

G.I.-30 SEPT. 1976

GEOCRES No. 61 413-~~74~~DIST. 18 REGION W.P. No. 19-76-03CONT. No. 80-205W. O. No. STR. SITE No. 385-123HWY. No. 638LOCATION Thessalon RiverNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

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NOTE: For purposes of the contract these reports supercede all other foundation reports prepared by or for the Ministry in connection with the above mentioned projects.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (FSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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

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

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}U$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c, N_γ BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{w_L - w_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{w_L - w_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 α_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

FOUNDATION INVESTIGATION REPORT

For

The Proposed Crossing at Thessalon River
and Secondary Highway 638
W.P. 19-76-03, Site 38S-123,
District 18, Sault Ste. Marie

INTRODUCTION

This report contains the results of a foundation investigation performed at the abovementioned site for the Ministry by Geotechnical Consultant, Dominion Soil Investigation Inc. Fieldwork was carried out during the period of June 26 to July 7, 1978, consisting of nine sampled boreholes. Three of the boreholes were located in the river and were drilled with a diamond drill rig mounted on a raft. The remaining six boreholes were located on the riverbanks and were advanced by means of an auger machine equipped with hollow stem augers. The depth of the boreholes ranged from 21 feet to 78 feet. Disturbed samples of the overburden were recovered with a split barrel sampler which was driven into the ground in accordance with the specifications for Standard Penetration Test. In three of the boreholes, bedrock was proven by recovering 4 to 7 feet of N-size rock core samples.

SITE AND GEOLOGY

The site is located on Lot 6, Concession 2 of Aberdeen Township, in the District of Algoma on Highway 638 about 2.2 miles west of Highway 561.

The topography of the area is hilly. The river has cut its channel into an approximately 900 foot wide valley. The elevations of the terrain rise from about 660 feet at the floor of the valley to about 750 feet on the east and 820 feet on the west side of the valley. The land on both sides of the highway is covered with mature growth of pine, poplar, alder and maple trees.

Geologically, the site is located on the Canadian Shield.

During the last Ice Age, the area was invaded by continental glaciers which eroded much of the bedrock. As the ice sheet retreated, the waning glaciers exposed the basin of the present Great Lake system, which was then occupied by a complex series of lakes.

The lake level at this time was estimated to be at about elevation 610 to 630 feet. Differential uplift finally brought about the gradual lowering of the lake level, going through intermediate stages referred to as the Nipissing Great Lakes and Algoma Lake stage and, finally, the Huron level dropped to that of the present lake level at about elevation 580 feet. The remnants of this past lacustrine environment are the deep varved clay and the fine beach sand and silt deposits encountered around the fringes of the Great Lakes and extending into the valley of the rivers discharging into the lake. The floor of these clay beds is a sandy ground moraine which overlies the uneven surface of the bedrock. The bedrock in the area consists of igneous rock, metamorphosed in places.

SUBSOIL CONDITIONS

GENERAL DESCRIPTION

The present ground surface elevation on the line of the proposed crossing ranges between elevation 662 and 650 feet on the west bank and between elevation 650 and 656 feet on the east bank of the river. The river bottom is at about elevation 645.5 feet. The average slope of the river bank on the west side is about 3 horizontal in 1 vertical and about 2 horizontal in 1 vertical on the east bank.

Below the existing ground surface and extending to the surface of the bedrock, i.e., to about elevation 590+ feet, the bridge site is underlain by a stratified deposit of sands and silts. The deposit is generally loose to very loose with occasional compact zones. Embedded in the upper sandy stratum of the deposit, to about elevation 637 to 627 feet, are pieces of partly decayed wood.

Although considerable variations were noticed in the composition, thickness and the elevation at which the various strata occur, the stratified sand and silt deposit can be divided into five major zones: an upper, middle and lower sand stratum which are separated from each other by two silt strata. On the west bank of the river the sand and silt deposit is overlain by about 10 feet of stiff clay.

The location and elevation of the boreholes are shown on Contract Drawing No. 38S-123-2. A description of the various soil types encountered is as follows:

Clay

A clay layer approximately 10 feet thick was encountered on the west bank extending to between elevations 653 and 650 feet.

The results of a hydrometer analysis performed on a sample (Figure 1) indicates up to 62% of clay size particles. The liquid limit of the soil ranges from 36 to 55%, the plastic limit between 22 and 24%, with a plasticity index of 14 to 30. Based on this, the soil is classified as a clay of intermediate to high plasticity. The natural moisture content ranges between 25 and 28%. A field vane test performed in this cohesive stratum indicates an undrained shear strength of 3200 p.s.f. and a laboratory quick, undrained triaxial compression test gave a shear strength value of 2400 p.s.f. The bulk unit weight of the soil is 118 p.c.f.

Upper Sand Stratum

In the riverbed and on the east bank, an 11 to 30 foot thick sand stratum was encountered below the ground surface. This stratum extends to between elevation 634 and 627 feet.

Grain size distribution curves of this material are shown on Figures 2 and 3, indicating a generally uniformly graded fine to medium sand with up to 25% of silt. Embedded in the sand are occasional partly decayed pieces of wood, suggesting a

geologically recent alluvial origin. In certain locations on the east bank, sandy peat seams ranging in thickness between 2 inches and 3.5 feet and a 2.5 foot thick organic silt layer were also encountered in this sand. Standard Penetration resistances range between 1 and 11 blows per foot, indicating a generally very loose to loose relative density. The permeability of this stratum is estimated to be of the order of 10^{-2} cm./sec. Because of the small particle sizes and the lack of cohesive bond between these particles, the material in this stratum is considered to be highly susceptible to erosion.

Upper Silt Stratum

The abovementioned clay deposit and sand deposit are underlain by a layer of silt. The thickness of this silt ranges between 5 feet to 33 feet. Similar large variations were also found in the elevation to which the underside of this silt layer extends (625 to 594 feet).

This stratum consists mainly of non-plastic silt size particles as shown on Figure 4. Randomly distributed throughout the stratum occasional slightly plastic zones or thin seams of silty clay were also encountered. The Standard Penetration resistances ('N' - values) range between 3 and 17 blows per foot, but are typically less than 10 blows per foot, indicating a very loose to loose relative density. The stratum is expected to behave as an essentially non-plastic, non-cohesive granular deposit.

Middle Sand

In some locations a 5 to 15 foot thick sand layer was encountered below the silt, extending to between elevations 612 and 607 feet. Grain size distribution curves of this material are not available, but based on visual examination of the soil samples it consists of mainly fine sand particles with up to an estimated 35% of silt. Based on the results of the Standard Penetration tests performed in this stratum ('N' = 5 to 19 blows per foot), the relative density of this stratum is inferred to be loose to

compact.

Lower Silt Stratum

In certain locations a second layer of silt was encountered below elevation 610+ feet. The thickness of this stratum is generally 5 feet, but in one location on the east bank where a 20 foot thick layer was penetrated. The underside of this stratum extends to between elevations 604 and 592 feet. Standard Penetration resistances range between 4 and 18 blows per foot, but are typically less than 10 indicating a generally loose relative density. Gradation curves of this material are shown on Figure 5. The silt in this zone did not exhibit any plastic or cohesive properties.

Lower Sand

The lower silt stratum described above is underlain by a 4.5 to 12 foot thick sand layer. This sand extends to the surface of the bedrock, that is to between elevation 594 and 585 feet. The particle size distribution characteristics of a typical sample are shown on Figure 6, indicating a predominantly fine sand with a trace to some gravel and silt. Occasional larger, cobble and boulder size, particles were also encountered. 'N'-values in the stratum range between 14 and over 100 blows per foot, indicating a range of relative density between compact and very dense. In certain locations, artesian water conditions were noted in this stratum.

Bedrock

The surface of bedrock was encountered or inferred from refusal between elevation 594.2 and 585.0 feet. Bedrock is a granitic intrusive rock. The top 2 to 3 feet of bedrock was fractured with R.Q.D. (Rock Quality Designation) values of 30 to 44%, but was sound below (R.Q.D. = 60 to 100%).

Because of the complex nature of the deposits, the above description cannot be complete and, therefore, reference should

be made to the individual borehole logs and to the soil profile and section presented on Drawing No. 38S-123-2.

GROUNDWATER CONDITIONS

The position of the groundwater table in the boreholes was recorded between elevation 655.4 feet on the west bank and 649.5 feet on the east bank indicating a small hydraulic gradient from west to east. In two locations, artesian conditions were encountered below elevation 600 and 593 feet respectively. The measured head was at elevation 654.6 feet and 650.3 feet or up to about 5 feet above the river level which, at the time of the investigation, was at elevation 649.6 feet.

