

G.I.-30 SEPT. 1976

GEOCRES No. 413-34DIST. 18 REGION W.P. No. 19-76-01CONT. No. 80-205W. O. No. STR. SITE No. HWY. No. 638LOCATION Embankment at
Sta 275+50No of PAGES - =====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6

(416) 751-6565

SOIL INVESTIGATION
FOR DIVERSION OF LEEBURN CREEK
SAULT STE. MARIE, ONTARIO

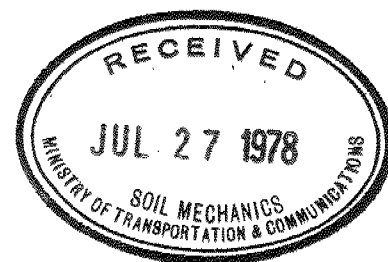
PRELIMINARY

Ref. No. 78-6-19

JULY 1978

Prepared for:

Ministry of Transportation and
Communications,
Soil Mechanics Section,
West Building,
1201 Wilson Avenue,
Downsview, Ontario.



C O N T E N T S

	<u>Page No.</u>
1.0 INTRODUCTION.....	1
2.0 SITE AND GEOLOGY.....	2
3.0 METHOD OF INVESTIGATION.....	
3.1 Field Work.....	3 & 4
3.2 Laboratory Testing.....	4
4.0 SUBSOIL CONDITIONS.....	
4.1 General.....	5
4.2 Surficial Deposits.....	
4.2.1 Fill.....	5
4.2.2 Silty Sand.....	5
4.2.3 Clayey Silt and Silty Sand.....	5 & 6
4.3 Varved Clay.....	6 & 7
4.4 Sand and Gravel.....	7
4.5 Granite Bedrock.....	8
5.0 GROUNDWATER CONDITIONS.....	9
6.0 DISCUSSION OF THE RESULTS.....	
6.1 General.....	10
6.2 Foundations.....	10
6.2.1 Friction Pile Foundations.....	11
6.2.2 End-Bearing Pile Foundations.....	11 & 12
6.2.3 Horizontal Earth Pressures.....	12 & 13
6.3 Approach Fills.....	13
6.4 Construction.....	13 & 14

A P P E N D I X

APPENDIX 'A', Photographs 1, 2, 3 and 5...

E N C L O S U R E S

BOREHOLE LOCATION PLAN AND PROFILE.....	Drawing 1
RECORD OF BOREHOLE 1 AND CONE TEST 5.....	Enclosure 1
RECORD OF BOREHOLE 2 AND CONE TEST 4.....	Enclosure 2
RECORD OF BOREHOLE 3 AND CONE TEST 3.....	Enclosure 3
RECORD OF BOREHOLE 4 AND CONE TEST 2.....	Enclosure 4
RECORD OF BOREHOLE 5.....	Enclosure 5
RECORD OF BOREHOLE 6.....	Enclosure 6
CONE TEST 1.....	Enclosure 7
GRAIN SIZE DISTRIBUTION CURVES.....	Enclosure 8
CONSOLIDATION TEST SHEETS.....	Enclosures 9 and 10

1.0 INTRODUCTION

The Ministry of Transportation and Communications of the Province of Ontario contemplates the replacement of an existing bridge on Highway 638 over Leeburn Creek in the Township of Aberdeen, Ontario.

Dominion Soil Investigation Inc. has, at the request of the Engineering Materials Office, carried out a soil investigation with the purpose of determining the subsurface conditions at the location of the proposed structure.

The findings of the investigation, together with our recommendations, are presented in this report.

.../...

2.0 SITE AND GEOLOGY

The site is located in the Township of Aberdeen in the District of Sault Ste. Marie, on Highway 638.

Geologically, the site is located on the Canadian Shield and the bedrock in the area consists of intrusive rocks, such as granite, gneiss, granitized sedimentary or volcanic rocks belonging to the Archean Era.

The topography in the area surrounding the bridge is gently rolling, with ground surface elevations ranging between 656 and 676 ft. above sea level. The vegetation is sparse and consists of grass and light bush.

Small rock outcrops were noted within 600 to 900 ft. (183 to 274 m) of the site to the north and south of Highway 638.

The conditions at the site are illustrated on photographs 1 to 4 in the appendix of this report.

.../...

3.0 METHOD OF INVESTIGATION

3.1 Field Work

Six boreholes and five dynamic cone penetration tests were put down at the site at the locations shown on Drawing No. 197604-A. The boreholes were advanced by both augering, wash-boring and diamond drilling methods.

First, augering was effected until refusal was met. Below the refusal level, the boreholes were advanced by breaking the obstructions with a bi-cone and drilling N-size (3.5" diameter) casings. The debris inside the casings was removed by wash water. Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration test method using a 2-inch (51 mm) O.D. split spoon which was driven into the ground with 350 ft./lb. energy.

The undrained shear strength of cohesive strata was measured in-situ by a vane tester apparatus.

Relatively undisturbed samples of the clay were recovered by means of 2-inch (51 mm) O.D. thin walled tube samplers. The rock was cored by diamond drilling techniques using BXL (1-5/8" I.D.) core bits.

The field work was carried out on June 20 to 25, 1978, under the supervision of a senior soils technician who also located the boreholes in the field. The locations of these were referred to the centre line stakes established by the surveyors of M.T.C.

.../...

Ground surface elevations were referred to geodetic datum, the location of which is shown on M.T.C. Plan E-5620-1.

3.2 Laboratory Testing

The soil samples were shipped in air tight jars to Dominion Soil Investigation Inc. laboratory where they were examined and representative soil samples were selected for testing.

The laboratory testing programme consisted of the determination of the moisture contents, consistency limits and unit weights and sieve and hydrometer analyses. In addition, the undrained shear strength and the compressibility of the clay were determined by means of triaxial compression and consolidation tests carried out on relatively undisturbed soil samples.

The laboratory test results are presented on the Records of Boreholes (Enclosures 1 to 6 inclusive) and on Enclosures 8, 9 and 10.

.../...

4.0 SUBSOIL CONDITIONS

4.1 General

Based on the results of the boreholes, the subsoil profile consists of the following main strata:

1. Surficial Deposits consisting of silty sand, clayey silt and silty clay.
2. Varved Clay
3. Sand and Gravel
4. Granite Bedrock

4.2 Surficial Deposits

4.2.1 Fill

Borehole 5 encountered fill consisting of stiff clayey silt with sand and gravel and frequent boulders. The fill is compact ('N' = 11 blows per foot) and extends to about Elevation 658.4 ft., i.e., 7.5 ft. (2.3 m) below the ground surface. The stiff to very stiff clayey silt encountered in Borehole 3 could also possibly be fill material.

4.2.2 Silty Sand

Borehole 4 encountered loose ('N' = 7 blows per foot) brown to grey silty sand extending to about Elevation 651.0 ft., i.e., about 10 ft. (3 m) below the ground surface.

4.2.3 Clayey Silt and Silty Clay

Boreholes 2 and 6 encountered firm to very stiff ('N' = 8 to 25 blows per foot) silty clay or clayey silt extending to Elevation 659.3 ft., .../...

i.e., between 6.3 and 7.5 ft. (1.9 and 3.3 m) below the ground surface. Below the fill in Borehole 5 is a layer of firm ('N' = 6 blows per foot) silty clay extending to Elevation 653.4 ft., i.e., 12.5 ft. (3.8 m) below the ground surface.

