

DEPARTMENT OF HIGHWAYS — ONTARIO
MATERIALS AND TESTING OFFICE
VISUAL CLASSIFICATION SHEET

PROJECT 72-11013 SITE _____ BOREHOLE No. 1 GROUND ELEVATION _____

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DILATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	0-2'	-	-	-	80	20	LOW	Dull	Quick		EARLY BROWN	Nil			SILTY SAND	
			-													
3	4-6'	-	-	-	10	90	MED	"	MED		"	"	MED		CLAYEY SILT.	
4	6-8'	-	-	-	10	90	HIGH	"	MED		"	"	LOW		CLAYEY SILT.	
8	20-21½'		-		60	40	LOW	Dull	Quick		"	"	Nil		Silty Sand with clay	
7	25-26½'	-	-		70	30	LOW	"	"		"	"	"		" Sand "	
10	30-32'	1"	Round	20	50	30	"	"	"		"	"	"		" " "	

NOTES: VISUAL CLASSIFICATION

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REMARKS:—

DEPARTMENT OF HIGHWAYS — ONTARIO
MATERIALS AND TESTING OFFICE
VISUAL CLASSIFICATION SHEET

PROJECT 72-110,3 SITE _____ BOREHOLE No. 2 GROUND ELEVATION _____

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	0-2'	-	-	-	70	30	HIGH	DULL	med		EARTHY	BROWN	ML		Sand with fopsoil and DEB MAT.	
2	3-5'	-	-	-	80	20	LOW	"	QUICK		"	"	"		Sand with trace of clay.	
3	6-8	-	-	-	90	10	LOW	"	"		"	"	"		SAND Uniform	
4	9-11	-	-	-	90	10	"	"	"		"	"	"		"	
5	12-14	-	-	-	90	10	"	"	"		"	"	"		"	
6	15-17	-	-	-	70	30	"	"	"		"	GREY	"		"	
7	17-19	-	-	-	90	10	"	"	"		"	"	"		"	

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REMARKS:—

DEPARTMENT OF HIGHWAYS — ONTARIO
MATERIALS AND TESTING OFFICE
VISUAL CLASSIFICATION SHEET

PROJECT 72-11013 SITE _____ BOREHOLE No. 3 GROUND ELEVATION _____

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION			DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE										
				GRAVEL	SAND	SILT & CLAY								
1	0-6"	7/8"	SUB ROUND	70	20	10	LOW	DULL	Quartz	EXPOSED BROWN	WILL		GRAVEL with sand & clay	
3	4 1/2'	3/4"	ROUND	70	30	-	LOW	"	"	"	"		WELL GRADED sand & gravel	
4	6 1/2-7 1/2'	1/2"	SUB-ROUND	75	20	5	"	"	"	"	"		" " gravel	
5	12-14 1/2'	3/4"	Round	65	30	5	"	"	"	"	"		Well graded sand & gravel	
6	17 1/2-19 1/2'	7/8"	SUB ROUND	65	30	5	low	"	"	"	"		well graded sand - gravel	
7	19 1/2-21 1/2'	1"	SUB ROUND	70	25	5	low	"	"	"	"		POORLY GRADED SAND & GRAVEL	
8	22 1/2-24 1/2'	1 1/4"	"	70	25	5	"	"	"	"	"		WELL " " "	
9	22 1/2-24 1/2'	3/4"	"	60	40	-	"	"	"	"	"		" " " "	

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REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO
MATERIALS AND TESTING OFFICE
VISUAL CLASSIFICATION SHEET

PROJECT <u>72-11013</u>		SITE <u>PENFREW</u>		BOREHOLE No. <u>4</u>		GROUND ELEVATION <u>416.4</u>								
SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION			DRY STRENGTH	SHINE	DIALTANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE										
				GRAVEL SAND SILT & CLAY										
1	0-1.5	-	-	100	SLT	DULL	QUICK			DARK ORGANIC BROWN	NO		TOP SOIL	
2	3-5	-	-	5	95	HIGH	DULL SLOW			EARTHY GREY	NO		CLAYEY SILT	CL
3	6-8	1/2	ANGULAR	10	30	60	HIGH	DULL SLOW		EARTHY BROWN	NO		CLAYEY SILT, WITH SAND, TRACE GRAVEL	CL
4	9-11	1/2	ANGULAR SUB	10	30	60	MED	DULL SLOW		EARTHY GREY	NO		CLAYEY SILT, WITH SAND, TRACE GRAVEL	CL
5	12-14	1	ANGULAR	20	30	50	MED	DULL SLOW		EARTHY BROWN	NO		CLAYEY SILT, WITH SAND, TRACE GRAVEL	CL
6	15-17	1/4	ANG	70	80		SLT	DULL QUICK		EARTHY BROWN	NO		COARSE SAND, SOME GRAVEL	SP
7	20-22	1/4	ANG	20	80		SLT	DULL QUICK		EARTHY BROWN	NO		UNF. SAND, SOME GRAVEL	SU
8	25-27	1/2	ANG SUB	30	70		SLT	DULL QUICK		EARTHY BROWN	NO		UNF. SAND, WITH GRAVEL	SU
9	30-32	1/2	ANG	40	60		SLT	DULL QUICK		EARTHY BROWN	MILD		UNF. SAND & GRAVEL	SU

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REMARKS:-



VISUAL CLASSIFICATION SHEET

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PROJECT CONT 73-186

SITE HWY 17N-RENFREW-JAMIESON'S PROP BOREHOLE NO

BOREHOLE NO.

GROUND ELEVATION

497.8

SITE NO. 1000														
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PROJECT <u>CONT 73-186</u>		SITE <u>HWY 17 N-RENFREY-JAMIESON'S PRUP</u>		BOREHOLE NO. <u>2</u>		GROUND ELEVATION <u>501.2</u>								
SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION			DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE										
				GRAVEL	SAND	SILT AND CLAY								
1	2 1/2' - 4'	-	-	-	10	90				ORG.	BROWN		SILT (ORG. WITH LOW PLASTICITY) TR OF SA	OL
2	5' - 6 1/2'			-	90	10	NIL	DULL	ROUGH	NIL	CARESS	BROWN STAINING	SILTY U.F. SAND	
3	7 1/2' - 9'				"	"					"		"	
4	10' - 10 1/2'				"	"					"		"	
5	12 1/2' - 14'				"	"					"		"	
6	15' - 16 1/2'				"	"					"		"	
7	17 1/2' - 19'				95	5		"	"	"	"	"	MOD TO FINE SAND, TR OF SILT	
8	20' - 21 1/2'				"	"		"	"	"	"	"	"	
9	23' - 24'				"	"		"	"	"	"	"	"	

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REMARKS:-



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VISUAL CLASSIFICATION SHEET SOILS MECHANICS OFFICE

PROJECT CNT 73-186

SITE HW 17N-RENFREW-JAMIESON'S PROP BOREHOLE NO. 3

GROUND ELEVATION 506.8

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT AND CLAY										
1A	2 1/2' - 4'			+	10	90	MOD	DULL	SLW	MOD	BROWN GRAY	MILD		CLAYEY SILT, TR OF SAND		
1B	"				"	"	"	"	"	"	"	"		"		
2	5' - 6 1/2'	1 1/4"	ANG	10	75	15	NIL	"	QUICK	NIL	"	"	STRONG	SILTY V.F. SAND, TR OF GR		
3	7 1/2' - 9'				60	40	"	"	"	NIL	"	BROWN GRAY	MILD	CLAYEY SILT TO SILTY SAND		
4	12 1/4' - 14'	1 1/4"	ANG.	10	80	10	"	"	"	"	"	BROWN GRAY	"	SILTY SAND, TR OF GRAVEL		
5	15' - 16 1/2'				90	10	"	"	"	"	"	"	STRONG	SILTY V.F. SAND		
6	20' - 21 1/2'				70	30	"	"	"	"	"	"	MILD	SILTY V.F. SAND		
7	25' - 26 1/2'	1 1/2"	ANG	20	70	10					GRAY	STRONG		GRAVELLY SAND, TR OF SILT	GW	

NOTE: VISUAL CLASSIFICATION

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REMARKS:-



VISUAL CLASSIFICATION SHEET

SOILS MECHANICS OFFICE

PROJECT CON: 73-186

SITE HWY 17N - RENFREW - JAMIESON BOREHOLE NO. 4

GROUND ELEVATION 493.1

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION						DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE													
				GRAVEL	SAND	SILT AND CLAY											
1	2 1/4'	Sieve # 20	-	-	100	0	MD	DULL	SLOW	MED	EARTHY	BROWNISH GREY	MILD			CLAYY SILT, TR OF SAND	
2	5' 6 1/2"				100	0										"	
3	7 1/2' - 9'				95	5	NIL	"	QUICK	NIL	"	"	MILD TO STRONG			F TO V.F. SA, TR OF SILT	SU
4	10' - 11 1/2'				"	"	"	"	"	"	"	"	"			"	
5	12 1/2' - 14'				5	95	MED	"	SLOW	MED	"	GREY	MILD			CLAYY SILT, TR OF SA - COMBINED	
6A	17 1/2' - 19'				30	70	"	"	"	"	"	"	"			SANDY SILT - COMBINED	
6B	17 1/2' - 19'				"	"	"	"	"	"	"	"	"			PLASTIC SANDY SILT	
7	20' - 21 1/2'				95	5	NIL	"	QUICK	NIL	"	"	"			F. TO V.F. SA, TR OF SILT	

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REMARKS:-



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SOILS MECHANICS OFFICEPROJECT CONT. 73-186SITE HWY 17N-RENFREW - JAMIESON'S PROP.BOREHOLE NO. 5GROUND ELEVATION 492.9

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION						DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE													
				GRAVEL	SAND	SILT AND CLAY											
1	5' 6 1/2'	-	-	-	95	5	NIL	DULL	QUICK	NIL	EARTHY	BROWN	MILD		SILTY V. F. SAND		
2	10' 11 1/2'	-	-	-	10	90	MED	"	SLOW	MED	"	GREY	"		CLAYEY SILT, TR OF SAND		
3	15' 16 1/2'	-	-	-	95	5	NIL	"	QUICK	NIL	"	BROWN	"		F. TO V. F. SAND, TR OF SILT		

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REMARKS:-



VISUAL CLASSIFICATION SHEET SOILS MECHANICS OFFICE

PROJECT CONT. 73-186

SITE HWY 17N-RENFREW-JAMIESON'S BRIDGE

BOREHOLE NO. 6

GROUND ELEVATION 493.2

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION			DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE										
1	1'-2 1/2'	-	-	30	70	MED	DULL	SLOW	MED	ORG.	BROWN	NEG	AUGER SAMPLE - CLAYEY SILT WITH SAND	
2	2 1/2' - 4'	SILT 3/64	-	95	5	NIL	"	QUICK	NIL	EMERY	"	"	V.F. SILTY SAND	SU
3	5' - 6 1/2'	-	-	15	85	MED	"	SLOW	MED	"	BROWNISH GREY	"	CLAYEY SILT WITH SOME SAND	
3A							"	"	"	"	"	"	" (FROM VANE TIP)	
4	10' - 11 1/4'			60	40	SLOW	"	QUICK	NIL	"	GREY	MILD	V.F. SILTY SAND	SF
5	13' - 14'	-	-	5	95	MED	"	SLOW	MED	"	"	VERY MILD	CLAYEY SILT, TR OF SA	
6	20' - 21 1/2'			80	20	NIL	"	QUICK	NIL	"	"	MILD	SILTY V.F. SAND	
7	25' - 26 1/2'			95	5	"	"	"	"	"	"	"	SILTY FINE TO V.F. SAND	

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REMARKS:-



VISUAL CLASSIFICATION SHEET

SOILS MECHANICS OFFICE

PROJECT CONT. 73-186

SITE Hwy 17N - RENFREW - JAMESON'S POND

BOREHOLE NO. 7

GROUND ELEVATION 488.3

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION			DRY STRENGTH	SHINE	DILATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE										
1	2 1/2' - 4'	-	-	40 60	SLIGHT	DULL	QUICK	SLIGHT	EARTHY	BROWN GREY	MILD		2 1/2' - 3 1/2' F TO V.F. CLAYEY SILT TO SILTY SAND, WITH POCKETS OF SILT	
2	5' - 6 1/2'	-	-	60 40	"	"	QUICK	"	"	"	"		SILTY SAND - V.F.	
3	7 1/2' - 9'	-	-	5 95	MD	"	SLOW	"	"	GREY			CLAYEY SILT. TR OF SD	
5	15' - 16 1/2'	1"	ANG	20 65 15		"	QUICK	"	"	"			PREDOMINANTLY F TO V.F. SILTY SAND, SOME GRAVEL	GP

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REMARKS:-



VISUAL CLASSIFICATION SHEET
SOILS MECHANICS OFFICE

PROJECT CONT 73-186

SITE HWY 17N - RENFREW - JAMESON'S PR. V.P.