B. Ly

B. Ly, P. Eng.
Foundation Engineer.



M. Devata
M. Devata, P. Eng.
Senior Foundation Engineer.

September, 1979

APPENDIX

RECORD OF BOREHOLE No 1

W P 19-76-03 LOCATION Sta. 283+45 G ORIGINATED BY N. McC.
 DIST 18 HWY 638 BOREHOLE TYPE Augering (H.S. 3/4 I.D.) COMPILED BY I.R.
 DATUM Geodetic DATE July 5, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
663.1	GROUND LEVEL													
0.0	Firm to stiff. brown CLAY		1	SS	2		660							
			2	TW	--									
653.1	with occ. silty sand		3	SS	9									
10.0			4	TW	--	Dry								
	Very loose to loose, grey SILT, dilatant, some clay		5	SS	3		650							
			6	SS	2									
641.6			7	SS	7									
21.5	END OF BOREHOLE													↑ augering

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

W P 19-76-03 LOCATION Sta. 283+53 15' R.t. ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering and Diamond Drilling (NXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 27, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
662.4	GROUND LEVEL							SHEAR STRENGTH						
0.0	FILL							○ UNCONFINED + FIELD VANE						
659.9								● QUICK TRIAXIAL x LAB VANE						
2.5	Stiff, brown CLAY organic stained		1	SS	9			WATER CONTENT (%)					W _p W W _L	
649.9			2	SS	11			20 40 60						GR SA SI CL
12.5	Very loose to compact, grey SILT dilatant with occasional reddish brown Silty Clay layers		3	SS	8									
			4	SS	3									
			5	SS	3									
			6	SS	7									
			7	SS	8									
			8	SS	8									
			9	SS	8									
			10	SS	11									
622.4	Compact, brown Fine SAND with some fine gravel and clay		11	SS	11									
40.0			12	SS	9									
			13	SS	12									
607.4	Compact, grey SILT		14	SS	8									
55.0			15	SS	63									
600.0	Dense to very dense brown Silty Fine SAND		16	SS	46									
62.4			17	RC	100%									
595.7	Well graded SAND with occasional boulders		18	RC	83%									
68.2														
590.2	GRANITE BEDROCK													
72.2	END OF BOREHOLE													

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 4

W P 19-76-03 LOCATION Sta. 283 + 99 E
DIST 18 HWY 638 BOREHOLE TYPE Washboring (BX)
DATUM Geodetic DATE July 7, 1978
ORIGINATED BY N. McC.
COMPILED BY I.R.
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					
649.6	TOP OF RAFT DECK															
0.0	WATER															
645.7	RIVER BOTTOM															
3.9	Very loose SAND, well graded		1	SS	2											
636.6	with some wood chips															
13.0	Loose, grey Fine SAND, some silt and thin layers of Silty Clay		2	SS	5											
629.6	Loose, grey SILT with fine sand seams		3	SS	7											
20.0																
624.6			4	SS	11											
25.0																
	Loose to compact, grey Silty Very Fine SAND		5	SS	5											
			6	SS	10											
609.6																
40.0	Compact, grey Sandy SILT, with some silty clay layers		7	SS	9											
604.1																
45.5	Compact, grey Silty SAND		8	SS	25											
600.6																
49.0	Very dense, well graded SAND with fine gravel		9	SS	76											
592.9																
56.7	END OF BOREHOLE															Refusal @ 592.9'

*3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5

W P 19-76-03 LOCATION Sta. 284+15 C
DIST 18 HWY 638 BOREHOLE TYPE Washboring (BX)
DATUM Geodetic DATE July 7, 1978
ORIGINATED BY N. McC.
COMPILED BY I.R.
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					
649.6	TOP OF RAFT DECK																
0.0	WATER																
645.6	RIVER BOTTOM																0 98 2 0
4.0	Loose, well graded SAND with fine gravel and some decayed wood		1	SS	PM		640										
			2	SS	7												
			3	SS	8												
633.6	Loose to compact, grey SILT with occasional reddish/brown clay layers		4	SS	5		630										
16.0			5	SS	17												
623.1																	
26.5	END OF BOREHOLE																

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 6

W P 19-76-03 LOCATION Sta. 284+40 G ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Washboring (BX) COMPILED BY I.R.
DATUM Geodetic DATE July 6, 1978 CHECKED BY I.P.L.

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
649.6	TOP OF RAFT DECK																
0.0	WATER																
645.5	RIVER BOTTOM																
4.1	Loose, fine to medium SAND with some fine gravel		1	SS	4		640										2 90 8 0
	decayed wood		2	SS	7												
634.6	gravel		3	SS	4												3 72 25 0
15.0	Very loose to loose, grey SANDY SILT, dilatant with occasional embedded wood to El. 627 Ft.		4	SS	6		630										
			5	SS	2												
			6	SS	9		620										
614.6	Compact brown to grey SILTY SAND		7	SS	14												
35.0							610										
609.6	Loose, grey SILT, trace Clay		8	SS	6												
40.0			9	SS	4		600										
604.6	Compact, grey fine SAND & SILT, with trace gravel		10	SS	29												
45.0			11	SS	27												
592.5	coarse sand & fine gravel																
57.1	END OF BOREHOLE																Refusal at El. 592.5 Ft. Artesian conditions observed below El. 593 ft. Measured head @ El. 650.3 ft. Measured volume 3 gal./min.

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

W P 19-76-03 LOCATION Sta. 284+73 15' L.t. ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering (H.S. 3/4" I.D.) and Diamond Drilling COMPILED BY I.R.
DATUM Geodetic DATE June 27, 1978 (NXL size) 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	SHEAR STRENGTH					
657.2	GROUND LEVEL							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	20 40 60					GR SA SI CL
0.0	Very loose, brown Silty Fine SAND, with some organics		1	SS	2									

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

W P 19-76-03 LOCATION Sta. 284+78 15' R.t. ORIGINATED BY N. McC.
DIST 1B HWY 638 BOREHOLE TYPE Augering (H.S. 3 1/2" I.D.) and Diamond Drilling COMPILED BY I.R.
DATUM Geodetic DATE June 28, 1978 (NXL size) 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
656.8	GROUND LEVEL													GR SA SI CL
0.0	Dk.brown fine SAND													
654.3														
2.5	Very loose Silty SAND		1	SS	2									
	brown grey		2	SS	3		650							
			3	SS	<1									
			4	SS	<1									
644.3														
12.5	4" sandy peat		5	SS	3									
	2" sandy peat		6	SS	<1		640							
	very loose compact		7	SS	10									
	Grey SAND		8	SS	11		630							
626.8			9	SS	11									
30.0			10	SS	10		620							
	Light brown/grey Sandy SILT, dilatant		11	SS	8									
	compact loose		12	SS	3		610							
	very loose		13	SS	23									
	compact		14	SS	25		600							
	gravelly occ. cobbles		15	SS	13									
593.8			16	SS	14		590							
63.0	Compact coarse sand & fi. gravel, occ. boulders		17	RC BXL	100%									
589.3			18	RC BXL	100%									
67.5	GRANITE BEDROCK													augering wash boring
582.7														
74.1	END OF BOREHOLE													

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 9

W P 19-76-03 LOCATION Sta. 284+88 G ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering (H.S. 3 1/2" I.D.) COMPILED BY I.R.
DATUM Geodetic DATE June 26, 1978 CHECKED BY I.P.L.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
657.6																
0.0	Brown, Silty SAND, loose		1	SS	5											
650.1	some roots loose		2	SS	3											
7.5			3	SS	--											
647.6	Firm grey organic SILT		4	SS	<1											
10.0			5	SS	1											
	Very loose, grey organic Silty SAND, some wood fragments		6	SS	<1											
637.6			7	SS	4											
631.7	Loose Fine SAND															
21.5	END OF BOREHOLE															

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 10

W P 19-76-03 LOCATION Sta. 285+50 C ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering (H.S. 3/4" I.D.) COMPILED BY I.R.
DATUM Geodetic DATE June 26, 1978 CHECKED BY I.P.L.

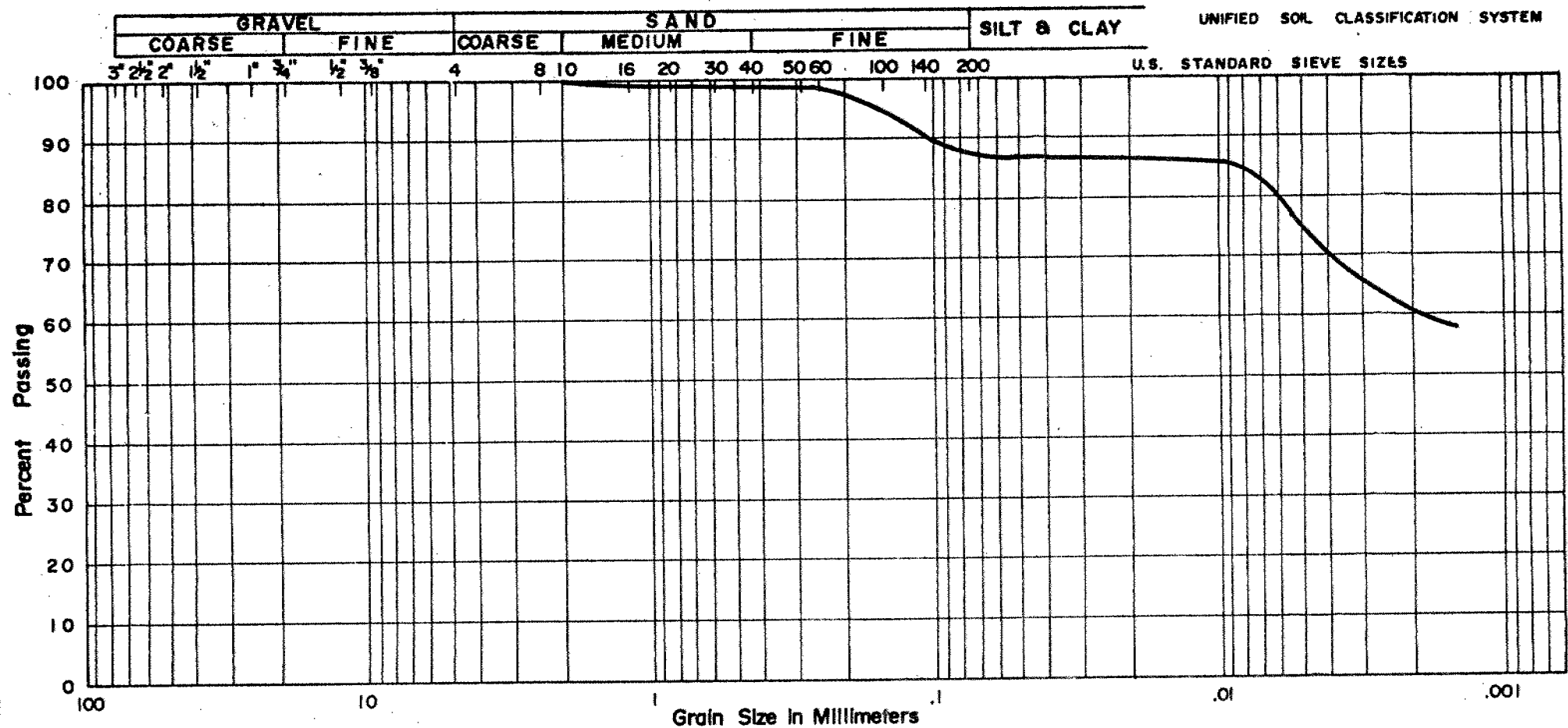
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
654.0	GROUND LEVEL																
0.0	Very loose, brown Sandy SILT, some Clay		1	SS	2		650										
649.0	5.0 Very loose, fine SAND some decayed wood		2	TW	--		W.L. 649.5 ft.										
646.0	7.0 Soft grey SILTY CLAY		3	SS	3												
644.0	10.0		4	TW	--												
	Loose to compact, grey SILT, dilatant		5	SS	12		640										
			6	SS	11												
632.0			7	SS	6												
22.0	END OF BOREHOLE																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity20
15 ϕ 5 (%) STRAIN AT FAILURE
10