4.3 Varved Clay

Below the above described surficial fill and natural deposits the area is underlain by grey reddish mottled varved clay. The clay extends to between Elevations 600.5 and 614.9 ft., i.e., between 47 and 67.7 ft. (14.3 and 20.6 m) below the ground surface.

Based on the results of the Standard Penetration tests, the consistency of the clay is soft to very soft ('N' = less than 1 to 4 blows per foot).

The undisturbed shear strength of the clay was measured in-situ by field density tests giving values between 555 and 2035 p.s.f. (average 900 p.s.f.). The undrained shear strength value obtained from laboratory triaxial compression tests performed on relatively undisturbed samples range between 288 and 720 p.s.f. (average 500 p.s.f.). The remoulded shear strength varies between 148 and 1110 p.s.f. (average 370 p.s.f.).

The plastic properties of the clay as revealed by laboratory Atterberg tests are as follows:

Liquid Limit	25 to 51%
Plastic Limit	14 to 25%
Plasticity Index	7 to 29%

The natural moisture content ranged between 12 and 71% (average 48%) and the measured unit weight between 100 and 106 p.c.f. (average 103 p.c.f.).

Consolidation tests (Enclosures 9 and 10) carried out on relatively undisturbed samples of the clay gave a coefficient of volume compressibility ranging between 0.07 and 0.04 ft.²/ ton. The coefficient of volume compressibility (m_v) was calculated from the consolidation curve for a range of pressure of 1 t.s.f. in excess of the overburden pressure (P_o). The test results indicate that the clay stratum has a high plasticity and compressibility and a medium sensitivity.

4.4 Sand and Gravel

Underlying the clay stratum in Boreholes 1, 3, 4 and 5 a compact to very dense ('N' = 26 to 68 blows per foot) sand and gravel stratum was encountered. In Borehole 1 this stratum contains frequent boulders. The grading characteristics of two typical samples obtained from this deposit are shown on Enclosure 8.

The sand and gravel stratum extends to the surface of the bedrock, which was encountered in Boreholes 1 to 5 inclusive at between Elevations 592.9 ft. (Borehole 1) and 613.2 ft. (Borehole 2), i.e., at depths of between 52.2 and 75.3 ft. (16 and 23 m) below the ground surface.

.../...



4.5 Granite Bedrock

Below the varved clay and sand and gravel deposits, the site is underlain by granite bedrock. The rock was proven by coring in Boreholes 1 to 5 inclusive to depths between 5.7 and 10.2 ft. (1.7 and 3.1 m) below the rock surface.

Generally, the rock is sound, with core recovery ranging between 77 and 100% (R.Q.D. between 61.5 and 100%). In Boreholes 3 and 4, however, the upper 1 to 4 ft. of the bedrock was found to be weathered and extensively fractured.

.../...

5.0 GROUNDWATER CONDITIONS

At the time of the investigation the water level in Leeburn Creek at the proposed centre line was at Elevation 655.5 ft.

Free water surfaces were encountered upon completion in Boreholes 1 and 2 at depths between 7.5 and 11.5 ft. (2.3 and 3.5 m) below the ground surface, i.e., between Elevations 654.1 and 660.7 ft. Borehole 6 bored dry and remained dry during the period of the investigation.

In Boreholes 3, 4 and 5, artesian conditions were encountered between Elevations 605 ft. (Borehole 4) and 610 ft. (Borehole 3). The measured artesian head was between Elevations 662.9 ft. and 674 ft., i.e., between 1 ft. (Boreholes 3 and 4) and about 8 ft. (Borehole 5) above the ground surface.

The measured volume of flow ranged between 1.5 and approximately 10 gallons per minute.

All the recorded groundwater levels are shown on the borehole logs.

.../...

6.0 DISCUSSION OF THE RESULTS

6.1 General

At the time of writing this report, it is proposed that the replacement structure will have a single span supported on closed abutments. The vertical alignment of the road will also be improved and the grade will be raised by about 17 ft. (5.2 m) on the west bank and 14 ft. (4.3 m) on the east bank of the crossing.

At the time of the investigation, the flow in Leeburn Creek was slow and the depth of water was about 2.6 ft. (79 cm). The stream bed along the new alignment is gravelly with some small submerged logs. Boulders up to 2 ft. (61 cm) in diameter (photographs 3 and 4) were noted around the existing abutments and piers within 5 ft. (1.5 m) of the proposed alignment.

At the proposed location of the structure, Boreholes 4 and 5 have indicated that below surficial fill or silty sand deposits the site is underlain by soft to very soft varved clay. The bedrock surface was encountered between Elevation 604 and 606.9 ft., i.e., between 57 and 59 ft. (17.4 and 18 m) below the ground surface.

6.2 Foundations

Because of the low bearing capacity of the soil and the significant consolidation settlements anticipated, spread footing foundations for the structure are not considered to be feasible at this site.

.../...



6.2.1 Friction Pile Foundations

Since a suitable bearing stratum was not encountered in the boreholes within depths of between 50 and 58 ft. below the ground surface, consideration was given to supporting the structure on friction piles.

Although calculations have indicated that 12-inch diameter timber piles could develop a safe working capacity of about 15 tons, because of the large (15 to 23-inches) consolidation settlement of the approach fills at the abutments, it was felt that possible differential settlements and lateral displacements of the soil could result in unacceptably large displacements of the abutments. In view of this, we do not recommend the use of friction piles.

6.2.2 End-Bearing Pile Foundations

The structure can be supported on end-bearing piles driven to practical refusal on the surface of the bedrock. It is expected that the piles will reach sufficient set between Elevation 606 and 603 ft.

Steel tube or H-piles appear to be most suitable for this project.

Recommended working loads for common pile sizes are as follows:

<u>Pile Section</u>	<u>Safe Working Load</u>
8BP36	50 tons
10BP42	60 tons
12BP53	80 tons
12" diameter tube	80 tons

.../...



Piles driven to the bedrock surface should encounter positive refusal and should not be overdriven. Because of the hard driving conditions expected through the sand and gravel stratum, the piles should be equipped with driving shoes. Piles driven to a satisfactory set will settle only negligibly under the working loads.

Unbalanced horizontal forces should be resisted by inclined piles driven in both direction parallel to the centreline of the road.

The piles should be designed to resist additional load due to negative skin friction. The recommended design value for negative skin friction is 560 p.s.f.

6.2.3 Horizontal Earth Pressures

For the calculation of horizontal forces on the abutments, the following design values are recommended:

unit weight of granular backfill $\gamma = 130 \text{ p.c.f.}$

coefficient of horizontal earth
pressure $k = 0.4$

The pressure distribution behind the abutments can be considered to be triangular, increasing with depth according to the following formula:

$$p_h = K (\gamma h + q)$$

where h = depth below the ground surface (ft.)

q = unit surcharge load applied at the ground surface (p.s.f.)

It is recommended that clean, freely draining granular backfill be placed immediately behind abutments and that weep holes be provided to relieve the hydrostatic water pressure.

6.3 Approach Fills

It is our understanding that the road embankments will be raised about 14 ft. (4.3 m) on the east approach and about 17 ft. (5.2 m) on the west approach.

We have analyzed the stability of these embankments and find that the safety factor for an embankment 36 ft. wide at the top and with side slopes of 2 horizontal to 1 vertical is about 1.3, which is considered adequate.