BOREHOLE NO. 8

GROUND ELEVATION 487.7

SAMPLE NO	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT AND CLAY										
1	2 1/2' - 4	1 1/4"	ANG.	15	75	10	NIL	NO SHINE	QUICK	NIL	EARTHY	GOLDEN BROWN	MILD		GRAVELLY SAND, TR OF SILT	GW
2	5' - 6 1/2'	1/2"	"	10	75	15	SLIGHT	"	"	"	"	"	"		SILTY SAND, TRACES OF GRAVEL, CLAY	GW
3	7 1/2' - 9	3/8"	"	5	80	15	"	"	"	"	"	"	"		" " " " " "	
4	12 1/2' - 14	1"	"	20	60	20						GREY			VERY FINE SILTY SAND WITH SOME GRAVEL	GF

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REMARKS:-

MEMORANDUM

TO: Mr. T. C. Kingsland (2)
Regional Bridge Planning Eng.
Eastern Region
Kingston, Ontario

FROM: Foundations Office
Design Services Branch
Downsview, Ontario

ATTENTION:

DATE: December 8, 1971

OUR FILE REF.

IN REPLY TO DEC 17 1971

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

The Overhead Structure at the
Crossing of Proposed Hwy.17 'New' (WBL)
And Canadian Pacific Railway
Twp. of Horton - Co. of Renfrew
District No. 9 (Ottawa)
W.O. 71-11085 -- W.P. 5-67-01

31 F-19

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

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

AGS/ao
Attach.

cc: Messrs. D. W. Farren
B. R. Davis
A. Rutka
S. J. Markiewicz
J. E. Callaghan
B. J. Giroux
E. R. Saint
G. A. Wrong
B. A. Singh

Foundation Files
Documents

A. G. Stermac
A. G. Stermac,
Principal Foundation Engineer

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FOUNDATION INVESTIGATION REPORT
For
The Overhead Structure at the
Crossing of Proposed Hwy. 17 'New' (W.B.L.)
And Canadian Pacific Railway
Twp. of Horton - Co. of Renfrew
District No. 9 (Ottawa)
W.O. 71-11055 -- W.P. 5-67-01

1. INTRODUCTION:

The Foundation Office was requested to carry out a subsurface investigation at the site of the proposed overhead structure at the crossing of Hwy. #17 'N' (W.B.L.) and the C.P.R. at Lot 7, Con. 4, Township of Horton, County of Renfrew. The request was contained in a memo from Mr. T. C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated August 10, 1971. An investigation was subsequently carried out by this Office to determine the subsoil, bedrock and ground-water conditions at this site.

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

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located about 3 miles west of the Town of Renfrew. At the location of the site the C.P.R. track is raised on an embankment about 4 ft. above the surrounding ground. The terrain in this area is flat and low lying with poor drainage. South of the track the area is swampy and was covered by

3 to 6 inches of water at the time of the field investigation. The surrounding land is cultivated and being used for farming purposes.

This area is situated in the physiographic region known as the 'Ottawa-Valley Clay Plains'. In this region clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies in thickness over the region. The clay is underlain by glacial till.

The overburden deposits are underlain by Precambrian rock.

3. FIELD AND LABORATORY WORK:

Eight sampled boreholes, seven of which were accompanied by a dynamic cone penetration test, were put down at this site using conventional diamond drill rigs adapted for soil sampling purposes.

Samples of the cohesive stratum, as well as the glacial till deposit were obtained, at specified intervals, in a 2-inch O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. In the softer portions of the cohesive stratum the testing programme was supplemented by taking 2-inch I.D. Shelby tubes, which were manually pushed into the soil. In addition, field vanes were carried out, where possible, to determine the undrained shear strength of the clay stratum. Bedrock was proven in 6 of the boreholes by obtaining BX size rock core samples.

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes.

The soil, bedrock and groundwater conditions, encountered at the boring locations, are presented on the Record of Borelog sheets appended to this report. The location and elevation of

the various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a Geodetic datum. The boring locations and elevations are shown on Drawing No. W.O. 71-11085A.

All the samples were subjected to a careful visual examination in the field, and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

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

The results of this testing are plotted on the Record of Borelog sheets and summarized on Figures No. 1 to 5, inclusive, all contained in the Appendix of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

Subsoil over the site consists of surficial deposits of sandy topsoil and organic silt up to 2 ft. thick, followed by a cohesive stratum composed of a very stiff to firm grey clayey silt. The thickness of this stratum varies from 10 to 14 feet. The cohesive subsoil is underlain by a 26 to 40 feet thick compact to very dense glacial till deposit, consisting of a heterogeneous mixture of silt, sand and gravel, trace of clay. The glacial till is, in turn, underlain by crystalline dolomite bedrock.

The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying borehole sheets. The stratigraphical section, shown on Drawing No. W.O. 71-11085A, has been inferred from this data.

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

4.2) Surficial Deposits:

The surficial deposit across the site consists of a 6 inch to a 2 foot thick deposit of loose sandy topsoil intermixed with organic silt. In the swampy area, south of the tracks, this deposit also contains organic material and peat.

4.3) Clayey Silt:

Directly beneath the surficial deposit is a cohesive stratum, composed of a grey clayey silt with silty sand seams throughout. The overall thickness of the cohesive soil varies from 10 to 14 feet. Generally the silty sand seams increase in thickness with depth, ranging from very thin partings in the upper portion of the deposit to distinct seams up to 3 inches thick below elevation 420. In the lower 2 to 3 ft. of the stratum, just above the underlying glacial till deposit, there is a transitional zone with alternate layers of silty sand, sand and clayey silt; the individual layers are up to 3 inches thick. Grain-size distribution curves for samples of the cohesive subsoil are shown on Figure #2, located in Appendix 1 of the report.

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

Identity Tests

		<u>Range</u>	<u>Average</u>
Bulk Density (p.c.f.)	()	117 - 133	126
Liquid Limit (%)	(W_L)	20 - 32	25
Plastic Limit (%)	(W_P)	14 - 18	16
Natural Moisture Content (%)	(W)	19 - 37	24

Consolidation Characteristics

Initial Void Ratio	(e_0)	0.6 to 1.0
Compression Index	(C_c)	0.21 to 0.69
Degree of Preconsolidation (t.s.f.)	($P_c - P'_0$)	2.3 to 3.6

<u>Undrained Shear Strength</u> (p.s.f.)	<u>(C_u)</u>	<u>Range</u>	<u>Average</u>
1) Field Tests		1,280 -	>2,000
2) Lab Tests		500 -	>2,000
<u>Standard Penetration</u> <u>Resistance Testing</u> (Blows/ft.)		2 -	27

The Atterberg limit tests are also plotted on the Plasticity Chart, Figure #1. These results indicate that the cohesive subsoil is essentially inorganic with a plasticity in the low range. The natural water content is at or slightly above the liquid limit.

The results of the undrained shear strength testing carried out indicates that the consistency of the deposit varies from firm to very stiff.

The consolidation characteristics of the stratum were determined by carrying out two laboratory tests, the results of which are shown as Void Ratio vs. Pressure plots on Figure #5. The results of these tests indicate that the clay stratum is preconsolidated by about 2.3 to 3.6 t.s.f. in excess of existing overburden pressure.

4.4) Heterogeneous Mixture of Silt, Sand and Gravel,
Trace of Clay (Glacial Till):

The clayey silt stratum is underlain by a non-cohesive glacial till deposit composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. The overall thickness of this deposit ranges from 26 to 40 feet. In certain borings (B.H. #1, 3, 5, 6 and 8), the upper 4 to 6 ft. of the glacial till consists of a layer of silty sand with some gravel. Occasional boulders up to 12 inches in size were encountered throughout the deposit. The boulders became more numerous with depth. Grain-size distribution curves for samples of the glacial till, as well as the upper silty sand layer, are plotted on Figure #4. Atterberg

limit tests were attempted on the more cohesive portions of the glacial till. These tests, which are plotted on Figure #3 indicate a low plasticity.

The Standard Penetration Tests, carried out within the glacial till deposit, are plotted on the Record of Borelog sheets. This testing gave 'N' values which ranged from 16 to 36 blows/ft. in the upper silty sand zone, and from 5 to greater than 100 blows/ft. in the remaining portion of the glacial till deposit. Based on these values it is estimated that the relative density of the upper 'silty sand' zone varies from compact to dense and the remainder ranges from loose to very dense.

4.5) Crystalline Dolomite Bedrock:

The glacial till is directly underlain by bedrock which was proven in 6 of the boreholes by obtaining 12 to 25 ft. of either BX or AXT size rock core samples. Over the site the bedrock surface was found to vary between elevations 376 and 385, which corresponds to depths below ground surface of from 52 to 40 feet, respectively.

The bedrock is composed of a crystalline dolomite. Generally the upper 7 to 18 feet of the bedrock is in a fractured condition. Occasional vertical seams were encountered within this upper fractured zone, and in some cases the bedrock was highly weathered along these seams. In B.H.#2 a cavity, some 4 ft. thick, was encountered within the bedrock. This cavity was filled with a deposit of silty sand with occasional layers of clayey silt up to 1 inch thick. Below this fractured zone the bedrock is in a sound condition as evidenced by the high percentage of core recovery.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. The observations are presented on the individual borelog sheets as well as on Drawing No. W.O. 71-11085A. The results indicate

that the water level, across the site, varies between elevations 424 and 426. These water levels correspond to depths below ground surface of from 0.5 to 1.5 feet.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a 44 ft. wide three-span (71'-60'-62') overhead structure at the crossing of the C.P.R. and Hwy. 17 'N' (W.B.L.). It is understood that the profile grade of Hwy. #17 'N' (W.B.L.), in the vicinity of the crossing, will be about elevation 459. The profile grade of the C.P.R. track is about elevation 430. It is proposed to extend the C.P.R. embankment about 20 ft. to the west to provide room for a second track. The associated approach fills will, therefore, have a maximum height of the order of 29 ft. in the longitudinal direction and 33 ft., above the existing ground surface, in the transverse direction.

The subsoil across the site is composed of a thin surficial organic deposit followed by a very stiff to firm grey clayey silt, which varies from 10 to 14 ft. in thickness. The cohesive stratum is underlain by a 26 to 40 feet thick generally non-cohesive glacial till deposit, which, in turn, is underlain by crystalline dolomite bedrock.

6.2) Approach Embankments:

No stability problems are anticipated for the height of fills contemplated, provided i) standard 2:1 slopes are employed and ii) all organic silt and peat is sub-excavated to its full depth from within the plan limits of the embankments. The sub-excavation should be backfilled with granular material to a level at least 1 foot above the prevailing groundwater level in the area.

The underlying clayey silt stratum will settle due to the loading of the approach fills, over a long-term period. In addition, some settlement will take place in the underlying

granular glacial till deposit. This settlement will be elastic in nature and negligible in magnitude. The estimated consolidation settlement due to the embankment loading, will be in the order of 3 to 4 inches. The total predicted consolidation settlement will take place in a relatively short period of time, e.g. approximately 50 percent within 12 months.

6.3) Structure Foundations:

The presence of the very stiff to firm compressible clay at a shallow depth below the ground surface will dictate the necessity of supporting the structure abutments and piers on piles.

The piers and abutments can be supported on end-bearing piles driven to their design load either within i) the competent glacial till stratum or ii) the upper fractured portion of the bedrock. For estimating purposes the pile tips can be assumed to be at the following elevations.

<u>Location</u>	<u>Estimated Pile Tip Elev.</u>	
West Abutment (B.H.'s #1 and 2)	385	Within Bedrock
West Pier (B.H.'s #3 and 4)	390	} Within Glacial Till
East Pier (B.H. #5)	393 to 398	
East Abutment (B.H. #6)	385 to 390	

Allowable loads will depend on the pile section chosen (e.g. 14BP74 steel H piles may be designed for 95 tons per pile).

At those locations where the pile tips will be located within the glacial till stratum the pile driving during construction, should be controlled by employing the Hiley Dynamic Pile Driving Formula, in accordance with current Department Standards, in order to attain the loads specified.

At least 4 feet of earth cover should be provided to the underside of the pile caps for frost protection purposes.