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY:
 LOCATION: HWY. 638 COEFFICIENT OF CURVATURE:
 BOREHOLE N^o: 3
 SAMPLE N^o: 2
 DEPTH: 10'
 ELEVATION: 652'

Classification of Sample and Group Symbol:

CLAY

CI

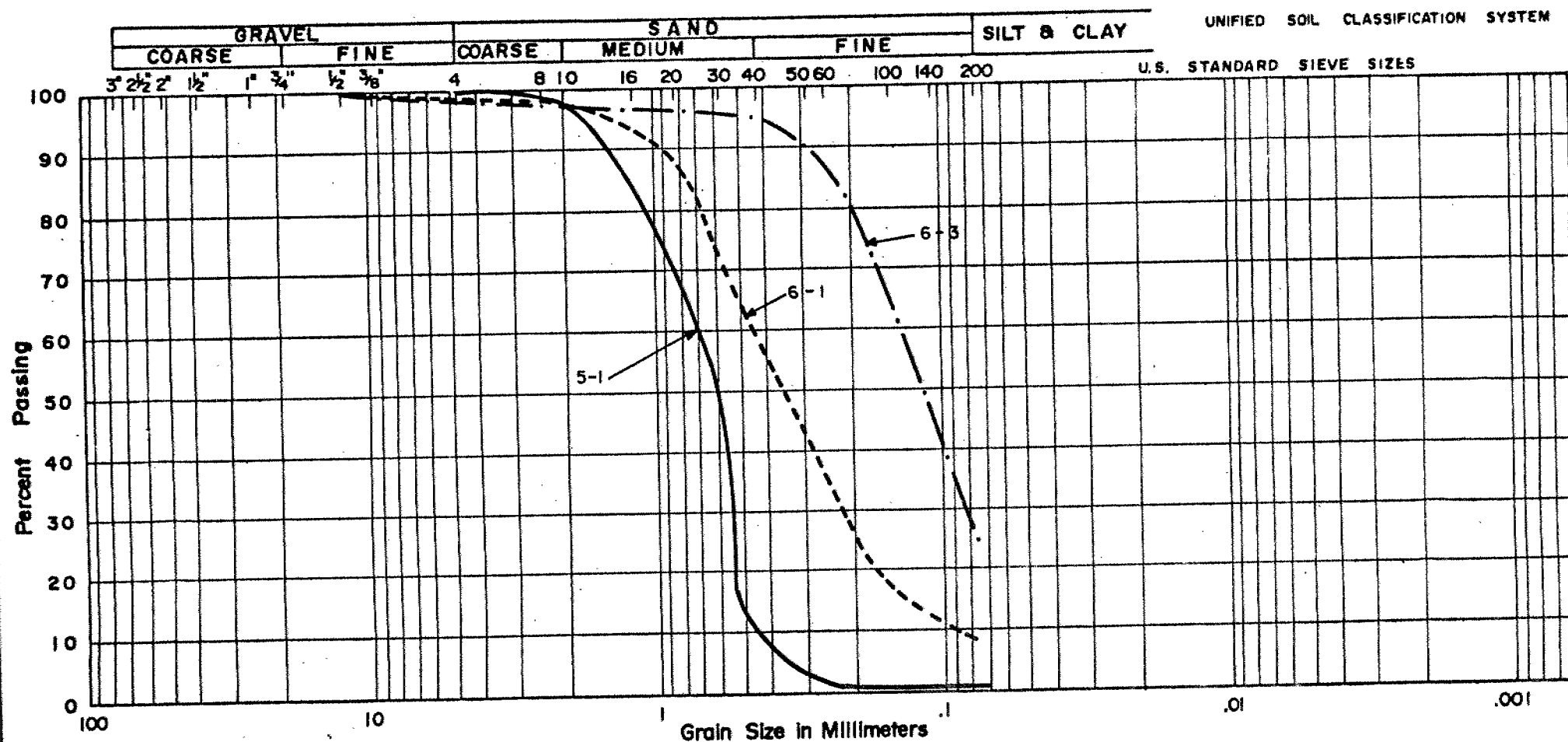
PLASTIC PROPERTIES

LIQUID LIMIT	% = 36
PLASTIC LIMIT	% = 22
PLASTICITY INDEX	% = 14
MOISTURE CONTENT	% = 27

FIG. 1

WP 19-76-03

DOMINION SOIL INVESTIGATION INC.
GRAIN SIZE DISTRIBUTION



PROJECT:	THESSALON RIVER CROSSING.			COEFFICIENT OF UNIFORMITY:
LOCATION:	HWY. 638			COEFFICIENT OF CURVATURE:
BOREHOLE N°:	5	6	6	
SAMPLE N°:	1	1	3	
DEPTH:	1'	1'	10'	
ELEVATION:	645'	645'	635'	

Classification of Sample

UPPER SAND STR.

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

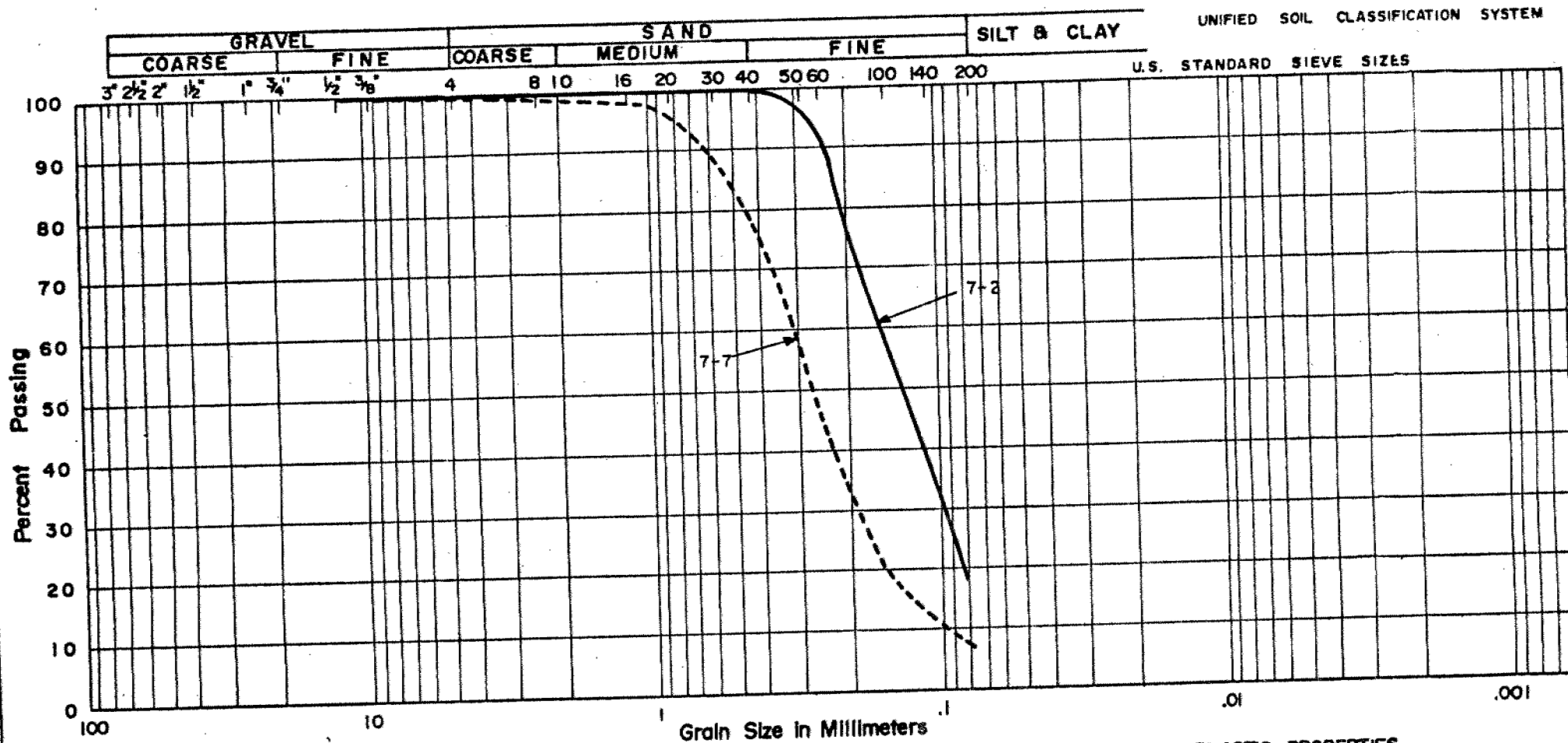
Classification of Sample and Group Symbol:

UPPER SAND STRATUM

SP - SM

FIG. 2

DOMINION SOIL INVESTIGATION INC.
GRAIN SIZE DISTRIBUTION



PROJECT:	THESSALON RIVER CROSSING.	COEFFICIENT OF UNIFORMITY:
LOCATION:	HWY. 638	COEFFICIENT OF CURVATURE:
BOREHOLE No:	7 7	
SAMPLE No:	2 7	
DEPTH:	5' 20'	
ELEVATION:	652' 637'	