From the consolidation test data, we estimate that the maximum settlement under the approach embankment will be about 15-inches under the west approach and 23-inches under the east approach. Allowance should be made in the design for such movements.

6.4 Construction

Because of the low permeability of the clay stratum, water seepage into the excavation will be small provided that the Creek is

.../...



temporarily diverted and the working area is surrounded by an impervious clay dyke or tight sheeting.

As the remoulded or disturbed shear strength of the clay (300 p.s.f.) is significantly less than the undisturbed value, it is important that the disturbance to the clay subgrade be kept to a minimum. To assure this, it is recommended that as soon as the final grade has been reached, a skim coat of lean concrete be placed as a working mat for the assembly of the reinforcing bars and the formwork for the pile caps.

The safety factor against bottom heave for a 10 ft. deep excavation was calculated to be about 2.6.

DOMINION SOIL INVESTIGATION INC.

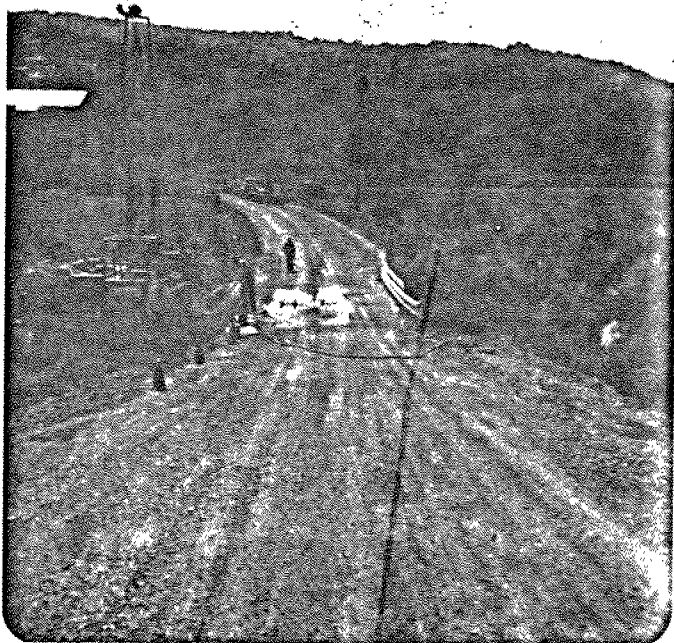

I. Rainu, P.Eng.

IR/kmj

A P P E N D I X

APPENDIX 'A'

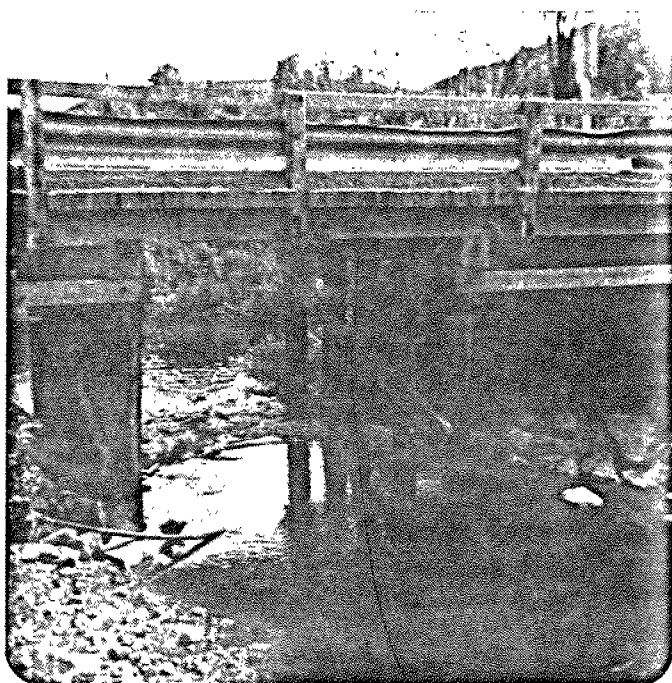
PHOTOGRAPHS



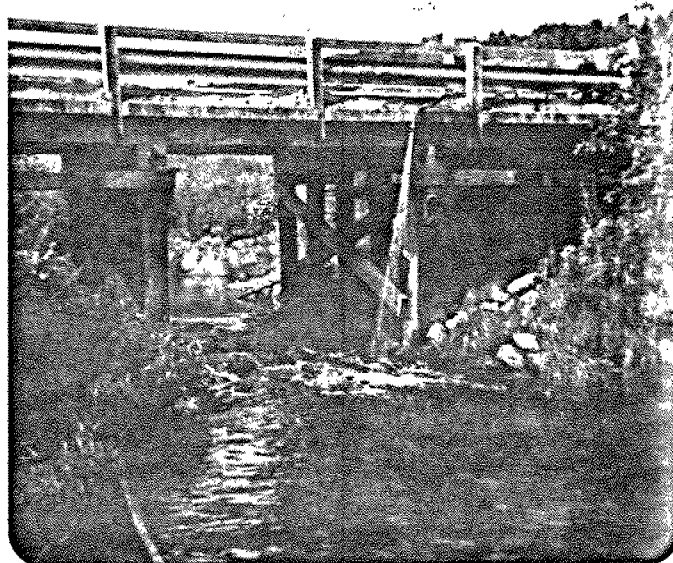
Photograph 1
Looking West along the East Embankment



Photograph 2
Looking East Along the West Approach



Photograph 3
Looking Down Stream from the North Side
of Existing Structure



Photograph 4
Looking Upstream from the South Side
of Existing Structure

ENCLOSURES

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1 & CONE TEST No. 5

W P 19-76-04 LOCATION Sta. 176+38 12' R.T. & Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 24 and 25, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH		W _p	W	W _L		
668.2	GROUND LEVEL							20 40 60 80 100						
0.0	light brown, weathered and fissured		1	SS	4									
	soft		2	SS	4									
	very soft		3	SS	2									
			4	TW	--									
			5	SS	1/18"									
			6	TW	--									
	Grey varved CLAY, mottled reddish/brown		7	SS	<2									
			8	TW	--									
			9	SS	<2									
			10	SS	2									
	soft		11	SS	3									
			12	SS	3									
			13	SS	3									
			14	TW	--									
			15	SS	3									
603.7			16	SS	22									
64.5	Very stiff, grey SILTY CLAY with fine sand		17	RC	0									
600.5				BXL										
67.7	Very dense SAND and GRAVEL with frequent boulders		18	SS	100/4"									
592.9			19	RC	100%									
75.3	GRANITE BEDROCK		20	RC	100%									
583.1				BXL										
85.1	END OF BOREHOLE													

+3, x5: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Augering
wash
boring
drilled BW casing and cleaned out with bi-cone

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2 & CONE TEST No. 4

W P 19-76-04 LOCATION Sta. 176+89 22' L.T. & Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 24, 1978 CHECKED BY I.P.L.

