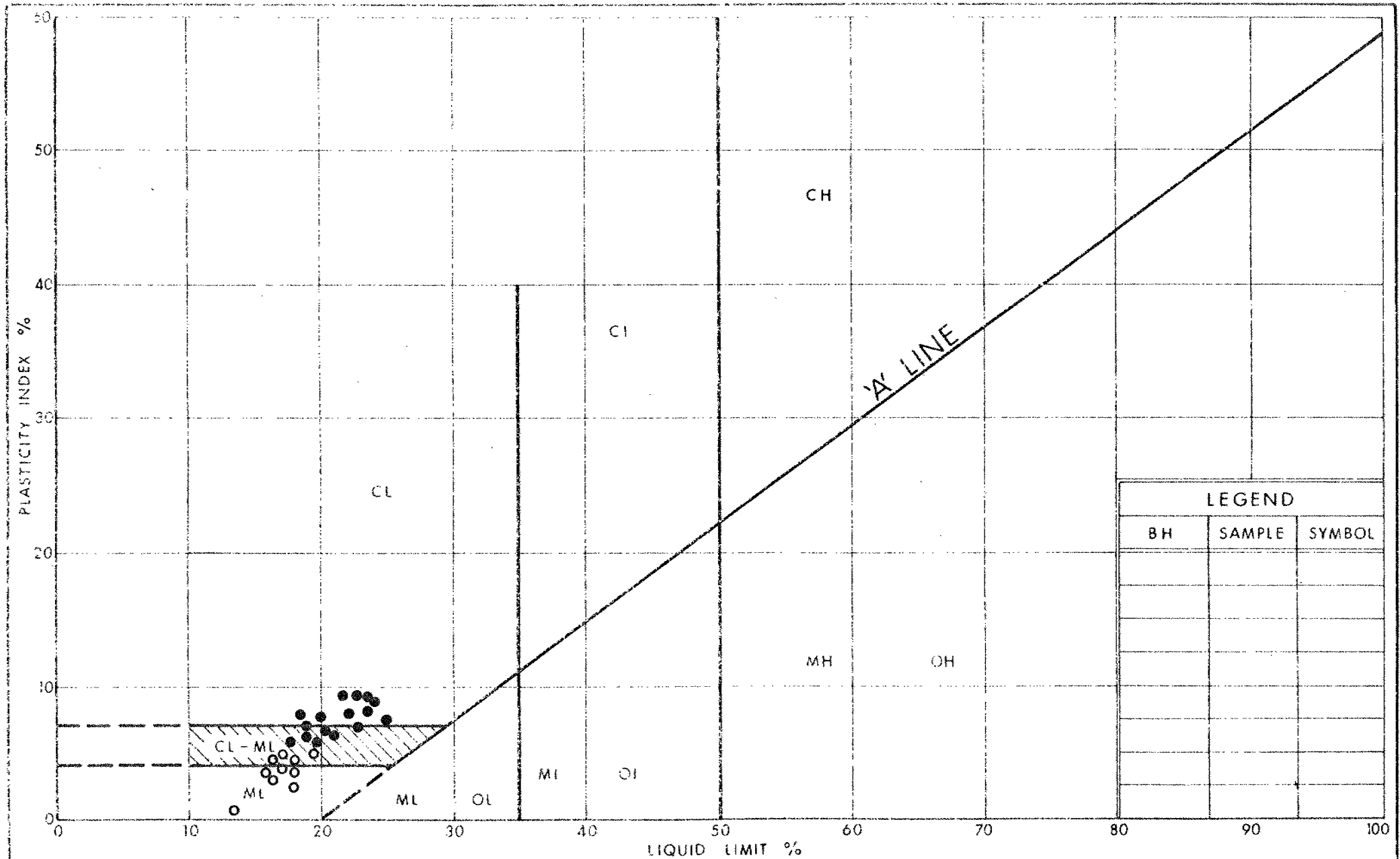
FIG No 2

W P 213-77-03



GRAIN SIZE DISTRIBUTION GLACIAL TILL

W P 213-77-03



Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART GLACIAL TILL

● COHESIVE

○ NON-COHESIVE

FIG No 4

W P 213-77-03