Classification of Sample

UPPER SAND

Classification of Sample and Group Symbol:
UPPER SAND STRATUM

SM

PLASTIC PROPERTIES

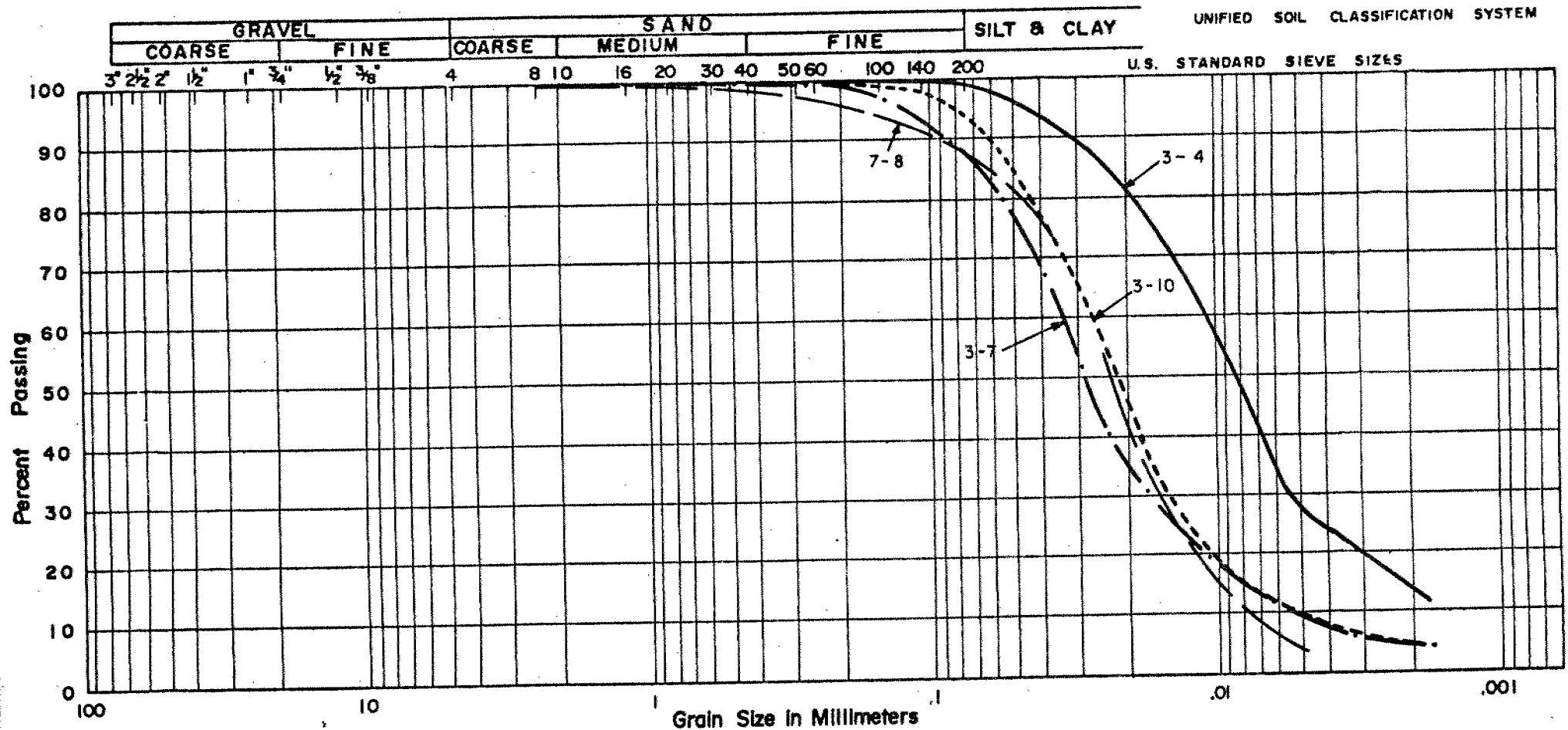
LIQUID LIMIT	%
PLASTIC LIMIT	%
PLASTICITY INDEX	%
MOISTURE CONTENT	%

FIG. 3

WP 19-76-03

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY: _____
 LOCATION: HWY. 638 COEFFICIENT OF CURVATURE: _____
 BOREHOLE N^o: 3 3 3 7
 SAMPLE N^o: 4 7 10 8
 DEPTH: 15' 22.5' 35'
 ELEVATION: _____

Classification of Sample and Group Symbol:

UPPER SILT STRATUM
non plastic, dilatant

ML

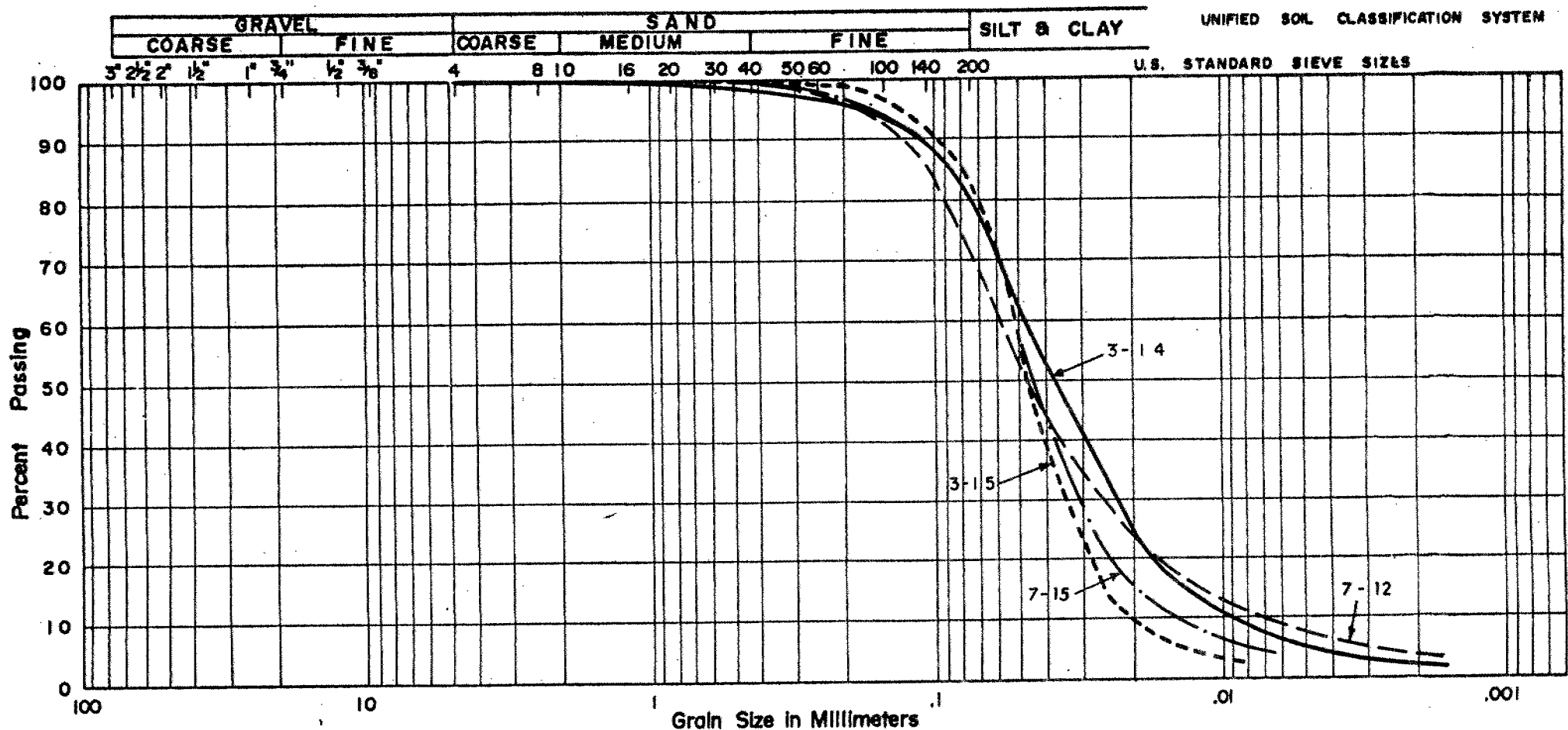
PLASTIC PROPERTIES

LIQUID LIMIT	% =	N / P
PLASTIC LIMIT	% =	
PLASTICITY INDEX	% =	
MOISTURE CONTENT	% =	20 - 28

FIG. 4

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY: _____
 LOCATION: HWY. 638 COEFFICIENT OF CURVATURE: _____
 BOREHOLE N^o: 3 3 7 7
 SAMPLE N^o: 14 15 12 15
 DEPTH: 55' 60'
 ELEVATION: 607' 602'

Classification of Sample and Group Symbol:

LOWER SILT STRATUM
some sand

ML

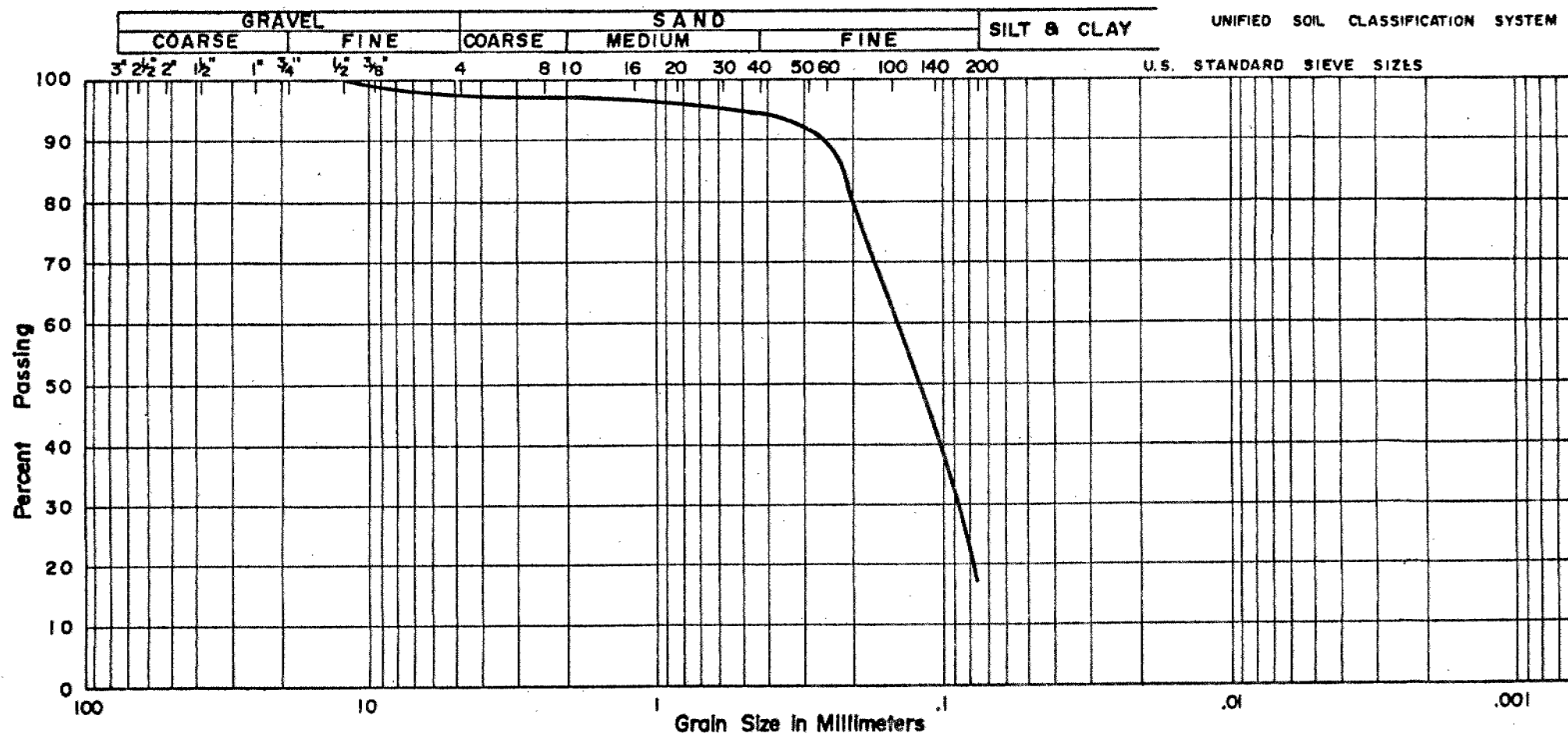
PLASTIC PROPERTIES
 LIQUID LIMIT % = _____
 PLASTIC LIMIT % = _____
 PLASTICITY INDEX % = _____
 MOISTURE CONTENT % = _____

FIG. 5

WP 19-76-03

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION



FOUNDATION INVESTIGATION REPORT

For

The Proposed Crossing at Leeburn Creek and Hwy. 638
W.P. 19-76-04, Site 38S-122,
District 18, Sault Ste. Marie

INTRODUCTION

This report contains the results of a foundation investigation performed at the abovementioned site for the Ministry by the Geotechnical Consultant Dominion Soil Investigation, Inc. Fieldwork was carried out during the period of June 20 to June 25, 1978, consisting of six sampled boreholes, five of which were accompanied by a dynamic cone penetration test. The boreholes were advanced by augering until refusal was met. Then bi-cone and diamond drilling techniques were employed to break up the obstructions to advance the borehole further. The depth of the boreholes ranged from 22 feet to 85 feet below ground surface. Disturbed samples of the overburden were recovered by means of a split spoon sampler driven into the ground with a 350 ft.-lb. energy. Relatively undisturbed samples of cohesive subsoil were obtained using thin walled Shelby tubes. Bedrock was proven by obtaining BXL size rock core samples.

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. Bedrock in the area consists of igneous rocks such as granite, and metamorphic rocks such as gneiss, granitized sedimentary, belonging to the Archean Era.

The topography of the area surrounding the existing 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 feet of the site to the north and south of Highway 638.

SUBSOIL CONDITIONS

General

The location and elevation of the boreholes are shown on Drawing No. 38S-122-2. The subsoil stratigraphy 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

A description of the various subsoil types encountered is as follows:

Surficial Deposits

Fill

Immediately east of the existing bridge, a 7.5 foot thick layer of fill consisting of stiff clayey silt with sand and gravel and frequent boulders was encountered immediately below ground surface. Based on an 'N' values of 11 blows/ft., the fill was relatively well compacted. The stiff to very stiff clayey silt encountered in one location on the west side of the creek could also possibly be fill material.

Silty Sand

On the west bank south of the existing bridge, a layer of loose ('N' = 7 blows per foot) brown to grey silty sand was encountered below ground surface, extending to elevation 651.0 feet, for a thickness of about 10 feet.

Clayey Silt and Silty Clay

In the area between the west approach and the creek, a layer of firm to very stiff ('N' = 8 to 25 blows per foot) silty clay or clayey silt was found extending below ground surface to elevation 659.3 feet, for a thickness of up to 7.5 feet. Below the fill material in the east approach is a 12.5 foot thick layer of firm ('N' = 6 blows per foot) silty clay, which extends below ground surface to elevation 653 feet approximately.

Varved Clay

Below the above described surficial fill and natural deposits is a stratum of grey reddish mottled varved clay. This varved clay extends to between elevations 600.5 and 614.9 feet, i.e., between 47 and 67.7 feet below the ground surface.

The undrained shear strength of the cohesive soil measured in-situ by field vane tests gave 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 ranged between 288 and 720 p.s.f. (average 500 p.s.f.). Based on these results, together with 'N' values of less than 1 to 4 blows/ft., the consistency of the clay is soft to very soft.

The identity properties of the varved clay as determined by laboratory tests are as follows:

Liquid Limit (w_L)	25 to 51%
Plastic Limit (w_p)	14 to 25%
Plasticity Index (I_p)	7 to 29%

Based on this, the varved clay has a low to intermediate plasticity.

The natural moisture content ranged between 12 and 71% (average 48%), generally higher than the liquid limit. This is indicative of the high sensitivity of the varved clay to remoulding. The sensitivity as determined by field vane tests was found to be in the order of 3.

Consolidation tests (Figures 1 and 2) carried out on relatively undisturbed samples of the varved clay gave a preconsolidation pressure of 1.3 to 1.5 tsf and a coefficient of volume change (m_v) ranging between 0.01 and 0.06 feet²/ton in the pre-consolidated and normally consolidated pressure range of the clay. Based on this, the varved clay is highly compressible.

Sand, Some Gravel

Underlying the varved clay stratum is a layer of compact to very dense ('N' = 26 to 68 blows per foot) sand, which is up to 7 feet thick. In certain locations, this sand layer contains frequent boulders. The gradation characteristics of two typical samples obtained from this deposit, excluding cobbles and boulders, are shown on Figure 3.

This sand layer extends to the surface of bedrock.

Granite Bedrock

Bedrock was proven in some locations by coring to depths between 5.7 and 10.2 feet below the rock surface. Bedrock surface was encountered between elevation 593 and 613, corresponding to a depth of 52 and 75 feet below ground surface.

Bedrock is a granite and it is generally hard and sound, with core recovery ranging between 77 and 100% and R.Q.D. between 62 and 100%. However, in certain places, the upper 1 to 4 feet of the bedrock was found to be weathered and extensively fractured.

GROUNDWATER CONDITIONS

At the time of the investigation, the water level in Leeburn Creek was at elevation 655.5 feet.

Free water surfaces in the boreholes were encountered between elevations 654.1 and 660.7 feet, corresponding to depths of 7.5 and 11.5 feet below ground surface.

Artesian conditions were also encountered between elevation 605 feet and 610 feet. The measured artesian head was between elevations 662.9 feet and 674 feet, i.e. between 1 foot and 8 feet above the ground surface.

All the recorded groundwater levels are shown on the borehole logs and Drawing No. 38S-122-2.

B. Ly

B. Ly, P. Eng.
Foundation Engineer.

M. Devata

M. Devata, P. Eng.
Senior Foundation Engineer.

September, 1979

APPENDIX



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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)				
668.2	GROUND LEVEL													GR SA SI CL
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		17	RC	0									
600.5	CLAY with fine sand													
67.7	Very dense SAND and GRAVEL with frequent boulders			BXL										
592.9			18	SS	100/4"									
75.3	GRANITE BEDROCK		19	RC BXL	100%									
583.1			20	RC BXL	100%									
85.1	END OF BOREHOLE													

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

↑ augering
↓ wash
boring
drilled BW
casing and
cleaned
out with
bi-cone

RECORD OF CONE TEST No. 1

W P 19-76-04 LOCATION Sta. 178+69 5' R.T. & 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 W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
669.0							SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
0.0													
600.4													
65.6	END OF CONE TEST						110/7"						

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2 & CONE TEST No. 4

W P 19-76-04 LOCATION Sta. 176+89 22' L.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 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 60 80 100							
								SHEAR STRENGTH							
						○ UNCONFINED	+ FIELD VANE								
						● QUICK TRIAXIAL	x LAB VANE								
						1000	2000								
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"										
			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	50/3"										
607.7			15	BXL											
			16	RC											
57.9	END OF BOREHOLE					89%									

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3 & CONE TEST No. 3

W P 19-76-04 LOCATION Sta. 177+59 1.5' R.T. G 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					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
661.9	GROUND LEVEL							SHEAR STRENGTH						
								O UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								1000 2000						
								WATER CONTENT (%)						
								Wp W WL						
								20 40 60						
661.9	Stiff to very stiff brown, organic stained CLAYEY SILT, with some decayed wood(poss. FILL)		1	SS	21		660						106	Artesian condition observed below Elev. 610.0'
654.5			2	SS	9		650							Measured head at Elev. 662.9'
7.5			3	SS	2									Measured volume 1 gallon/45 seconds
			4	TW	--									
			5	SS	<1									
			6	TW	--									
			7	SS	<1									
			8	SS	2									
			9	TW	--									
			10	SS	2									
			11	TW	--									
614.9	very stiff, with fine sand seams		12	SS	19		620							
47.0	Compact, well graded SAND, with fine gravel and silt		13	SS	26		610							
609.9	broken rock		14	RC	77%									
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 \diamond 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 636 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	Very soft to soft, grey varved CLAY mottled reddish brown		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	with dilatant silt layers		13	TW	--		610										8 80 12 0 Augering wash boring
50.0	Very dense SAND and GRAVEL		14	SS	68												
604.0	GRANITE BEDROCK fractured		15	RC	90%												
57.0			16	BXL	77%												
597.4			17	RC	88%												
63.6	END OF BOREHOLE																