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					
665.6	GROUND LEVEL													
0.0	Brown/grey Clayey SILT, weathered	very stiff firm	1	SS	25									
659.3			2	SS	8									
6.3			3	SS	3									
			4	SS	2									
			5	SS	1/18	"								
			6	SS	1/18	"								
	Soft to very soft grey varved CLAY mottled reddish brown		7	TW	--									
			8	SS	1/18	"								
			9	TW	--									
			10	SS	<2									
			11	TW	--									
			12	SS	<3									
613.2		gravelly	13	SS	3	"								
52.2	GRANITE BEDROCK		14	RC BXL	50/73									
607.7			15	RC BXL	89%									
57.9	END OF BOREHOLE		16	RC BXL										

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 & CONE TEST No. 3

W P 19-76-04 LOCATION Sta. 177+59 1.5' R.T. Q-Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 22 and 23, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH			W _p	W	W _L		
661.9	GROUND LEVEL							20 40 60 80 100							GR SA SI CL
0.0	Stiff to very stiff brown, organic stained CLAYEY SILT, with some decayed wood(poss.FILL)		1	SS	21		660	○ UNCONFINED	+ FIELD VANE						Artesian condition observed below Elev. 610.0'
654.5			2	SS	9			● QUICK TRIAXIAL	x LAB VANE						Measured head at Elev. 662.9'
7.5			3	SS	2			1000	2000						Measured volume 1 gallon/ 45 seconds
			4	TW	--										
			5	SS	<1										
			6	TW	--										
	Very soft grey varved CLAY mottled reddish brown		7	SS	<1		650							106	
			8	SS	2		640								Casing broke off at 52.0' on contact with rock. Re-located hole 4' S. and augered to 45'
			9	TW	--		630								
			10	SS	2		620								
			11	TW	--		610								
614.9	very stiff, with fine sand seams		12	SS	19										
47.0	Compact, well graded SAND, with fine gravel and silt		13	SS	26										10 74 16 0
609.9	broken rock		14	RC	77%										↑ augering wash ↓ boring
52.0	GRANITE BEDROCK		15	RC	100%										
601.6			16	RC	100%										
60.3	END OF BOREHOLE														

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 & CONE TEST No. 2

W P 19-76-04 LOCATION Sta: 178+11 16.5' R.T. & Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 21, 1978 CHECKED BY I.P.L.

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				
661.0	GROUND LEVEL															
0.0	Loose brown/grey SILTY SAND organic stained		1	SS	7		660									Artesian condition below Elev. 605.0' Measured Head at Elev. 663.0' Measured volume 2 gallons/minute
651.0			2	SS	<2		650									
10.0			3	SS	1/18"											
			4	SS	1/18"											
			5	TW	--											
			6	TW	--											
			7	SS	<2											
			8	SS	<2											
			9	SS	4											
			10	SS	2											
			11	TW	--											
			12	SS	3											
611.0	Very soft to soft, grey varved CLAY mottled reddish brown		13	TW	--		610									8 80 12 0 ↑ augering wash boring
50.0	Very dense SAND and GRAVEL		14	SS	68											
604.0			15	RC	90%											
57.0	GRANITE BEDROCK fractured		16	BXL	77%											
			17	RC	88%											
597.4				BXL			600									
63.6	END OF BOREHOLE															

+3, x⁵: Numbers refer to Sensitivity
20
15 10 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

W P 19-76-04 LOCATION Sta. 178+63 7' L.T. & Line 'D' ORIGINATED BY N. McC
DIST 18 HWY 638 BOREHOLE TYPE Augering & Diamond Drilling (BXT Size) COMPILED BY I.R.
DATUM Geodetic DATE June 20, 1978 CHECKED BY I.P.L.

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	WATER CONTENT (%)						
								SHEAR STRENGTH								
								○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL x LAB VANE								
								1000 2000								
665.9	GROUND LEVEL															
0.0	CLAYEY SILT with Sand and Gravel, frequent boulders FILL compact		1	SS	11		660								Artesian condition below Elev. 608.0' Measured head at Elev. 674.0' Measured volume 10 gallons/ minute	
658.4			2	SS	6											
7.5	Firm, light brown/grey SILTY CLAY		3	SS	2											
653.4			4	TW	--		650									
13.5			5	SS	1/18 "											
			6	TW	--											
			7	SS	1/18 "											
			8	SS	1/18 "											
			9	TW	--											
			10	SS	2											
			11	SS	--											
			12	SS	2											
			13	SS	2											
			14	TW	--											
607.9	with sand and fine gravel inclusions		15	SS	75/3 "		610									
58.0	Dense SAND & GRAVEL														↑ augering wash ↓ boring	
59.0																
	GRANITE BEDROCK		16	RC	91.1 %		600									
597.8																
68.1	END OF BOREHOLE															

+3, x⁵: Numbers refer to
Sensitivity

20

15-5 (%) STRAIN AT FAILURE

10

OFFICE REPORT ON SOIL EXPLORATION



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

W P 19-76-04 LOCATION Sta. 176+48 22.5' L.T. & Line 'D' ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE June 23, 1978 CHECKED BY I.P.L.

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					
666.8	GROUND LEVEL																
0.0	Stiff, grey/brown SILTY CLAY		1	SS	15												
659.3			2	TW	--												
7.5	Very soft grey varved CLAY, mottled reddish brown		3	SS	2												
			4	TW	--												
			5	SS	<2												
			6	TW	--												
644.8			7	TW	--												
22.0	END OF BOREHOLE																

+³, x⁵: Numbers refer to
Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

RECORD OF CONE TEST No. 1

W P	19-76-04	LOCATION	Sta. 178+69 - 5th R.T.C. Line 'D'	ORIGINATED BY	N. McC.
DIST	18 HWY 638	BOREHOLE TYPE	Dynamic Cone Penetration Test	COMPILED BY	I.R.
DATUM	Geodetic	DATE	June 21, 1978	CHECKED BY	I.P.L.

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		
669.0													
0.0													
600.4													
65.6	END OF CONE TEST							110/7"					

+3, x5: Numbers refer to Sensitivity

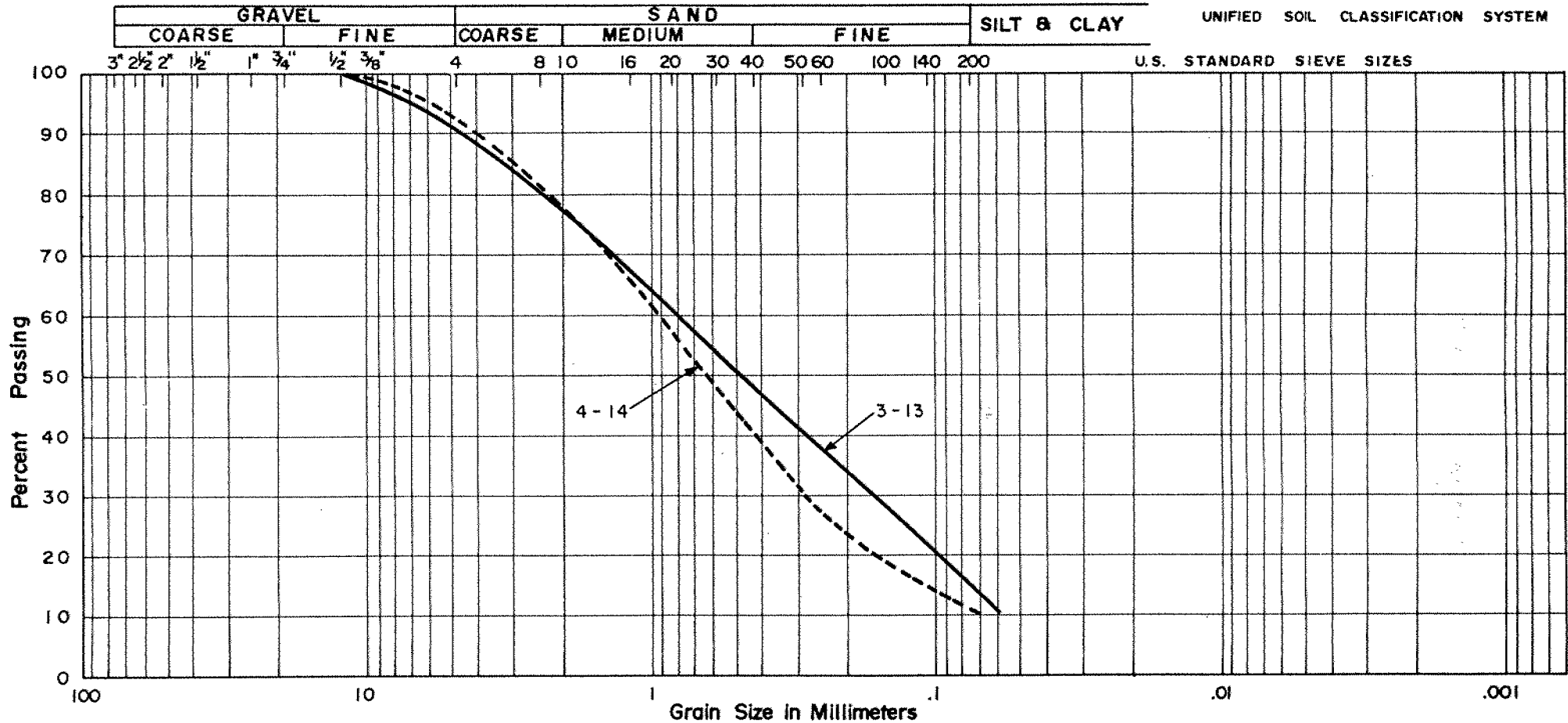
20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 78-6-19