The base of the pier pile cap excavations will be below the groundwater level recorded during the period of the investigation. However, no major dewatering problems are anticipated due to the relatively impervious nature of the subsoil. Any groundwater seepage or surface runoff occurring in the excavation could be handled using standard techniques such as pumping from sumps.

No bouldery or rock fill should be placed in areas where piles are to be driven.

7. MISCELLANEOUS:

The field work for this project was carried out during the period of September 7 to October 22, 1971, under the supervision of Mr. W. G. Hutton, Project Foundation Engineer, who also prepared this report.

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

The equipment used was owned and operated by the F. E. Johnston Drilling Co. Ltd., Ottawa, Ontario.

W. G. Hutton
W. G. Hutton, P. Eng.

M. Devata
M. Devata, P. Eng.

WGH/ao
December 2, 1971.




APPENDIX I

FOUNDATION SECTION

ORIGINATED BY WE

COMPILED BY SO

CHECKED BY 

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _P WATER CONTENT ——— w		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.		WATER CONTENT % 15 30 45			
425.5	Ground Level										
0.0	Organic Silt		1	SS	3						GR SA SI CL 424.6
	Clayey silt, silty sand seams up to ¼" thick below el. 420. Firm to Stiff. Grey		2	TW	4		x>			126	
415.0	Silty sand, trace of gravel.		3	SS	10		+>				0 46 (54)
408.5	Dense. Grey		4	SS	11						
17.0	Glacial Till		5	SS	35						
	Het. mix. of silt, sand & gravel, trace of clay.		6	SS	36			150/80			
	occ. boulders up to 5" in size below el. 405. Dense to Very Dense Grey		7	SS	46						42 36 18
385.0	-fractured-		8	RC	10%						
40.5	Bedrock		9	SS	77						
	Crystalline Dolomite		10	SS	79						
371.0	Sound		11	SS	75/76						
54.5	White		12	RC	39%						
	End of Borehole		13	RC	37%						
			14	RC	59%						
			15	RC	91%						

FOUNDATION SECTION

ORIGINATED BY MT
COMPILED BY SO
CHECKED BY ED

SOIL PROFILE		SAMPLES	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — w _L PLASTIC LIMIT — w _p WATER CONTENT — w
ELEV. DEPTH	DESCRIPTION	NUMBER TYPE BLOWS / FOOT	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 400 800 1200 1600 2000	WATER CONTENT % w _p ———— w _L 15 30 45
26.0	Ground Level			
24.0	Organic Silt. Black	1 SS 5		
2.0	Clayey silt, silty sand seems up to 2" thick below EL. 20.	2 TW 7		
	Firm to Stiff.	3 TW 9		
		4 TW 11		
12.3	Grey	5 TW 13		
13.7	Silty sand, trace of gravel.	6 SS 14		
18.0	Compact. Grey	7 SS 16		
	Glacial Till	8 SS 25		
	Het. mix. of silt, sand & gravel, trace of clay	9 SS 30 1/2"		
		10 RC 72%		
	Boulders up to 12" in size below el. 22.	11 RC 50%		
		12 SS 18		
		13 SS 25%		
		14 SS 17%		
	Compact to Very Dense	15 SS 52%		
32.5	Grey	16 SS 52/23		
45.5	Bedrock	16 RC 52%		
	Crystalline Dolomite	17 RC 80%		
	Fractured - some weathering along vertical seams.	18 RC 53%		
		19 RC 66%		
36.2	White with Pink Zones	20 RC 55%		
61.3	Sound White	21 RC 90%		
52.5				
66.5	End of Borehole			

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11085

LOCATION Sta. 509 + 16 20' Lt.

ORIGINATED BY WH

W.P. 7-57-03

BORING DATE Sept. 7, 8, 9, 10 & 15, 1971

COMPILED BY SO

DATUM Geodetic

BOREHOLE TYPE Diamond Drill Washcoring

CHECKED BY JLN

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT 20 40 60 80 100	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	WATER CONTENT % 15 30 45			
425.7	Ground Level										
425.7	Organic Silt, Black	1	SS	7							P.C.F. GR SA SI CL
	Clayey silt	2	SS	19	420						424.2
	silty sand seams up to	3	TW	18							
	3" thick throughout.	4	TW	PH							
424.4	Firm to Very Stiff	5	TW	PH							121 0 37 47 16
423.3	Grey										
	Glacial Till	6	SS	8	420						
	Het. mix. of silt, sand	7	SS	38							16 38 41 5
	and gravel, trace of	8	SS	62	400						
	clay.	9	SS	116							5 52 33 10
	Roulders up to 17" in	10	SS	70 1"	370						
	size below el. 393.	11	SS	90 1"							
	Loose to Very Dense	12	RC	100%							
378.7	Grey	13	RC	20%	380						
417.9	Dolomite Bedrock	14	SS	75							
	occ. vertical seams	15	RC	90%							
373.7	Fractured. White	16	RC	5%							
52.0		17	SS	115 7/8"	370						
368.7	Highly weathered.	18	RC	4%							
57.0		19	RC	45%							
362.9	Fractured	20		53%							
62.8		21	RC	78%	360						
	Crystalline Dolomite										
	Bedrock										
	Sound										
353.7	White with Pink Zones	22	RC	86%							
72.0	End of Borehole				350						

FOUNDATION SECTION

ORIGINATED BY WES
COMPILED BY SO
CHECKED BY E.D.

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 71-11085

LOCATION Sta. 510 + 51 20' Lt.

ORIGINATED BY **WHE**

W.P. 7-67-03

BORING DATE October 18, 19, 20 & 21, 1971

COMPILED BY SO

DATUM Geodetico

BOREHOLE TYPE Diamond Drill Washboring

CHECKED BY: ELD

SOIL PROFILE		SAMPLES	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LQUID LIMIT ——— w _p PLASTIC LIMIT ——— w _s WATER CONTENT ——— w	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER TYPE BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
			O UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB. VANE	w _p — w — w _s — WATER CONTENT %		
			400 800 1200 1600 2000	15 30 45		
125.5	Ground Level				P.C.F.	GR SA SI CL
0.0	Clayey silt, silty sand seams up to ¼" thick throughout. Stiff to Very Stiff Gray	1 SS 6 2 SS 23 3 SS 11 4 SW 27	~1200	+ = 7	127.5	= 124.8
113.5	Silty Sand, some gravel Compact to Dense	5 SS 35 6 SS 76	~1100			
107.5	Glacial Till Net mix of silt, sand & gravel, trace of clay.	7 SS 75 8 SS 31 9 SS 50	~1000			12 45 33 10
18.0	Boulders up to 5" in size throughout. Dense to Very Dense Gray	10 SS 50-73 11 SS 52-71 12 SS 40-71 13 SS 80	~320			
372.2	Bedrock - Fractured Weathered along vertical seams	14 RC 100% 16 RC 82% 17 RC 62%	~370			22 45 26 7
365.5	Crystalline Dolomite Sound White with Pink Zones End of Borehole	18 RC 96% 19 RC 90%	~360			

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 71-11085

LOCATION Sta. 507 + 40

ORIGINATED BY WH

W.P. 7-67-03

BORING DATE Sept. 28, 1971

COMPILED BY SO

DATUM Geodetic

BOREHOLE TYPE Diamond Drill Washboring

CHECKED BY E.D.

[illegible]

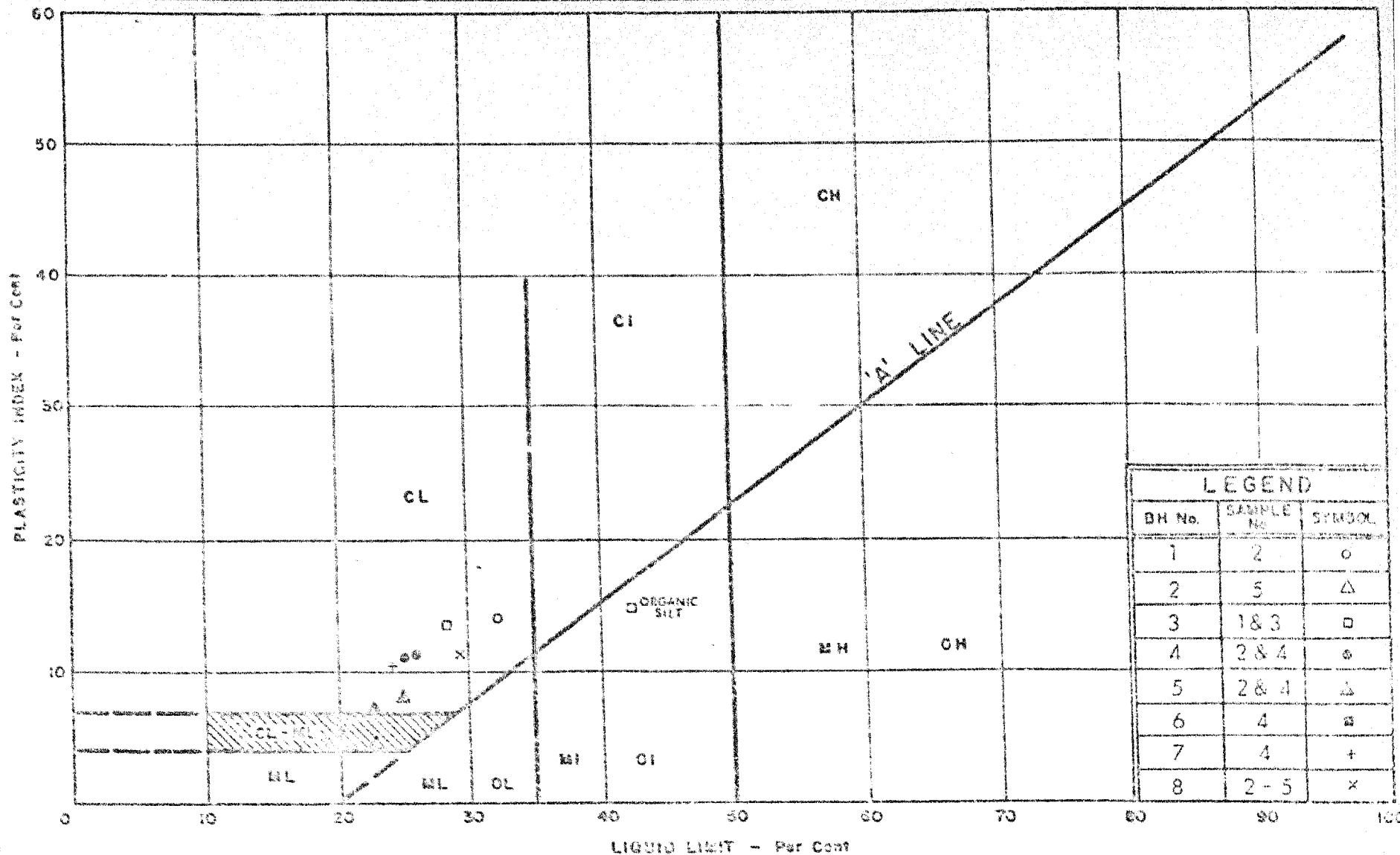
FOUNDATION SECTION

ORIGINATED BY WH

COMPILED BY SO

CHECKED BY EID

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _P WATER CONTENT ——— w	BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	SHEAR STRENGTH PS.F.	W _p ————— W ————— w _i WATER CONTENT % 15 30 45	P.C.F.	
425.5	Ground Level				20 40 60 80 100			
0.0	Organic Silt. Brown	(X)	1	C.S.				
2.0	Clayey silt silty sand seams up to 2' thick throughout.		2	TW			126	424.8
			3	SS				
			4	TW				
			5	TW			124.5	
422.6	Grey		6	TW				
12.9	Silty sand, some gravel		7	SS				
	Glacial Till		8	SS				
	Het. mix. of silt, sand & gravel, trace of clay		9	SS				3 48 44 5
	Loose to Very Dense		10	SS				
			11	SS				
	Grey		12	SS				6 49 30 15
334.5			13	SS				
31.0	End of Borehole							