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

W P 19-76-04 LOCATION Sta. 178+63 7' L.T. Q 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 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					
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	--												
13.5			5	SS	1/18 "		650										
			6	TW	--												
			7	SS	1/18 "												
			8	SS	1/18 "		640										
			9	TW	--												
			10	SS	2		630										
			11	SS	--												
			12	SS	2		620										
			13	SS	2												
			14	TW	--		610										
607.9	with sand and fine gravel inclusions		15	SS	75/3 "												
58.0	Dense SAND & GRAVEL																↑ augering wash ↓ boring
59.0																	
	GRANITE BEDROCK		16	RC	91.1 %		600										
597.0																	
68.1	END OF BOREHOLE																

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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		660										
659.3			2	TW	--												
7.5	Very soft grey varved CLAY, mottled reddish brown		3	SS	2												
			4	TW	--												
			5	SS	+2		650										
			6	TW	--												
644.8			7	TW	--												
22.0	END OF BOREHOLE																Hole wet at 19'

+³, x⁵: Numbers refer to
Sensitivity

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

DOMINION SOIL INVESTIGATION INC.
CONSOLIDATION TEST

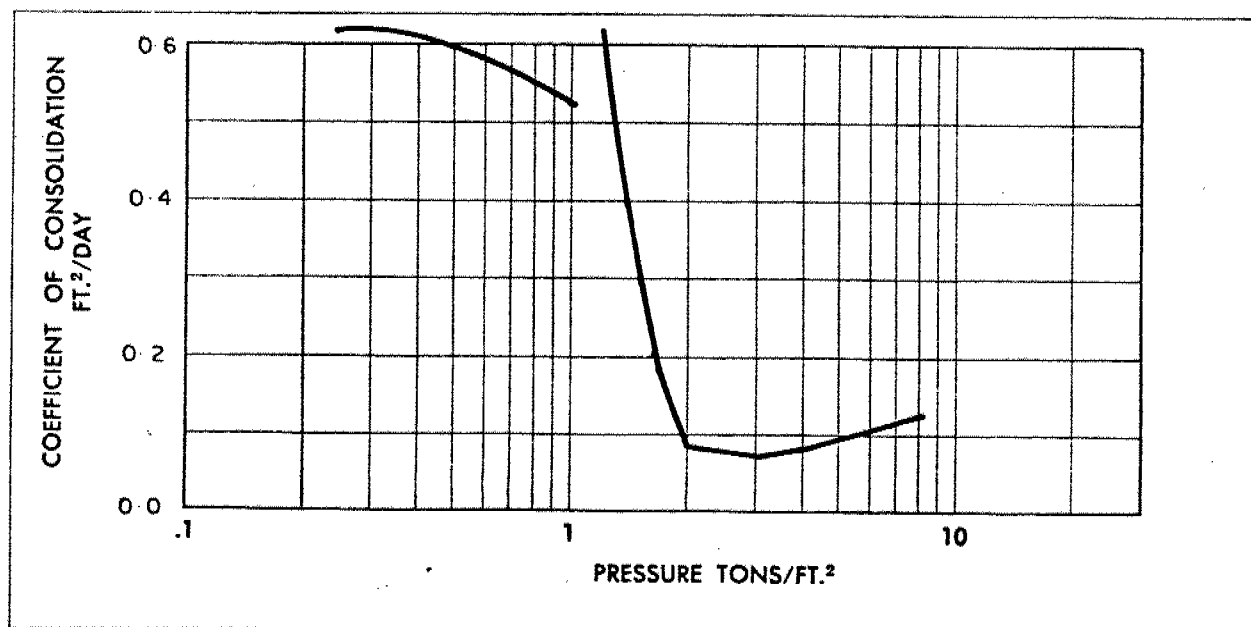
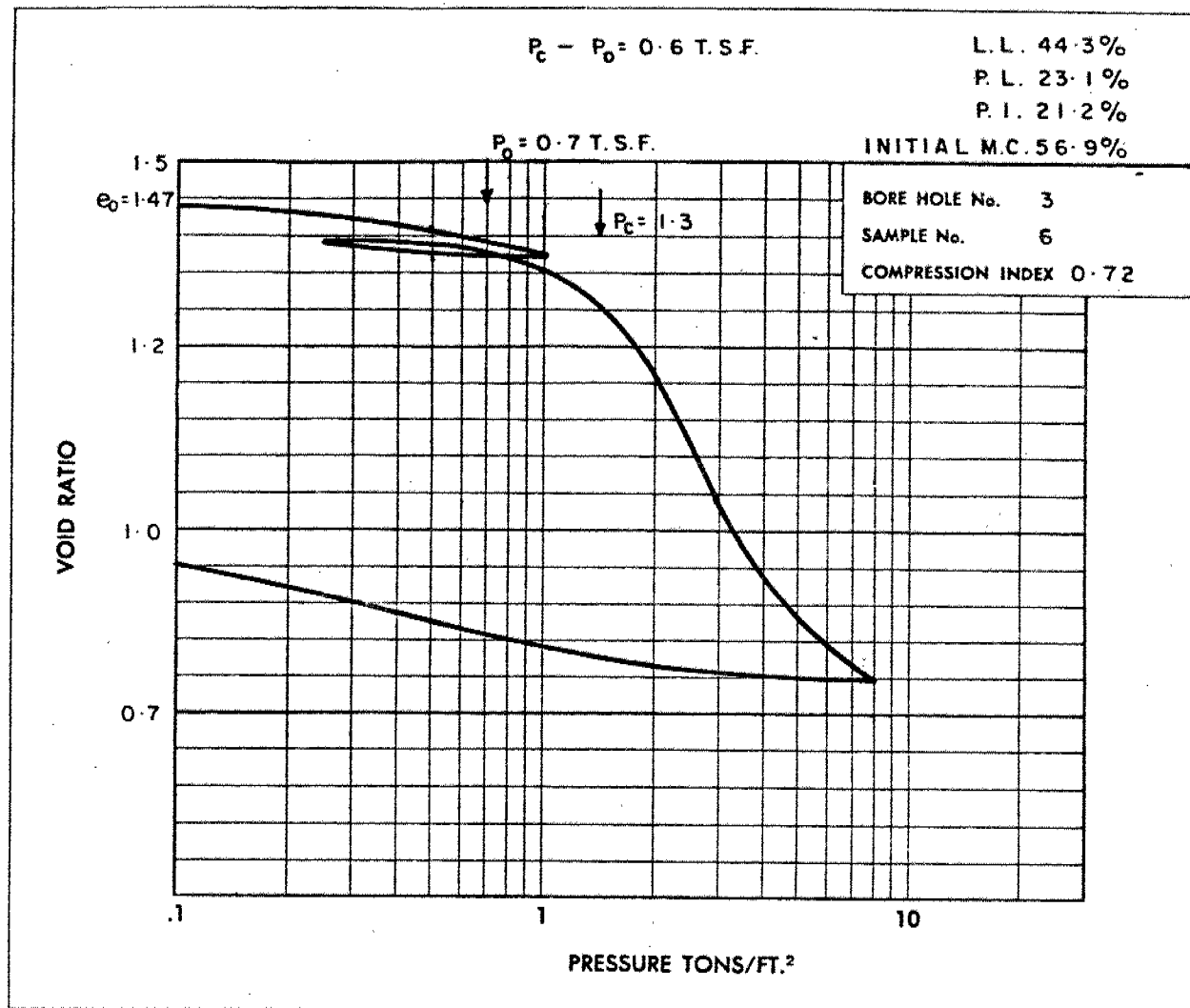