PROJECT: BRIDGE REPLACEMENT
 LOCATION: HWY. 638 & LEEBURN CREEK.
 BOREHOLE NO: 3 4
 SAMPLE NO: 13 14
 DEPTH: 51' 56'
 ELEVATION: 610.9' 605'

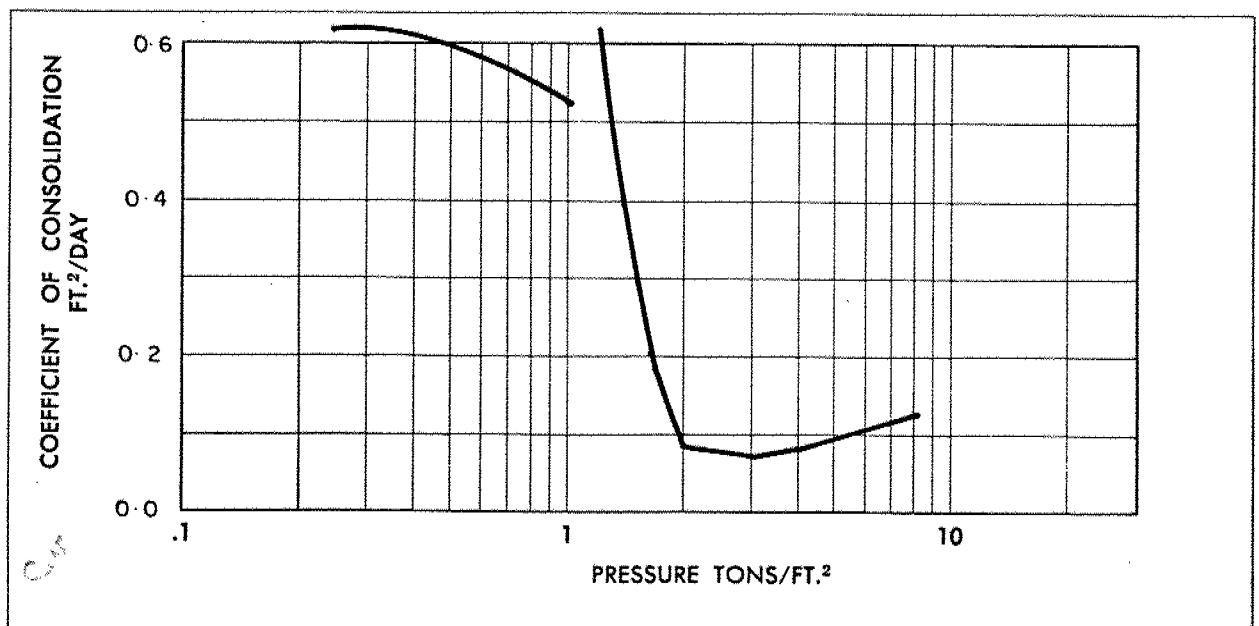
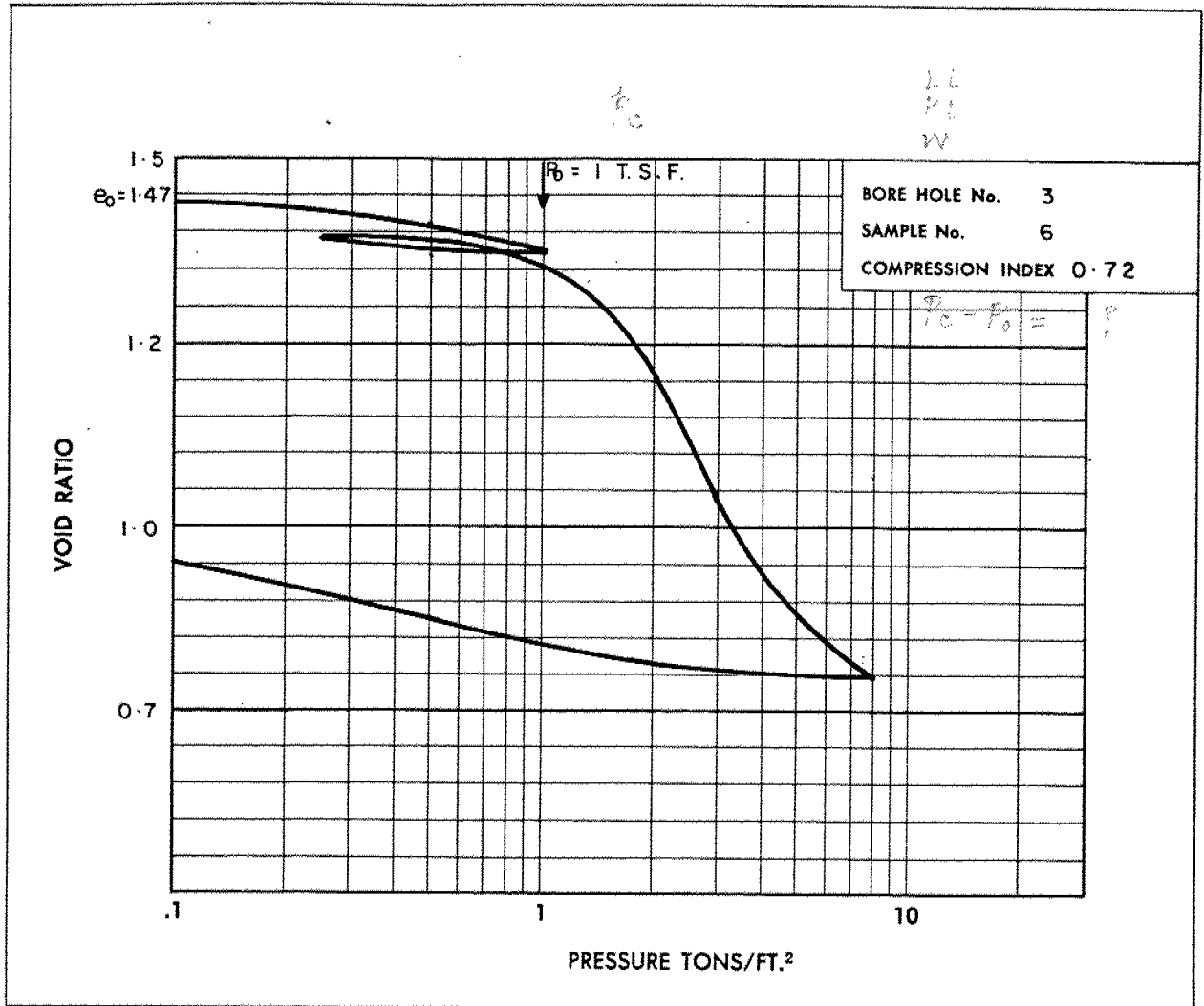
COEFFICIENT OF UNIFORMITY :
 COEFFICIENT OF CURVATURE :