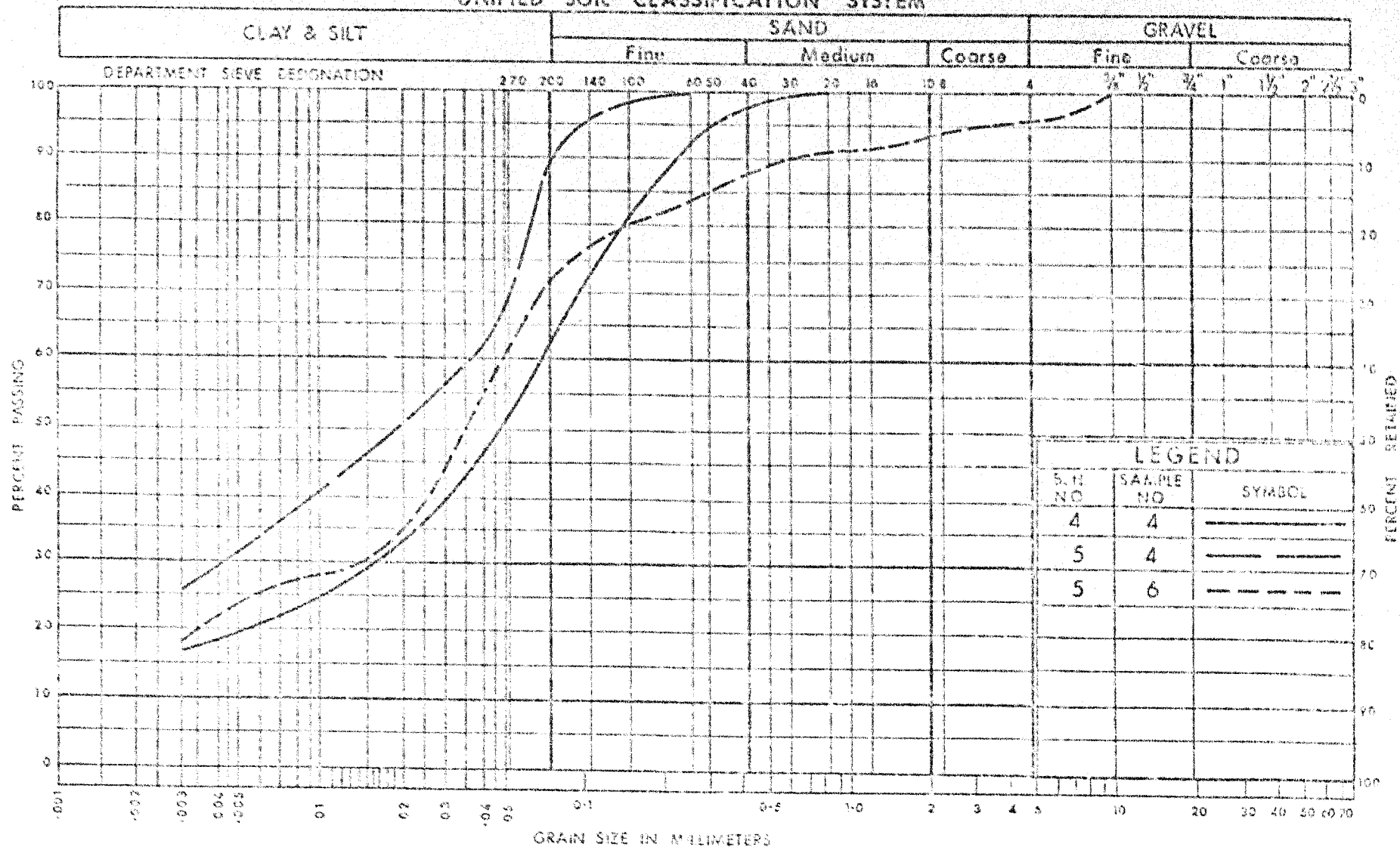


DEPARTMENT OF HIGHWAYS
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PLASTICITY CHART CLAYEY SILT THIN SILTY SAND SEAMS

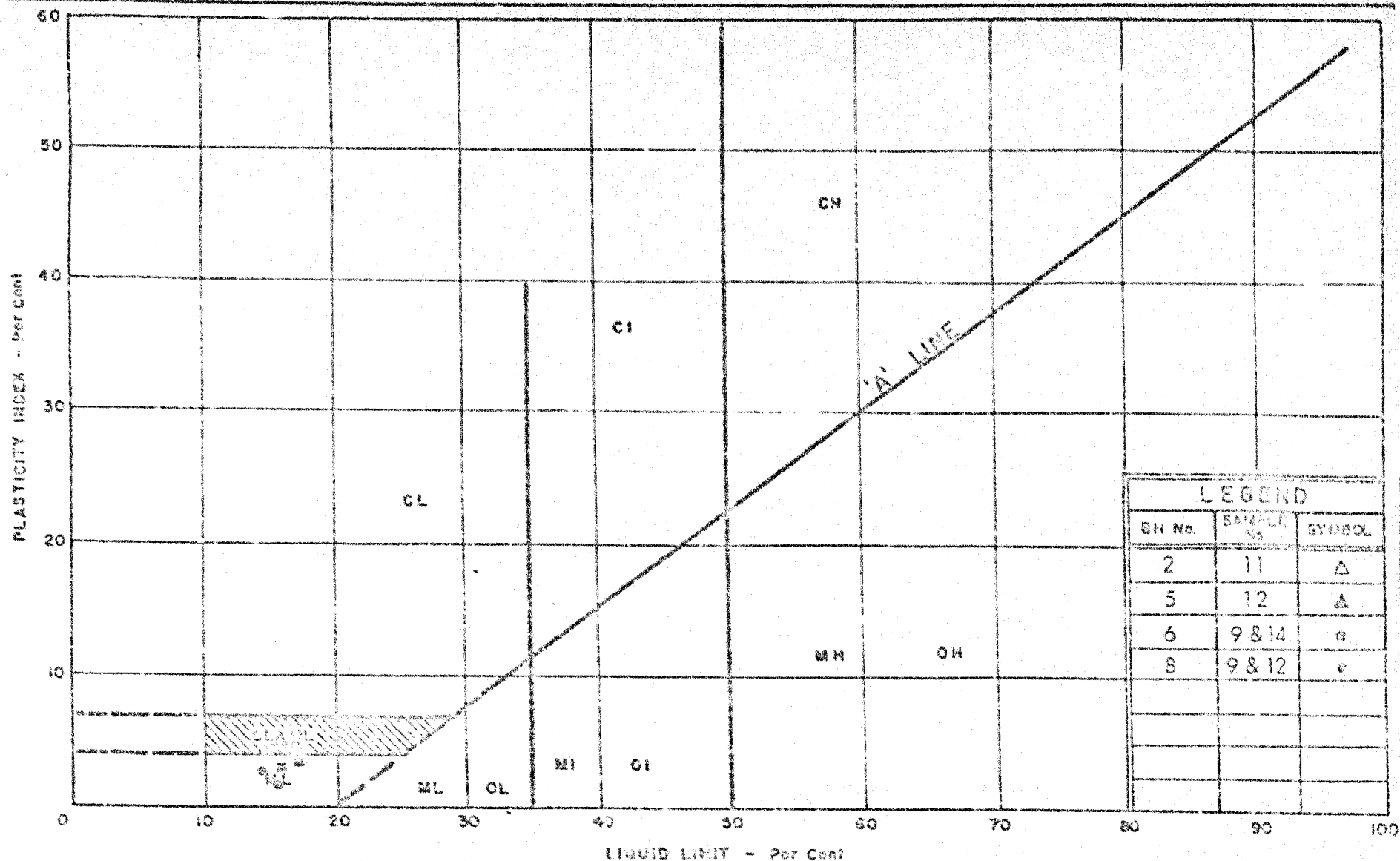
WP No. 7-57-03
JOD No. 71-11085
FIG. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
CLAYEY SILT
WITH SILTY SAND SEAMS