FIG. 1

WP 19-76-04

DOMINION SOIL INVESTIGATION INC.
CONSOLIDATION TEST

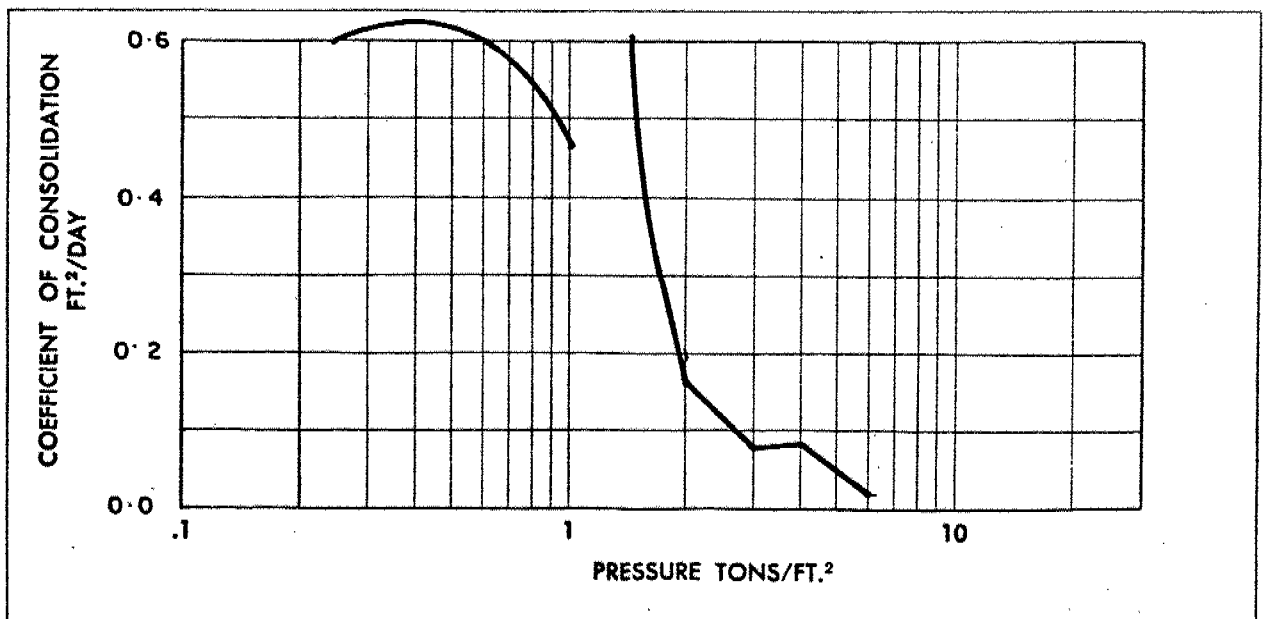
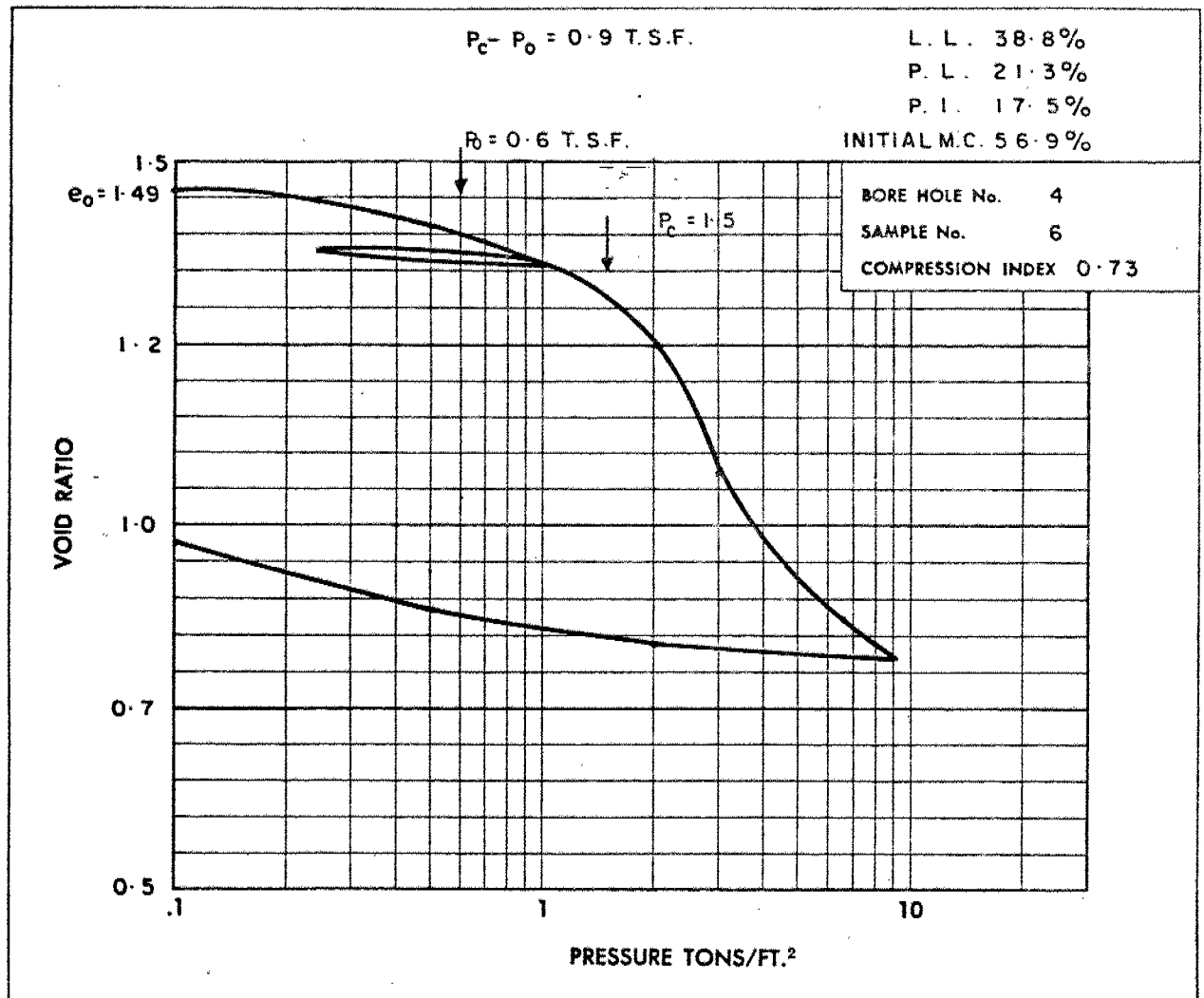
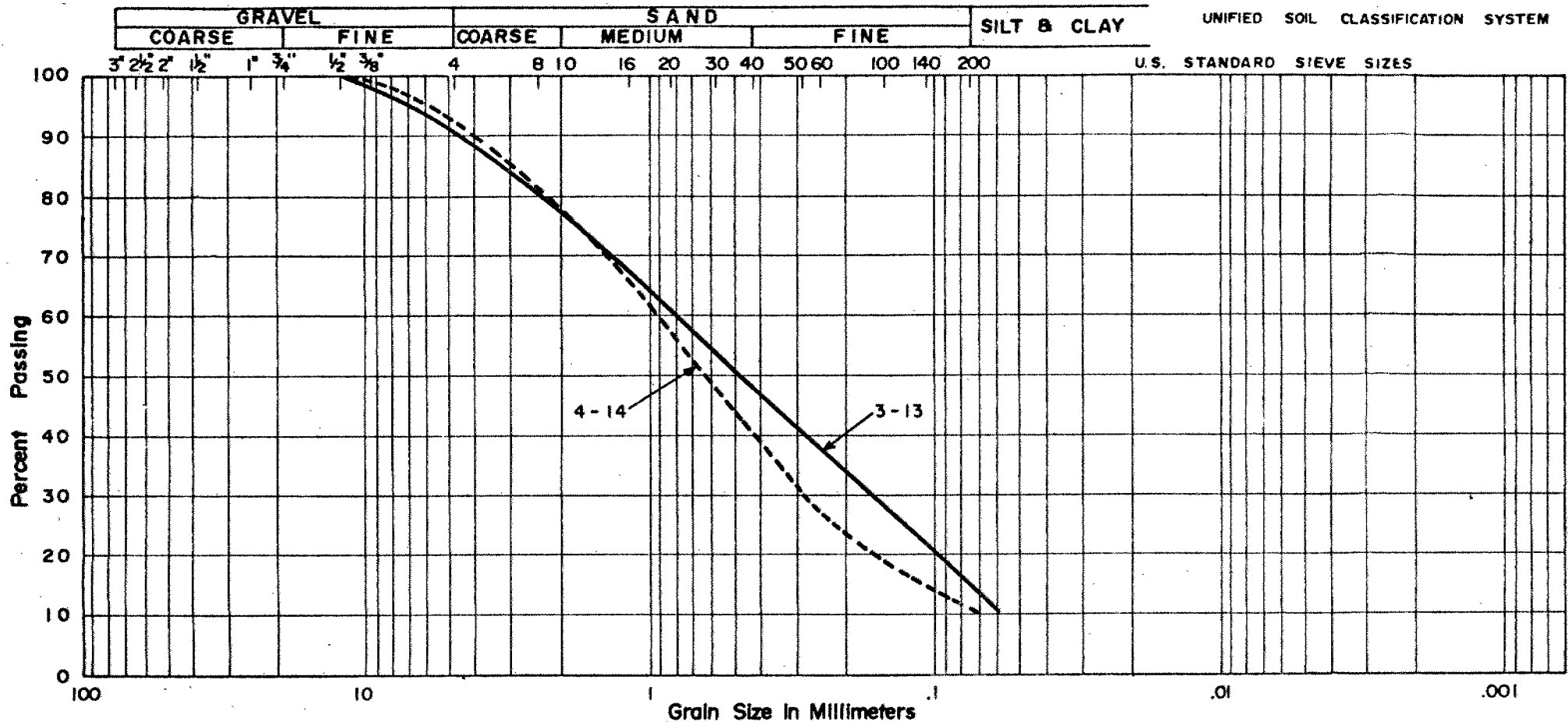


FIG. 2

WP 19-76-04

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION



PROJECT: BRIDGE REPLACEMENT
 LOCATION: HWY. 638 & LEEBURN CREEK
 BOREHOLE N^o: 3 4
 SAMPLE N^o: 13 14
 DEPTH: 51' 56'
 ELEVATION: 6109' 605'

COEFFICIENT OF UNIFORMITY :
 COEFFICIENT OF CURVATURE :

Classification of Sample and Group Symbol:
 SAND
 SOME GRAVEL

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

FIG. 3

WP 19-76-04



DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

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

(416) 751-6565

FOUNDATION INVESTIGATION
PROPOSED CROSSING AT THESSALON RIVER
AND SECONDARY HIGHWAY 638
WP19-76-03, Site ^{No.} NO. 38S-123
DISTRICT 18

PRELIMINARY

Ref. No. 78-6-20

August 1978

Prepared for:

Ministry of Transportation
and Communications
DOWNSVIEW, Ontario

DISTRIBUTION:

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and Communications
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A P P E N D I X

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E N C L O S U R E S

BOREHOLE LOCATION PLAN.....	Drawing 1
RECORD OF BOREHOLE NO. 1.....	Enclosure 1
RECORD OF BOREHOLE NO. 3.....	Enclosure 2
RECORD OF BOREHOLE NO. 4.....	Enclosure 3
RECORD OF BOREHOLE NO. 5.....	Enclosure 4
RECORD OF BOREHOLE NO. 6.....	Enclosure 5
RECORD OF BOREHOLE NO. 7.....	Enclosure 6
RECORD OF BOREHOLE NO. 8.....	Enclosure 7
RECORD OF BOREHOLE NO. 9.....	Enclosure 8
RECORD OF BOREHOLE NO. 10.....	Enclosure 10
GRAIN SIZE DISTRIBUTION CURVES.....	Enclosures 10 to 16 inclusive



1.0 INTRODUCTION

The Ministry of Transportation and Communications is planning the replacement of an existing Bailey Bridge on Highway No. 638 over the Thessalon River, between the Villages of Leeburn and Ophir, Ontario.

At the request of the Engineering Materials Office, Soil Mechanics Section of the Ministry, Dominion Soil Investigation Inc. has carried out a foundation investigation with the purpose of determining the subsurface conditions at the site of the proposed structure. The investigation in the field was completed in July 1978 and the findings are presented in this report.

.../...

*Topography, flow
+ land use.*

2.0 SITE AND GEOLOGY

The site is located on Lot 6, Concession 2 of Aberdeen Township, in the District of Algoma on Highway 638 about 2.2 miles west of Highway 561.