Classification of Sample and Group Symbol:
SAND
 well graded, some fine gravel and silt.

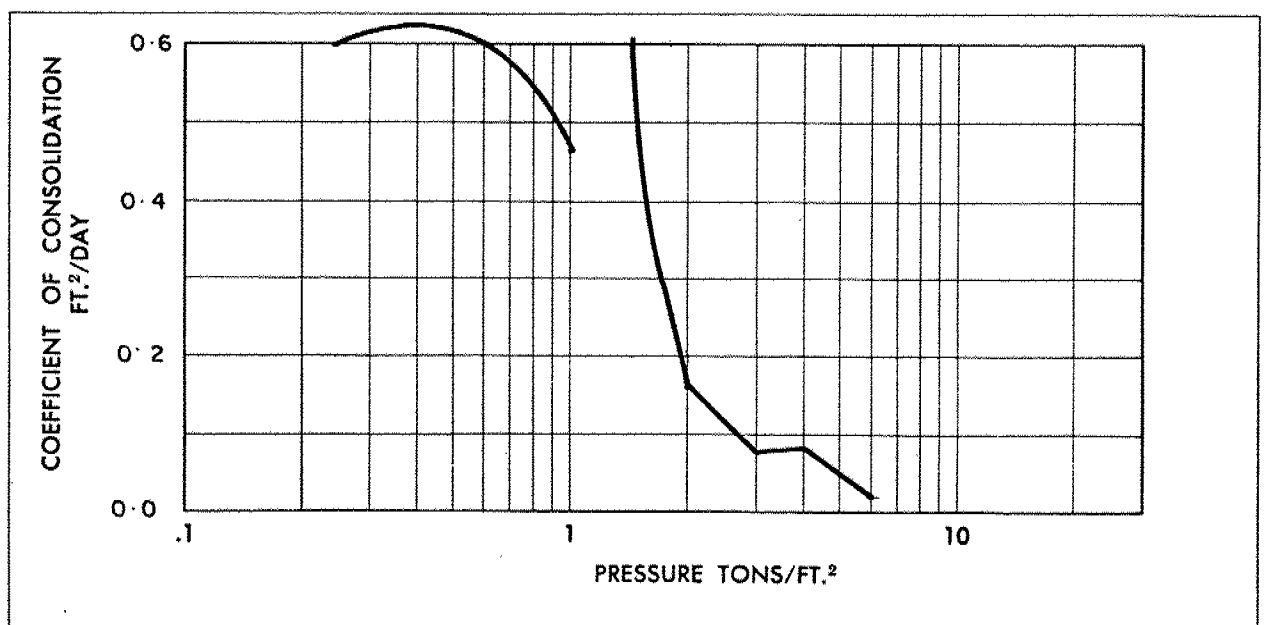
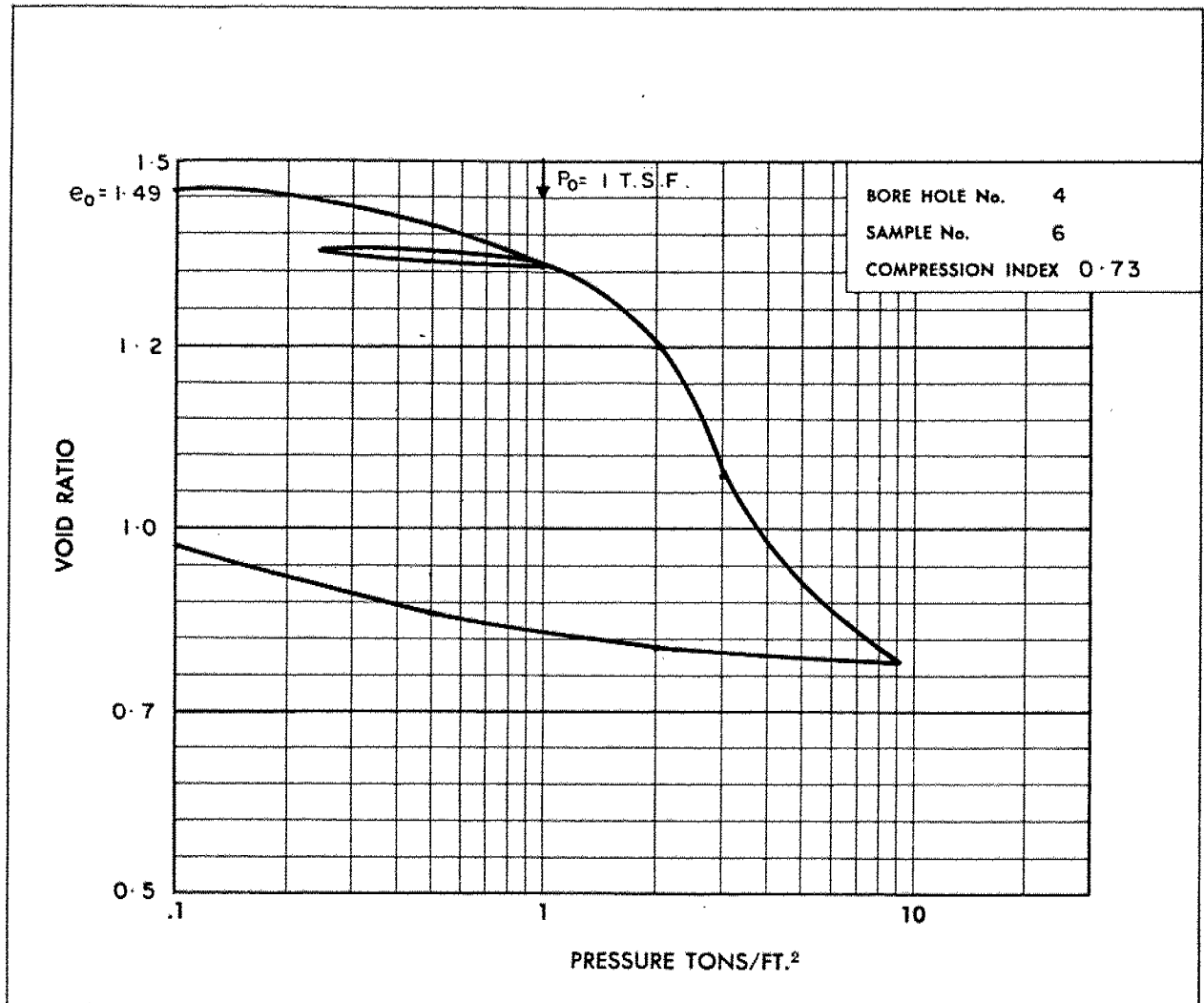
PLASTIC PROPERTIES
 LIQUID LIMIT % =
 PLASTIC LIMIT % =
 PLASTICITY INDEX % =
 MOISTURE CONTENT % =