W.P. No. 7 - 67 - 03
JSD No. 71-11035
FIG. 2



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART

GLACIAL TILL

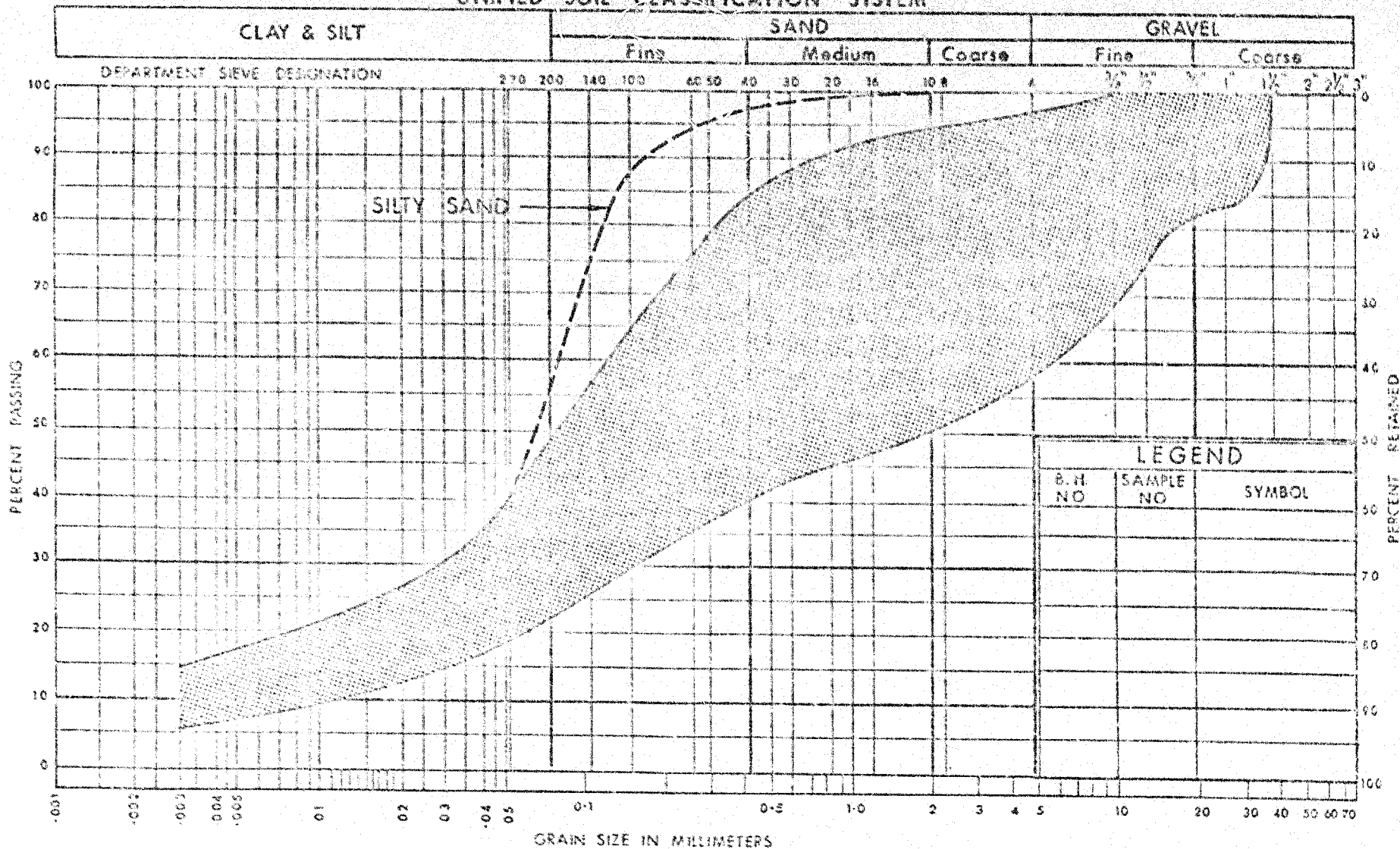
HEAVY MIXTURE OF SILT, SAND & GRAVEL, TRACE OF CLAY

WP No. 7-67-03

JOB No. 71-11085

FIG. 3

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

GLACIAL TILL

HET. MIXTURE OF SILT, SAND & GRAVEL, TRACE OF CLAY

DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES
BRANCH

W.P. No. 7-67-03

JOB No. 71-11085

FIG. 4

VOID RATIO - PRESSURE CURVES

JOB NO. 71-11085

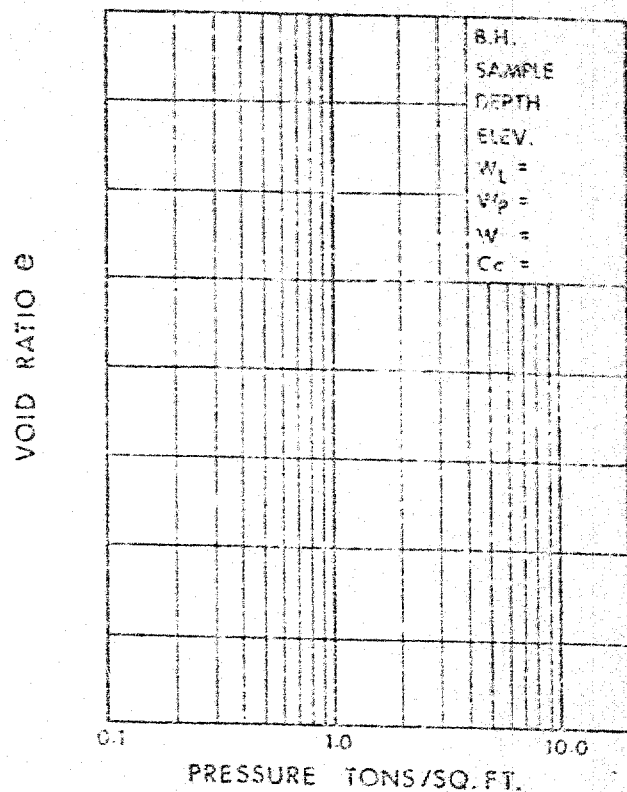
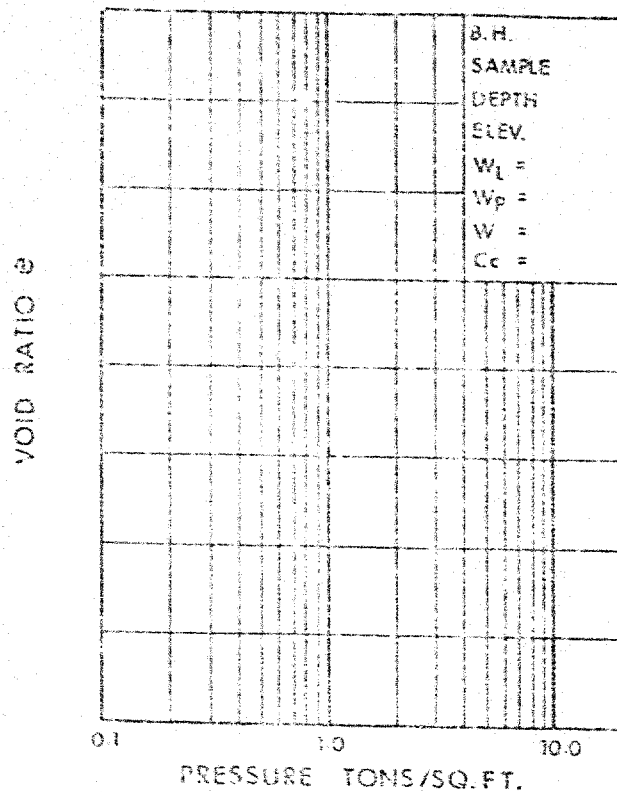
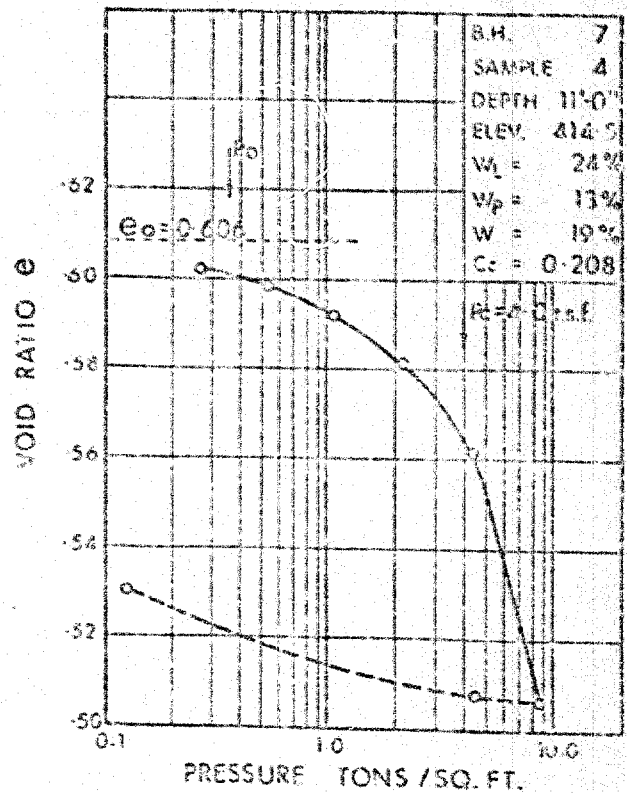
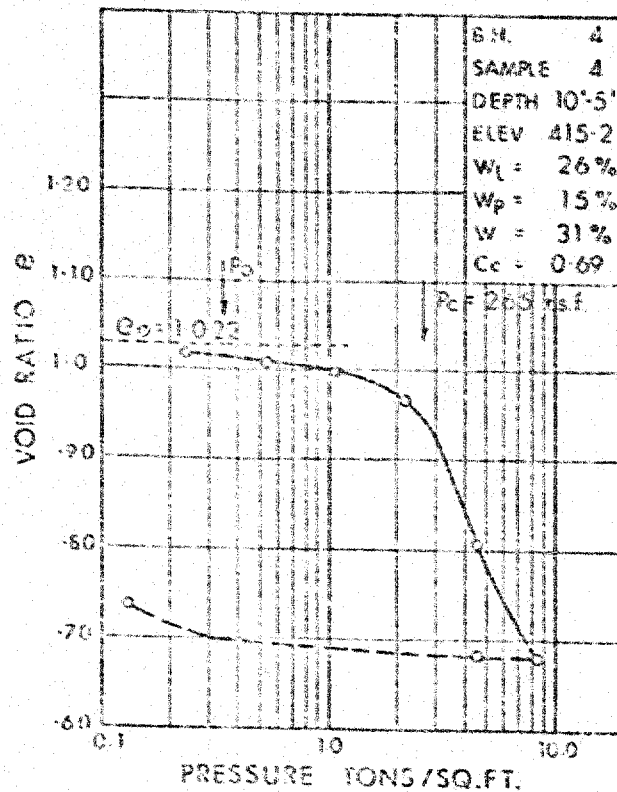


FIG. 5

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE "N" - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 300 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

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

TYPE OF SAMPLE

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

SOIL TESTS

QU	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNPAINED TRIAXIAL	F.V.	FIELD VANE
QCB	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_r	SENSITIVITY

GENERAL

π	≈ 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

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

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. A. G. Stermac,
Principal Foundation Engineer,
Downsview, Ontario.

FROM: Bridge Section,
Kingston, Ontario.

ATTENTION: Mr. M. Devata

DATE: January 7, 1972.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 5-67-01, Renfrew By-pass,
Highway 17N, District 9 - Ottawa

With reference to my discussion with Mr. Devata on Thursday, January 6th, I enclose copy of part Plan B-68-17 (N)-2 and Profile C-68-17 (N)-2 with Creek 'A' marked to denote the location where Regional Materials and Testing Section have requested a bore hole to be placed.

In addition to bore hole 'A' I shall be glad if you will carry out an investigation at location 'B' on the same Creek where proposed Highway 17N westbound lane crosses it.

T. C. Kingsland
T. C. Kingsland
Regional Bridge Planning Engineer

TCK/1
Encl.
c. 1 -

E. R. Saint - Att. M. Batten
C. S. Grebski

ONA
12/Jan/72
72-F-013
73-186

MEMORANDUM

To: Mr. M. Devata,
Supervising Foundation Engineer,
Room 107, Central Building.

FROM: Soils Office,
Design Services Branch,
1st Floor, West Building

ATTENTION: Mr. B. Darch

DATE: January 20, 1972.

OUR FILE REF.

IN REPLY TO

SUBJECT:

Bridge-Site Investigations
W. P. 5-67-01 & W. P. 6-67-02
District #9 - Ottawa

As requested by you, I am enclosing a report on the above proposed river crossing.

It is recommended that the loads should be transferred through the unsuitable clayey soils to a more suitable bearing stratum below it.

No instability problems of any major significance are anticipated.

Please feel free to let us know if we can be of any further assistance in the matter.



B. Sen Mathur,
Airphoto Interpretation Engineer.

BSM/sd
Enclosed (2)

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. T. C. Kingsland, (4) FROM: Foundations Office,
Regional Structural Planning Eng., Design Services Branch,
Eastern Region, West Bldg., Downsview.
Kingston, Ontario.

ATTENTION:

DATE: June 26, 1972.

OUR FILE REF.

IN REPLY TO

JUL 4 1972

SUBJECT:

31 F-53

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossings of Hwy. #17 (New) W.B.L.
and O'Brien St. Extension and Creek Valley
Concession 4 Lots 9 and 10
Township of Horton County of Renfrew
District No. 9 (Ottawa)
W.O. 72-11013 -- W.P. 5-67-01

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

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

AGS/ao

Atch.

cc: Messrs. D. W. Farren

B. R. Davis

A. Rutka

S. J. Markiewicz

J. E. Callaghan

B. J. Giroux

E. R. Saint

G. A. Wrong

B. A. Singh

A. G. Stermac

A. G. Stermac,

PRINCIPAL FOUNDATIONS ENGINEER.

Foundations Files ✓
Documents

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 3. FIELD AND LABORATORY WORK.
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 - 4.2) Site B - Hwy. #17 (New) W.B.L. Crossing.
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 - 6.2.1) General.
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 - 6.3.3) Culvert (C.S.P.) Installation.
 7. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossings of Hwy. #17 (New) W.B.L.
and O'Brien St. Extension and Creek Valley

Concession 4 Lots 9 and 10

Township of Horton County of Renfrew

District No. 9 (Ottawa)

W.O. 72-11013

W.P. 5-67-01

1. INTRODUCTION:

The Foundations Office was requested to carry out a foundation investigation at the two aforementioned creek crossing locations on Concession 4, lots 9 and 10, in the Township of Horton, County of Renfrew. The request for this foundation investigation was contained in a memo from Mr. T.C. Kingsland, Regional Bridge Planning Engineer, Eastern Region, dated January 7, 1972. An investigation was subsequently carried out by this Office to determine the subsoil, bedrock and groundwater conditions at the respective crossings.

This report contains the factual results obtained from the investigation. Included, are recommendations pertaining to the stability and settlement considerations associated with the fills required to cross this valley, as well as recommendations pertaining to the installation of culverts required to carry the creek beneath the fill sections.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The area under consideration is located immediately north of O'Brien St. just outside the east limits of the town of Renfrew. The land in this area is being cultivated and used for farming purposes.

The terrain is rolling to undulating in relief between about elevations 415 to 430. Numerous creeks and rivers have cut deeply into the overburden in this region. Immediately north of O'Brien Street such a gorge exists. This gorge is 30 to 60 feet deep and has a crest width varying from 250 to 300 feet. The side slopes range randomly from 1½:1 to 2:1. A shallow (2 feet deep) creek flows along the floor of this valley.

In Renfrew County there are prominent east-west trending scarps (fault zones) on both sides of a valley which encompass the area being considered. The south-westerly one, lying south of Calabogie Lake and Clear Lake, is known as the St. Patrick fault, while on the north-eastern side, the Coulange fault separates the valley from the Laurentian Plateau. Thus, a block, 35 miles in width, has been down-dropped, forming a depression which is geologically known as the "Ottawa-Bonnechere" graben. The Ottawa River is located within this downdropped block. Within it are many minor breaks and disconformities.

The majority of this valley is situated in the physiographic region known as the "Ottawa Valley Clay Plains". Here, extensive clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region; in some localized areas it is known to extend to depths in excess of 200 feet. The clay is generally underlain by glacial till and/or interglacial sand and gravel deposits, followed in turn by bedrock of Precambrian Age.

3. FIELD AND LABORATORY WORK:

Four boreholes were put down during the period of the investigation; these borings were advanced by the use of a conventional diamond drill rig adapted for soil sampling purposes. Samples of the overburden were obtained at specified intervals, in a 2" O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. In the cohesive portion of the overburden, the testing programme was supplemented by taking 2" I.D. Shelby tube samples, which were manually pushed into the soil. In addition, field vane tests were carried out, where possible, to determine the undrained shear strength of the clay stratum. Bedrock was proven in one of the boreholes by obtaining BX size rock core samples. The groundwater conditions, during the period of the investigation, were recorded by taking readings in the open boreholes.

The soil conditions, encountered at the boring locations, are presented on the Record of Borelog sheets. The locations and elevations of the various boreholes were provided by personnel from the Eastern

Region Engineering Surveys Section. The elevations in this report are referenced to a geodetic datum. Boring locations and elevations are shown on Drawing No. 72-11013A. Two stratigraphical sections across the site are also shown on this drawing.