ENCLOSURE NO 8

DOMINION SOIL INVESTIGATION INC. CONSOLIDATION TEST



DOMINION SOIL INVESTIGATION INC.
CONSOLIDATION TEST



Mr. C. Smith
Head, Geotechnical Section
Northwestern Region
Thunder Bay

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 09 28

Re: Soil Investigation Report For
Embankment at Sta. 275+50, Hwy. 638
W.P. 19-76-01, District 18, Sault Ste. Marie

The Ministry has retained Dominion Soil Investigation Inc. to investigate the stability of a proposed 40 foot high embankment in the vicinity of Sta. 275+50. We have reviewed the Consultant's report and submit the following comments.

If constructed with 2:1 side slopes, the proposed embankment is found to have an adequate factor of safety with respect to deep seated failures. However, in order to prevent surficial erosion, embankment in excess of 30 feet in height should be constructed with a 10 foot wide mid-height berm incorporating an intercepting ditch.

The Consultant's report is attached herewith for your information. If we can be of further assistance to you, we will be happy to oblige.

B. Ly
Senior Engineer

Attach.

BL/gs

cc: W. Kulmatickas
D.A. Jarvis (2)
W.A. Stewart (2)
E. Van Beilen
G.A. Wrong
B.J. Giroux
R.S. Pillar
R. Hore
N. Maluzinsky)
J. Anderson) memo only
G. Sloan)
Files



DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6

(416) 751-6565

41J-34

GEOCRE5 No.

SOIL INVESTIGATION
PROPOSED EMBANKMENT
HIGHWAY 638
STATION 275 + 50
W.P. 19-76-01

Ref. No. 78-6-20B

September 1978

Prepared for:

Ministry of Transportation
and Communications

DISTRIBUTION:

- 15 copies - Ministry of Transportation and Communications
- 2 copies - Dominion Soil Investigation Inc. (Toronto)
- 1 copy - Dominion Soil Investigation Inc. (Thunder Bay)





DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6

(416) 751-6565

September 26, 1978

Ref. No. 78-6-20B

41J - 34

GEOCRES No.

Ministry of Transportation
and Communications
Soil Mechanics Section
Engineering Materials Office
Room 315
Central Building
1201 Wilson Avenue
DOWNSVIEW, Ontario
M3M 1J8

Attention: Mr. C. Mirza, P.Eng.
Head, Soil Mechanics Section

Re: Soil Investigation
Proposed Embankment
Highway 638
Station 275 + 50
W.P. 19-76-01

Dear Sirs:

Further to your request and our agreement # 4243-9078-23, dated August 17, 1978, we have investigated the subsurface conditions in the area of a proposed 40 ft. high road embankment. The purpose of the investigation was to determine the stratification and the properties of the subsoil as relevant to the stability of the embankment. We have now completed the investigation and are pleased to present to you the results of the investigation together with our recommendations.

.../...



The Site

The site is located on Highway 638, approximately 900 ft. west of the Thessalon River. From the river to about this point, the land is flat with ground surface elevations about 670 ft. above the sea level. From this level, the grade rises sharply to the west, reaching its peak at about Elevation 830 ft. near Station 241 + 00. Both sides of the road are heavily covered with mature pine, maple, birch and poplar trees.

Further details of the site and the geology were given in our report dated August 1978 (Ref. No. 78-6-20).

Subsurface Conditions

The investigation in the field consisted of drilling one borehole at 50 ft. left of Station 275 + 70. The borehole was drilled with a power auger machine to a depth of 36.5 ft. and to this depth, the subsoil was sampled at 2.5 and 5.0 ft. intervals by the Standard Penetration test method. The results of the borings and penetration tests are given on the Record of Borehole (Enclosure No. 2).

The borehole indicates that from the ground surface (Elevation 668.9 ft.) to a depth of 7 ft. the subsoil is stiff clayey silt with a trace of organic matter. An Atterberg test indicated a liquid limit of 26%, a plastic limit of 20% and a plasticity index of 6. The natural moisture content was measured to range between 20 and 30%. Standard

.../...

Penetration resistances ranged between 3 and 10 blows per foot and an in-situ vane test indicated an undrained shear strength of 1500 p.s.f.

Below the clayey silt (below Elevation 661.9 ft.), the subsoil is dense to very dense silty fine sand. Standard Penetration resistances ranged between 26 and 73 blows per foot, with an average value of 39 blows per foot. The grain size distribution of the soil is given on Enclosure No. 3. The borehole was terminated within this stratum at a depth of 36.5 ft. below the ground surface, i.e. at Elevation 632.4 ft.

Upon the withdrawal of the augers, the water level in the open borehole was recorded 6.3 ft. below the ground surface at Elevation 662.6 ft. The water level remained stationary at this level for a period of 2 hours.

Discussion of the Results

The proposed change in the vertical alignment of the road will result in the placing of approximately 40 ft. of fill at this location. When considering the stability of the proposed embankment, the significant soil deposit is the stiff clayey silt which occupies the upper 7 ft. of the sub-stratum. Any potential failure plain will lie within this deposit.

Based on the measured shear strength of the subsoil (1500 p.s.f.) and taking the unit weight of the fill to be 130 p.c.f., it is estimated

.../...

that the factor of safety for a 40 ft. high embankment constructed with 2 : 1 side slopes will be greater than 1.3, which is considered to be adequate.

It is, therefore, concluded that the proposed embankment can be constructed as proposed.

We trust that our report is complete within our terms of reference, however, if you have any questions in connection with this project, please do not hesitate to call us.