All the samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

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

The results of the testing are plotted on the Record of Borelog sheets and summarized on Figures #1 and #2, both of which are contained in the Appendix of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

Borings were put down at two separate points along the gorge; these are designated as Sites A and B. The location of each of these sites is shown in plan on Drawing No. 72-11013A. The stratigraphy at each site, as inferred from the boring data, is also shown on the aforementioned drawing. The stratigraphical sequence encountered is quite different at the two sites, this being the case, the subsoil conditions at each crossing, will be discussed separately in the sub-sections to follow.

4.1) Site A - O'Brien St. Extension Crossing:

1) Silty Sand - Surficial Deposit:

A surficial deposit of very dense silty sand was encountered along the valley bank (refer to B.H. #1). The thickness of this deposit was 4 feet.

ii) Clayey Silt Stratum:

A cohesive stratum composed of stiff to very stiff clayey silt, with layers of sand up to 3" thick throughout, underlies the surficial granular deposit. This stratum is 12.5 feet thick.

iii) Silty Sand to Sand:

On the valley banks the cohesive deposit is underlain by a compact to dense ('N' values between 9 and 44) silty sand to sand with a trace of clay, silt and gravel throughout. The gorge has cut through the clayey silt stratum, thus the valley floor is directly underlain by this stratum. On the valley floor this deposit has a thickness of 16 feet. Grain-size distribution curves, obtained on representative samples from this deposit are plotted on Figure #1 in the Appendix.

iv) Glacial Till:

A 2.5 feet thick deposit of very stiff to hard glacial till composed of a clayey silt with sand and gravel underlies the granular deposit.

v) Marble Bedrock:

Bedrock was proven in B.H. #2 by obtaining 7 feet of BX size rock core samples. The surface of the bedrock was encountered at about elevation 370 - i.e., 18.5 feet below the valley bottom. The bedrock was composed of marble which is in a relatively sound condition.

4.2) Site B - Hwy. #17 (New) W.B.L. Crossing:

i) Clayey Silt with Sand and Gravel:

In this area a thin topsoil cover is underlain by a cohesive stratum, composed of very stiff to hard ('N' values between 25 blows/ft. and 60 blows for 6 inches) clayey silt with some sand and gravel. The thickness of this stratum varies from 4 feet on the valley floor to 13.5 feet on the valley banks.

ii) Sandy Gravel to Sand and Gravel:

The cohesive stratum is underlain by a granular deposit composed of compact to very dense ('N' values between 25 and 88 blows/ft.) sandy gravel to sand and gravel. The granular deposit was not fully

penetrated at the site; however, it was proven to extend to a depth of at least 20.5 feet at B.H. #3. Grain-size distribution testing was carried out on samples obtained from this material using 2" O.D. sampling equipment. The results are plotted on Figure #2, in the Appendix.

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out during the period of the investigation by recording the water levels in the open borings. The observations are recorded on the Borelog sheets and summarized on Drawing No. 72-11013A.

Based on these observations, it is estimated that the groundwater level is at about elevation 379, which corresponds to a depth of 9 feet below existing ground surface at the bottom of the gorge. This groundwater level is similar to that recorded during a previous investigation in this area (W.C. 69-F-73, Feb. 24, 1970).

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

The O'Brien St. Extension and Hwy. #17 (New), W.B.L. will cross the same natural gorge in the Township of Horton, County of Renfrew. The crossings have been designated as Site A and Site B, respectively.

The proposed profile grades for the O'Brien St. Extension and Hwy. #17 (New), in this area, are shown on Drawing No. 72-11013A. At these grades, fills between 40 and 60 feet in height will be required to cross the natural gorge. It is understood that the water in the creek, located on the floor of the gorge, will be carried through these fill sections using corrugated steel pipes (C.S.P.).

Comments with regard to the stability and settlement considerations associated with the fills to be constructed over this gorge will be discussed separately in the sub-sections to follow.

6.2) Site A - O'Brien St. Extension Crossing:

6.2.1) General:

Drawing No. 72-11013A shows the profile grade proposed for the

O'Brien St. Extension in this area. The fill height across the natural gorge will be of the order of 40 feet. In addition, the street will be in a cut section, both north and south of the gorge. The maximum depth of the cuts will be about 5 feet.

6.2.2) Stability and Settlement Considerations - Fill over Gorge:

The earth fill will be placed directly on a competent granular deposit (refer to B.H. #2). No stability problems are, therefore, anticipated provided,

- i) standard 2:1 slopes are employed, and
- ii) that the fill material is properly placed and compacted in accordance with current M.T.C. practices.

Settlement will be induced in the foundation subsoil by the fill loading. As the granular subsoil is competent in nature, settlement should not exceed 1 inch; further, it will be elastic in nature - i.e., take place during or immediately following the construction period.

6.2.3) Culvert (C.S.F.) Installation:

Prior to placing the culvert all soft or otherwise unacceptable material, located within the flood plain of the existing creek, should be sub-excavated and replaced with a granular type of material. The bedding and backfilling of the culvert should be carried out in accordance with current M.T.C. practices, namely Type I - Earth Excavation, Standard No. DD-808A.

6.3) Site B - Hwy. #17 (New) W.B.L. Crossing:

6.3.1) General:

Drawing No. 72-11013A shows the profile grade proposed for Hwy. #17 (New) in this area. The fill height across the natural gorge will be of the order of 60 feet. In addition, the highway will be in a cut section, both east and west of the gorge. The maximum depth of the cuts will be about 14 feet.

6.3.2) Stability and Settlement Considerations - Fill over Gorge:

The maximum height of the earth fill will be placed directly

on a thin (4 feet thick) competent cohesive stratum which is underlain by an extensive granular deposit (refer to S.H. #3). No stability problems are, therefore, anticipated provided,

- i) standard 2:1 slopes are employed, and
- ii) that the fill material is properly placed and compacted.

Settlement will be induced in the foundation subsoil by the fill loading. Computations have been carried out and the results have indicated that the settlement should be within 2 inches. This settlement will be elastic in nature - i.e., take place during or immediately following the construction period.

6.3.3) Culvert (C.S.P.) Installation:

Any soft or otherwise unacceptable material, located within the flood plain of the existing creek should be sub-excavated and replaced as discussed in sub-section 6.2.3). The bedding and backfilling of the culvert should be carried out in accordance with current M.T.C. practices, namely Type #1 - Earth Excavation, Standard No. DD-808A.

7. MISCELLANEOUS:

The field work for this project was carried out during the period from February 10, to February 24, 1972, under the immediate supervision of Mr. W.V. Urie, Foundations Technician (Field) and general supervision of Mr. B.T. Darch, Senior Foundations Engineer.

The drilling equipment was owned and operated by F.E. Johnston Drilling Co. Ltd., Ottawa, Ontario.

This report was written by Mr. E.C. Ballinger, Student Technician (Field) and reviewed by Mr. M. Devata, Supervising Foundations Engineer.

ECB/ht

E.C. Ballinger
E.C. Ballinger

M. Devata
M. Devata, P. Eng.

June 23, 1972

APPENDIX I

CHECKED BY *[Signature]*

[illegible]

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 72-11013

LOCATION Sta. 662 + 80 E Hwy. 17 (new) W.B.L.

ORIGINATED BY WVU

W.P. 5-67-01





BORING DATE Feb. 15, 1972

COMPILED BY WVU

DATUM Geodetic

BOREHOLE TYPE NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w <div>w_p ——— w ——— w_L</div>				BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE						WATER CONTENT % 10 20 30					
357.5	Ground Level																	
0.0	Clayey silt with grav. (occ. boulders)		1	SS		350										72 23 (1) No water observed		
353.4	Hard																	
4.1	Sandy Gravel		3	SS	45													
			4	SS	41													
				5	SS	26	340									63 30 (5)		
				6	SS	26												
				7	SS	30												
			8	SS	25													
333.0	Compact to Dense		9	SS	33													
24.5	End of Borehole					330												

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 72-11013

LOCATION Sta. 161 + 70 @ Hwy. 17 (New) WBL

ORIGINATED BY WJU

W.P. 5-67-01



BORING DATE Feb. 24, 1972

COMPILED BY SVU

DATUM Geodetic

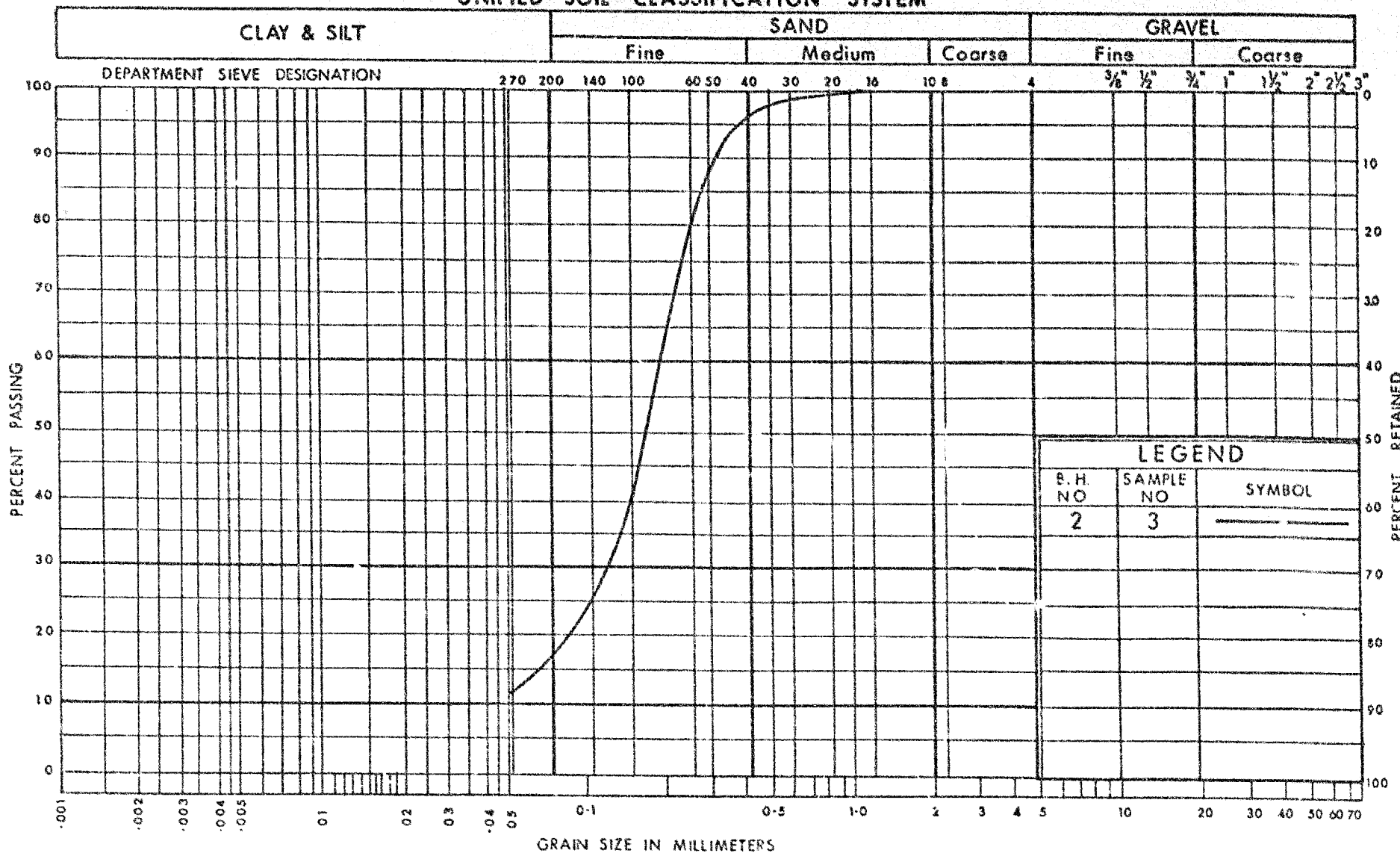
BOREHOLE TYPE NX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w				BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE				w_p ——— w ——— w_L						
416.8	Ground Level															
415.3	Topsoil		1	SS	21.5	frozen									GR. SA. SI. CL.	
1.5	Clayey silt with some sand (some gravel below El. 408.)		2	SS	28	410									BH Dry	
			3	SS	25											
			4	SS	42											
			5	SS	73											
401.8	Very Stiff to Hard															
15.0	Sand and Gravel		6	SS	29	400										
			7	SS	43											
			8	SS	88	390										
			9	SS	50											
384.8	Compact to Very Dense															
32.0	End of Borehole					380										

BH Dry

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION

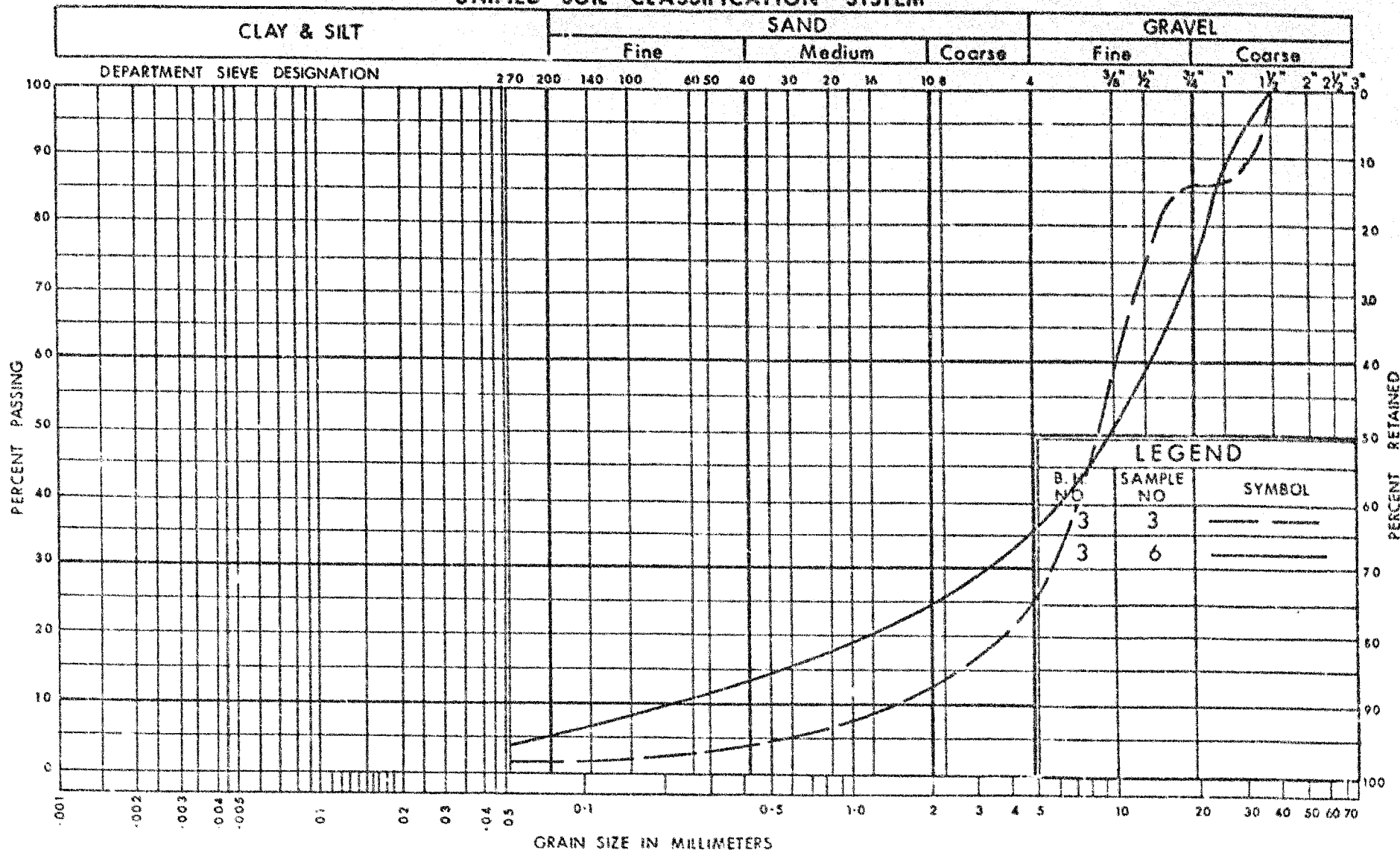
SILTY SAND TO SAND

W.P. No. 5-67-01

JOB No. 72-11013

FIGURE No. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION
SANDY GRAVEL TO SAND & GRAVEL

W.P. No. 5-67-01

JOB No. 72-11013

FIGURE No. 2

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS -

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

TYPE OF SAMPLE

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	OS	OESTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH	SAMPLE ADVANCED HYDRAULICALLY	
	PW	SAMPLE ADVANCED MANUALLY	

SOIL TESTS

QU	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	FIELD VANE
QCU	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
Q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{C_v t}{d^2}$ (d , DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_s	SHEAR STRENGTH
c'	EFFECTIVE COHESION
	INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_s	SENSITIVITY

GENERAL

π	$= 3.1416$
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

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

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
θ	ANGLE OF SLOPE TO HORIZONTAL

MEMORANDUM

TO: Mr. E. R. Saint,
Regional Materials Engineer,
Eastern Region,
Kingston, Ontario.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION: Mr. M. Batten.

DATE: July 11, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT: Suitability of Cut Material,
Vicinity of Bonnechere Bridge
Hwy. #17N, Near Renfrew
W.P. 5-67-01 W.O. 73-11057(X)

As requested by your Office, we have carried out three sampled boreholes at the above-described location.

We believe the purpose of this investigation is to determine the physical properties of the natural subsoil so that the cut material in this area could be used as fill material for the construction of Hwy. #17N.

Physical properties, as determined from field and laboratory tests, are as follows:

	<u>Range</u>	<u>Average</u>
Natural Moisture Content (%)	21 - 51	39.9
Liquid Limit (%)	34 - 57	49.6
Plastic Limit (%)	24 - 37	27.7
Bulk Density (p.c.f.)	106 - 118	113.1
Undrained Shear Strength (p.s.f.)	700 - 2220	1254
'N' Values (blows per foot)	11 - 23	16

Grain-size distribution curves are plotted on Fig. 1. Proctor Tests give the following results:

B.H. #1 (Samples #2, #3, #5 and #6 Combined)

Maximum Wet Density:	118.2 p.c.f.
Maximum Dry Density:	91.7 p.c.f.
Optimum Moisture Content:	28.6%

B.H. #2 (Samples #2, #3, #5 and #6 Combined)

Maximum Wet Density:	118.3 p.c.f.
Maximum Dry Density:	92.3 p.c.f.
Optimum Moisture Content:	28.4%

B.H. #3 (Samples #1, #2, #4 and #5 Combined)

Maximum Wet Density:	121.6 p.c.f.
Maximum Dry Density:	96.6 p.c.f.
Optimum Moisture Content:	25.8%


The test results are also plotted on the attached Record of Borehole sheets.

The locations and elevations of the borings will be determined by your Office.

We believe that the above information will be sufficient for your immediate requirements. If additional information is required, please contact our Office.

PP/ao
Atch.
c.c. J. A. Cruickshank
A. Rutka
G. A. Wrong

Foundations Files ✓
Documents


P. Payer,
Senior Foundations Engineer,
For: M. Devata,
Supervising Foundations Engineer.

DESIGN SERVICES BRANCH

FOUNDATION OFFICE

RECORD OF BOREHOLE NO 1

JOB ~~73-11057~~ (x)

LOCATION #

ORIGINATED BY JB

W.P. 5-67-01

BORING DATE June 12, 1973

COMPILED BY PP

DATUM -

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 1000 2000 5000			WATER CONTENT % W_P W W_L 15 30 45			
0.0	Ground Level												
	Silty clay and clay		1	SS	12								0 7 51 42
			2	TW	PH								115
	Trace of sand		3	TW	PH								112
			4	SS	11								0 9 41 50
			5	TW	PH								106
			6	TW	PH								109
			7	TW	PH								109
12.0	End of Borehole												
	Note: Max.wet density: 118.2 PCF Max.dry density: 91.7 PCF Optimum Moisture: 28.6% (Samples #2, #3, #5 and #6 combined)												

* Location and Elevation will be determined by the Regional Materials Office

DESIGN SERVICES BRANCH

FOUNDATION OFFICE

RECORD OF BOREHOLE NO 2

JOB ~~73-11057~~(x)

LOCATION *

ORIGINATED BY JB

W.P. 5-67-01

BORING DATE June 12, 1973

COMPILED BY FP

DATUM -

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W W_P — W — W_L			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE 1000 3000 5000			WATER CONTENT % 15 30 45				
0.0	Ground Level													
	Clayey silt and clay		1	SS	23									
			2	TW	PH								114.5	
	Some Sand		3	TW	PH								111	
			4	SS	19									0 13 39 48
			5	TW	PH								111	
			6	TW	PH								111	
12.5	End of Borehole													
	Note: Max. Wet Density: 118.3 PCF Max. Dry Density: 92.3 PCF Optimum Moisture: 28.4% (Samples #2, #3, #5 and #6 combined)													

* Location and Elevation will be determined by the Regional Materials Office

DESIGN SERVICES BRANCH

FOUNDATION OFFICE

RECORD OF BOREHOLE NO 3

JOB MI 73-11057(x) LOCATION * ORIGINATED BY JB
 W.P. 5-67-01 BORING DATE June 12, 1973 COMPILED BY PP
 DATUM - BOREHOLE TYPE Cont. Flight Auger CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— W_L PLASTIC LIMIT ——— W_P WATER CONTENT ——— W W_P ——— W ——— W_L WATER CONTENT % 15 50 45	BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT						
0.0	Ground Level										
	Clay Trace of sand		1	TW	PH					116	0 5 55 40
			2	TW	PH						
			3	TW	PH						
			4	TW	PH						
			5	TW	PH						
11.5	End of Borehole										
<p>Note: Max. Wet Density: 121.6 PCF Max. Dry Density: 96.6 PCF Optimum Moisture: 25.8% (Samples #1, #2, #4 and #5 combined)</p>											

* Location and Elevation will be determined by the Regional Materials Office

* Location and Elevation will be determined by the Regional Materials Office

MEMORANDUM

75-11-013

TO: Mr. R. J. Forrest,
Regional Schedule Co-Ordinator,
KINGSTON, Ontario.

FROM: Materials and Testing Office,
KINGSTON, Ontario.

ATTENTION:

DATE: April 9th, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT: W. P. 5-67-01, Hwy. 17N, From 9.7 Mi. W. of Arnprior W. Limits W'y. to 0.7
Miles W. of County Road # 4, District # 9, Ottawa

The Pre-Contract Review Meeting for the above noted project decided that Materials and Testing would assess the proposed wet clay cuts with a view to providing lab data for field control of the fill construction where this material is being used. On assessing the material in these cuts, for this purpose, it has become apparent that alterations to the soils design may be necessary.

It is therefore requested that pre-engineering dates be established for re-assessment of the soils design and any subsequent System's Design work. These dates can be established at the Scheduling Meeting on April 17th.

A. M. Batten
A. M. Batten,
Senior Soils Supervisor

AMB/sjgp

c. c. - A. J. Percy
M. Devata -
G. A. Wrong
J. E. Callaghan

Design Services Branch,
1201 Wilson Avenue,
Downsview, Ontario.
M1M 1J8

May 4, 1973.

Telephone: 246-3182.

Master Soil Investigation,
184 Kenhar Drive,
Woodbridge, Ontario.

Dear Sirs:

This letter confirms our request of May 1, 1973,
for the supply of C.M.S. 843 Auger machine together with
all necessary equipment, as specified under the terms of
our Contract Agreement, at Alfred, Ontario, on May 7, 1973.

Mobilization will be from Ottawa.

Our Project Number is W.O. 73-11015 & 73-11024.

Yours truly,

*Foundations Office Advice - no work shut
for 5 hrs at Kenhar done as addition
to W.P. 73-11016
Changed to General W.P. 73-11050*

M. Devata,
Supervising Foundations Eng.,
A. G. Sternac,
Principal Foundations Eng.

c.c. W. W. Fry
(Attn: Mrs. J. McLaren)

For:

Foundations Files
Documents

Design Services Branch,
1201 Wilson Avenue,
Downsview, Ontario.
M3M 1J8

Telephone: 248-3282.

July 23, 1973.

Master Soil Investigation,
104 Kenhar Drive,
Weston, Ontario.
M9L 1W4

Dear Sirs:

This letter confirms our request of June 11, 1973,
for the supply of C.M.E. 55 together with all necessary
equipment, as specified under the terms of our Contract
Agreement, at Kenfrew on June 12, 1973.

Mobilization will be from Ottawa, Ontario.


Our Project Number is W.O. 73-11057(X).

Yours truly,

MD/ao

C.C. W. W. Fry
(Attn: Mrs. M. Porter)

For:


M. Devata,
Supervising Foundations Engineer,
A. G. Sternac,
Principal Foundations Engineer.

Foundations Files
Documents


P.S. Please resubmit Invoice sent out June 28, 1973, re
Kenfrew, Ontario, quoting the above-noted W.O. number.

Re: Meeting on Contract Documents Review
Boardrooms E-1 and E-2.