Yours very truly,

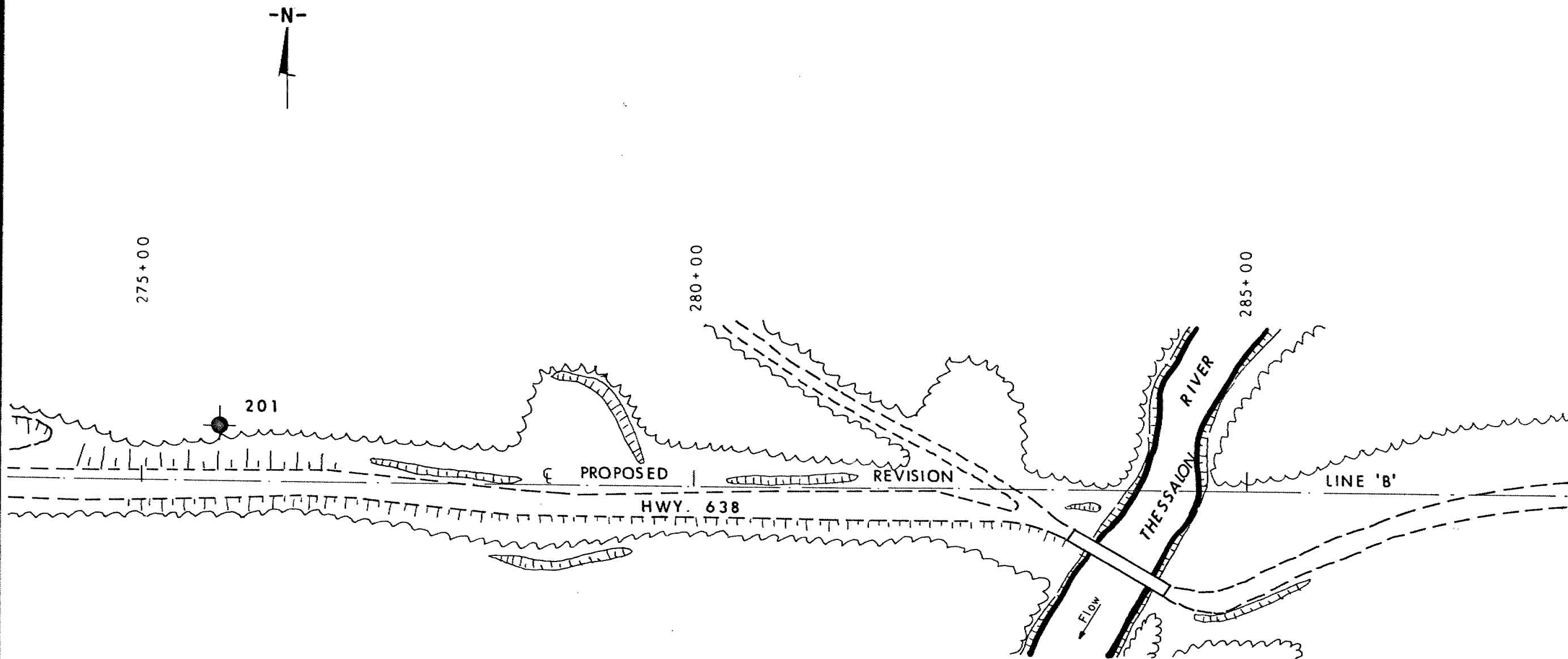
DOMINION SOIL INVESTIGATION INC.



I.P. Lieszkowszky, P.Eng.

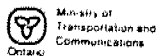
IPL:esp





BOREHOLE LOCATION PLAN

SCALE: 1"= 100 FT.



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 201

W P 19 - 76 - 01 LOCATION STA. 275+70: 50 ft. Lt., HWY. 638, LINE 'B' ORIGINATED BY D.C.
 DIST 18 HWY 638 BOREHOLE TYPE AUGERING, HOLLOW STEM 3 1/4-inch I.D. COMPILED BY D.C.
 DATUM GEODETIC DATE AUGUST 19, 1978 CHECKED BY I.P.L.

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					
668.9	GROUND SURFACE														
0.0	Stiff Clayey SILT trace of wood and organics		1	SS	10										
661.9			2	SS	3										
7.0	Dense to very dense grey Silty Fine SAND		3	SS	30										
			4	SS	73										
			5	SS	32										
			6	SS	49										
			7	SS	37										
			8	SS	26										
			9	SS	36										
			10	SS	33										
632.4			11	SS	35										
36.5	END OF BOREHOLE														

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

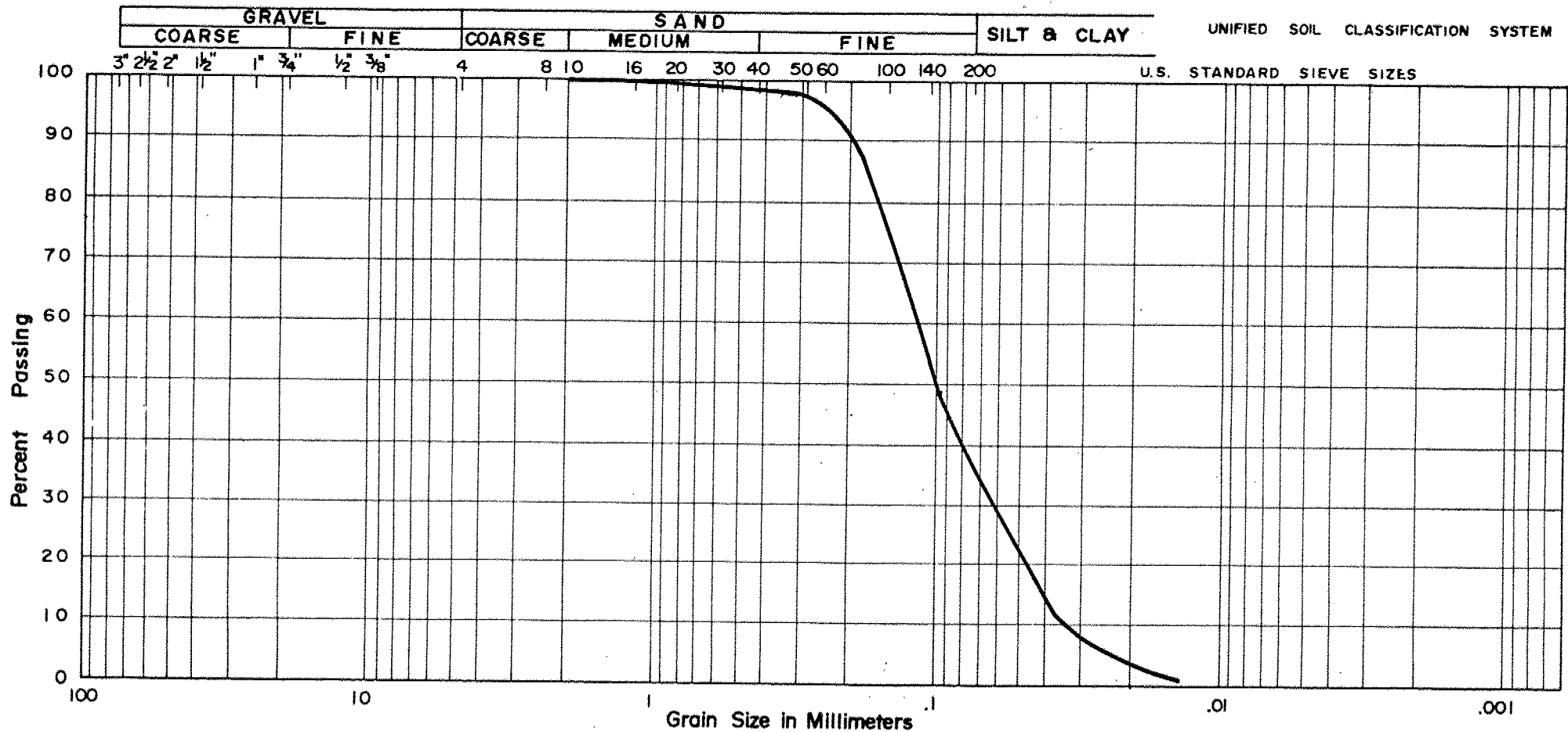
20
15
10

5 (%) STRAIN AT FAILURE

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 78-6-20B



PROJECT:

LOCATION:

BOREHOLE №: 201

SAMPLE №: 4

DEPTH: 11'

ELEVATION: 657.9'

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

PLASTIC PROPERTIES

LIQUID LIMIT % = N.A.

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % = 20.4

Classification of Sample and Group Symbol:

SILTY FINE SAND

ENCLOSURE № 3