The following contract documents and drawings will be available for review on Friday, October 12, 1973 at 9:00 a.m.

No.	W.P.	Cont.	Hwy.	Dist.	Location	Type	Adv. Date
1*	802-66-01 (Gr.No.) 825-71-01		7,8	3	Hwy. 7 & 8 from New Hamburg Diversion W'ly to Shakespeare Pav East limits & Hwy. 59 from Tavistock North limits N'ly to Shakespeare.	HM	Nov. 7/73
			59				
2*	208-65-02 (Gr.No.) 122-68-01		124	11	2.5 mi. W. of Hwy. 11 W'ly 4.3 mi. & from 8.2 mi. W. of Hwy. 11 W'ly 2.8 mi.	G-D GB	1974
3*	926-70-01 (Gr.No.) 115-72-01		69	11	From 2.0 mi. N. of Nobel N'ly 14.22 mi.	HM Pav	1974
4	5-67-01 (Gr.No.) 71-11-013 ⑥ 6-67-02 71-11-084 ⑦ 7-67-02 - 71-11-087 ⑧ 7-67-03 71-11-085		17	9	From 9.7 mi. W. of Araprior W. limits W'ly 9.27 mi.	G-D & Str.	Nov. 7/73
			(New)				

EJO/dp
 * FILMS WILL BE SHOWN


 E. J. Orr,
 Director.

Systems Design

J. R. Wear
 D. W. Fry
 G. K. Hunter
 V. A. McCullough
 A. Kip
 A. Wittenberg
 J. Percy
 S. McCombie
 E. J. Willis (5)

Design Services

W. Melinyshyn
 S. Cobden
 M. Stoyanoff
 C. Grebski
 G. A. Wrong
 A. Sternac
 W. McFarlane
 T. Stolarski

Operations

L. R. Eadie
 J. E. Callaghan
 D. M. Hopper
 R. Verscheure
 A. Rutka
 W. R. Bennett
 Z. Katona

Others

A. Lennox
 J.M. Crannie
 A. E. Argue
 J. MacDougall
 B. J. Giroux
 M. Queen
 J. Parkinson

Donnacona River Str. — At Pier #3, #4 within river channel,
 (71-11084) piles have to penetrate the bouldering zone. Reinforced
 tips for these piles recommended as per our letter Oct. 3/73

71-11084 17N 20L C CNR — C.K.

71-11085 17N 20L C CNR — Surface organic silt should be removed

Telephone(416) 248-3282.

Soil Mechanics Section,
Geotechnical Office,
West Building,
1201 Wilson Avenue,
DOWNSVIEW, Ontario. M3M 1J8

November 8th, 1974.

Hawthorne Drilling Ltd.,
P.O. Box 4218,
Station "E", Hawthorne Road,
OTTAWA, Ontario. K1S 5A7

Dear Sirs:

This letter confirms our request by telephone of November 6th, 1974, for the supply of a Type II Auger Drill Machine (Item No. 5.2.1), together with all necessary equipment, as per your Tender for Supply Contract S-74-2110, at Renfrew, Ontario, on November 12th, 1974.

Mobilization will be from Ottawa, Ontario.

Our Project Number is Contract 73-186.

Yours truly,

M. Devata,
Supervising Engineer.

MD/mj
c.c. W.W. Fry
(ATTN: Mrs. M. Porter)

Files (2)
Documents

MEMORANDUM

TO: Mr. A.J. Percy,
Manager,
Systems Design,
Eastern Region, Kingston.

FROM: Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

ATTENTION:

DATE: November 25th, 1974.

OUR FILE REF.

IN REPLY TO

SUBJECT: Highway 17N - Westbound Lane near Jamieson's
Property; Sta. 393+00 to 396+50,
Township of Horton, County of Renfrew,
District #9, Ottawa, Contract No. 73-186.

Construction of Highway 17N westbound lane is in progress under Contract No. 73-186. According to the original design, the top of cut for the westbound lane will be well within the property of Mr. Jamieson. Due to difficulties in resolving property problems, it was concluded that a revision in alignment would be desirable in this area. In order to determine the subsoil, groundwater, and bedrock conditions as requested by your office, a foundation investigation consisting of eight sampled boreholes have been carried out at the above-mentioned site between November 12th, 1974 and November 16th, 1974.

These borings revealed that the bedrock surface is considerably lower than those indicated on the Soils Profile submitted by the Regional Materials Section (Kingston). The bedrock surface inferred from our fieldwork varies from elevations 468.4 to 476.8 as shown on enclosed drawing No. 56701-A. The overburden essentially consists of granular type of material, predominantly silty fine sand with occasional gravel. In addition, random boulders were present within the overburden. In the vicinity of Sta. 396+00 where the house is located, distinct layers of cohesive clayey silt, up to 5 ft. thick were observed within the overburden. The consistency of this cohesive portion of the deposit is generally ranging from soft to firm. Water levels observed in the boreholes during the course of the field investigation vary from elevations 481.3 to 484.6. The boundaries of the various soil stratas, bedrock and water level elevations are shown on the enclosed Drawing No. 56701-A.

It is understood that the westbound lane of Highway 17N in this area will be shifted some 90 feet westerly of the original alignment. The proposed grade of the westbound lane in this portion ranges from elevation 477.5 to elevation 466.6. This indicates that the roadway will be in a cut section. The subsoil conditions are such that there will be nominal rock excavation. However, the original design indicated extensive rock cuts in this area. It is believed that borings were not carried out in this area by Regional Materials Section due to property restrictions, and any information given on the Soils Profile was based on seismic data.


November 25th, 1974.

Mr. A.J. Percy - RE: Contract No 73-186.

The presence of soft to firm clay within the overburden requires certain measures in order to ensure the stability of the overall cut section in this area. Our recommendations are as follows:

- 1) A bench of 15' wide at elevation 482.0 will be required. The cut slopes should be constructed with 2 horizontal to 1 vertical. The original design called for a uniform slope of 2.5 horizontal to 1 vertical in the overburden. However, the new slope with bench will result in an overall average slope of 2.5 horizontal to 1 vertical. The suggested section is shown on the enclosed drawing #56701-A.
- 2) In order to prevent any local sloughing of the material below the prevailing water levels, especially in the Jamieson's property area (east slope of cut), a granular blanket of minimum thickness of 18 inches should be provided on the slope. The granular blanket should extend from the base of the cut to at least 1 foot above the prevailing water level.
- 3) In order to maintain uniform slopes, the nominal rock cut may be carried out with a 2 horizontal to 1 vertical, rather 1/4 horizontal to 1 vertical normally used.
- 4) The excavation for the cuts should be carried out initially from the west side of the cut, gradually extending toward the east portion of the cut. It may be advantageous to construct a longitudinal pilot trench at the west side of the cut within the limits of the cut area, commencing from low end of grade. This will lower the water table in the general area, as a result of that the majority of the granular portion of the cut material could be used for embankment construction.

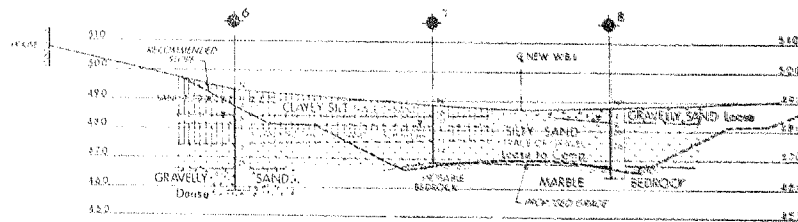
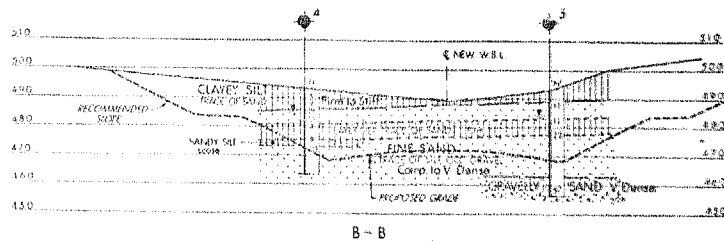
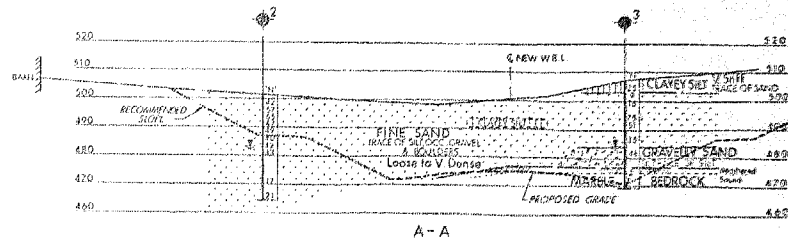
We believe that this information will be adequate for your design needs. Should you require any further information, please contact our Office.


 H. Shah,
 Project Engineer,
 For: M. Devata,
 Supervising Engineer.

HS/mj

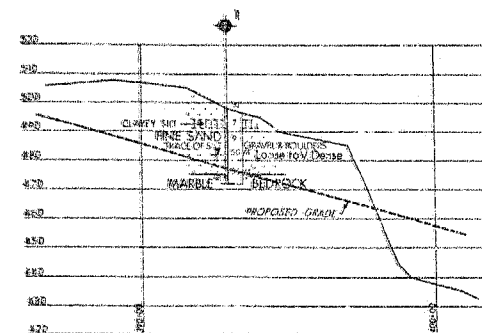
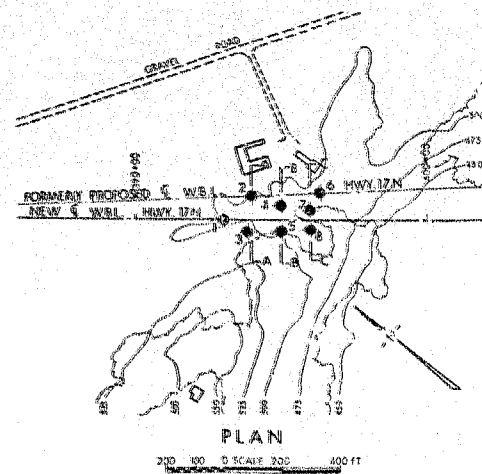
c.c. P.D. Billings
 J. Callaghan T.C. Kingsland
 J.M. Childs G. Martens
 D. Hopper E.J. Orr
 E. Saint
 G.A. Wrong

Files
 Documents

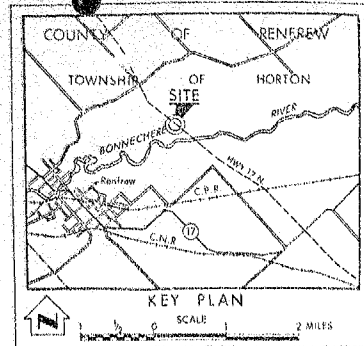


SECTIONS

20 10 0 SCALE 20 40 FT



VERT. 20 10 0 SCALE 20 40 FT
HORIZ. 200 100 0 SCALE 200 400 FT



LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Resistance Test		
	Bore Hole & Cone Test		
	Water Level established at time of field investigation NOV. 1974		
NO.	ELEVATION	STATION	OFFSET NEW W.B.L.
1	497.8	393+00	0'
2	501.2	394+00	07' LT
3	506.8	393+84	40' RT
4	493.1	395+00	50' LT
5	492.9	395+00	36' RT
6	493.2	396+30	100' LT
7	488.3	396+00	31' LT
8	487.7	396+00	31' RT

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

NOTE FOR CONTRACT DOCUMENTS
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundation Office, Renfrew and at the DISTRICT OFFICE.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO

ALIGNMENT REVISION FOR
JAMESON PROPERTY
STA. 393+00 TO STA. 396+50
HIGHWAY NO. 17N W.B.L. DIST NO. 9
CO., RENFREW
TWP. HORTON

BORE HOLE LOCATIONS & SOIL STRATA
DRAWN BY: [Name] CHECKED BY: [Name]
DATE: 22 NOV 1974
APPROVED BY: [Name]
PROJECT NO.: 56701-A
PROJECT NO.: 56701-A

CR 73-102

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31F-753

DIST. 0 REGION EASTERN

W.P. No. 5-67-01

CONT. No. 73-186

W. O. No. 72-11013

STR. SITE No. _____

HWY. No. 417 (NEW)

LOCATION O'HEAD STRUCTURE AT THE

CROSSING PROP. HWY. 17 'NEW' + ~~100M~~ O'RIEN

ST. EXT. + CREEK VALLEY

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 2

REMARKS: DOCUMENTS TO BE UNFOLDED BEFORE

MICROFILMED

61-50 SEP 1978