Geologically, the site is located on the Canadian Shield. During the last Ice Age, the area was invaded by continental glaciers which eroded much of the bedrock. As the ice sheet retreated, the waning glaciers exposed the basin of the present Great Lake system, which was then occupied by a complex series of lakes. The size, shape and distribution of these post-glacial lakes varied greatly, due to fluctuations in the ice front, the uncovering of new level outlets, and because of differential uplift of the northern part of the lake basins. The whole of the Lake Huron basin may have been uncovered by ice over 9,000 years ago, at which time the lake level was estimated to be at about Elevation 610 to 630 ft. Differential uplift finally brought about the gradual lowering of the lake level, going through intermediate stages referred to as the Nipissing Great Lakes and Algoma Lake stage and, finally, in the not too distant past, the Huron level dropped to that of the present lake level at about Elevation 580 ft. The remnants of this past lacustrine environment are the deep varved clay and fine beach sand and silt deposits encountered around the fringes of the Great Lakes and extending into the valley of the rivers discharging into the lake. The floor of these clay beds is a sandy ground moraine which overlies the uneven surface of the bedrock. The bedrock in the area consists of igneous rock, metamorphosed in places.

.../...



3.0 METHOD OF INVESTIGATION

Field Work

The work in the field consisted of putting down nine boreholes at the locations shown on Drawing No. 197603-A. Borehole 2 was omitted and was not drilled. The borings were carried out during the period of June 26 to July 7, 1978, using both augering, wash-boring and diamond drilling techniques. Boreholes 4, 5 and 6 were located in the river and were drilled with a diamond drill machine operated from a floating raft. The boreholes located on the river banks were drilled with a power auger machine equipped with hollow-stem augers. Disturbed soil samples were recovered with a 2-inch O.D. split spoon sampler driven into the ground with 350 ft.-lb. energy. The number of blows required to advance the sampler 12-inches into the undisturbed ground was recorded as the Standard Penetration resistance or 'N'-value. These values are shown on the "Records of Boreholes". Boreholes 3, 4, 6, 7 and 8 were advanced to a depth where refusal was met and in three boreholes the bedrock was cored to a depth of 4 to 7 ft. using 'N'-size (nominal 3-inch diameter) diamond equipment. Adjacent to Boreholes 3, 7 and 8 a dynamic cone penetration test was also performed.

The field work was carried out under the supervision of a soils technician who also laid out the boreholes in the field using the centre line stakes established by the surveyors of the M.T.C. as reference points. Ground surface elevation were referred to the local benchmark shown on M.T.C. Drawing No. E-5602-1.

.../...



Laboratory Testing

All soil samples were shipped in air tight jars to the laboratory of Dominion Soil Investigation Inc. for examination and testing. Representative soil samples were selected for sieve and hydrometer analyses, Atterberg tests and the measurement of the natural moisture contents. Plasticity values and moisture contents are plotted on the Records of the Boreholes (Enclosures 1 to 9) and the results of the grain size analyses are presented on Enclosures 10 to 16 inclusive.

4.0 SUBSOIL CONDITIONS

4.1 GENERAL DESCRIPTION

The present ground surface Elevation on the line of the proposed crossing ranges between Elevation 662 and 650 ft. on the west bank and between Elevation 650 and 656 ft. on the east bank of the river. The river bottom is at about Elevation 645.5 ft. The average slope of the river bank on the west side is about 3 horizontal in 1 vertical and about 2 horizontal in 1 vertical on the east bank.

Below the existing ground surface and extending to the surface of the bedrock, i.e., to about Elevation 590+ ft., the bridge site is underlain by a stratified deposit of sand and silt. The deposit is generally loose to very loose with occasional compact zones. Embedded in the upper sandy stratum of the deposit, to about Elevation 637 to 627 ft., are pieces of partly decayed wood.

.../...



Although considerable variations were noticed in the composition, thickness and the Elevation at which the various strata occur, the stratified sand and silt deposit can be divided into five major zones: an upper, middle and lower sand stratum which are separated from each other by two silt strata. On the west bank of the river the sand and silt deposit is overlain by about 10 ft. of stiff clay.

4.2 Clay

An approximately 10 ft. thick clay layer was encountered in Boreholes 1 and 3 extending to between Elevations 653 and 650 ft.

The results of a hydrometer analysis performed on a sample (Enclosure 10) indicates up to 62% of clay size particles. The liquid limit of the soil ranges from 36 to 55%, the plastic limit between 22 and 24%, with a plasticity index of 14 to 30. Based on this, the soil is classified as a clay of intermediate to high plasticity. The natural moisture content ranges between 25 and 28%. A field vane test performed in Borehole 1 indicates an undrained shear strength of 3200 p.s.f. and a laboratory quick, undrained triaxial compression test gave a shear strength value of 2400 p.s.f. The bulk unit weight of the soil is 118 p.c.f.

4.3 Upper Sand Stratum

In Boreholes 4 to 9 inclusive an 11 to 30 ft. thick sand stratum was encountered below the ground surface. This stratum extends to between Elevation 634 and 627 ft.

.../...

Grain size distribution curves of this material are shown on Enclosures 13 and 14, indicating a generally uniformly graded fine sand with up to 25% of silt. Embedded in the sand are occasional partly decayed pieces of wood, suggesting a geologically recent alluvial origin. In Boreholes 7 and 8 sandy peat seams ranging in thickness between 2-inches and 3.5 ft. and in Borehole 9, a 2.5 ft. thick organic silt layer were encountered in this sand. Standard Penetration resistances range between 1 and 11 blows per foot, indicating a generally very loose to loose relative density. The permeability of this stratum is estimated to be of the order 10^{-2} cm./sec. Because of the small particle sizes and the lack of any cohesive bond between these particles, this stratum is considered to be highly susceptible for erosion by the river.

4.4 Silt

In every borehole the surficial deposits (i.e., clay in Boreholes 1 and 3 and sand in Boreholes 4 to 9) are underlain by a layer of silt. The thickness of this silt ranges between 5 ft. in Borehole 4 to 33 ft. in Borehole 8. Similar large variations were found in the elevation to which the underside of this stratum extends (625 to 594 ft.).

This stratum consists mainly of non-plastic silt size particles as shown on Enclosures 11 and 15. Randomly distributed throughout the stratum occasional slightly plastic zones or thin seams of silty clay were also encountered. The Standard Penetration resistances ('N'-values) range between 3 and 17 blows per foot, but are typically less than 10 blows per foot, indicating a very loose to loose relative density. The stratum is .../...



expected to behave as an essentially non-plastic, non-cohesive granular deposit.

4.5 Middle Sand

In Boreholes 3, 4, 6 and 7 a 5 to 15 ft. thick sand layer was encountered below the silt, extending to between Elevations 612 and 607 ft. Grain size distribution curves of this material are not available, but based on visual examination of the soil samples it consists of mainly fine sand particles with up to an estimated 35% of silt. Based on the results of the Standard Penetration tests performed in this stratum ('N' = 5 to 19 blows per foot), the relative density of this stratum is inferred to be loose to compact.

4.6 Silt

Boreholes 3, 4, 6 and 7 encountered a second layer of silt below Elevation 610+ ft. The thickness of this stratum is generally only 5 ft., except in Borehole 7 where a 20 ft. thick layer was penetrated. The underside of this stratum extends to between Elevations 604 and 592 ft. Standard Penetration resistances range between 4 and 18 blows per foot, but are typically less than 10 indicating a generally loose relative density. Grading curves of this material are shown on Enclosures 12 and 15. The silt in this zone did not exhibit any plastic or cohesive properties.

4.7 Lower Sand

In Boreholes 3, 4, 6, 7 and 8, the silt stratum described in Section 4.6 is underlain by a 4.5 to 12 ft. thick sand layer. This sand extends to .../...

the surface of the bedrock, that is to between Elevation 594 and 585 ft. The particle size distribution characteristics of a typical sample are shown on Enclosure 16, indicating a predominantly fine sand with a trace to some gravel and silt. Occasional larger, cobble and boulder size, particles were also encountered (e.g., Boreholes 3 and 8). 'N'-values in this stratum range between 14 and over 100 blows per foot, indicating a range of relative density between compact and very dense. In Boreholes 4 and 6 artesian water conditions were noted in this stratum.

4.8 Bedrock

In the five deep boreholes (Boreholes 3, 4, 6, 7 and 8) the surface of the bedrock was encountered or inferred from refusal between Elevation 594.2 and 585.0 ft. The bedrock was cored at three locations, Boreholes 3, 7 and 8, and an examination of the rock cores indicated a granitic intrusive rock. The top 2 to 3 ft. of the rock was fractured with R.Q.D. (Rock Quality Designation) values of 30 to 44%, but was sound below (R.Q.D. = 60 to 100%).

Because of the complex nature of the deposits, the above description cannot be complete and, therefore, reference should be made to the individual borehole logs (Enclosures 1 to 9) and to the soil profiles presented on Drawing No. 197603-A.

.../...



5.0 GROUNDWATER CONDITIONS

The position of the groundwater table in the boreholes was recorded between Elevation 655.4 ft. in Borehole 3 and 649.5 ft. in Borehole 10, indicating a small hydraulic gradient from west to east. In Boreholes 4 and 6 artesian conditions were encountered below Elevation 600 and 593 ft. respectively. The measured head was at Elevation 654.6 ft. in Borehole 4 and at Elevation 650.3 ft. in Borehole 6, or about 5 ft. above the river level which, at the time of the investigation, was at Elevation 649.6 ft. The rate of flow of artesian water was measured to range between 2 and 3 gallons/minute.

why WL in BH 8 > WL in the river?

*How the WL was measured?
in open boreholes? or in cased
holes? or inside the augers?*

Did the holes collapse? to what depth?

6.0 DISCUSSION OF THE RESULTS

The proposed bridge replacement will be either a three-span structure with spill-through abutments and a total length of 150 ft. or a two-span structure with closed-end abutments and a total length of about 100 ft. The structure will be about 30 ft. wide. The proposed grade level is at about Elevation 671 to 673 ft. Our analysis and recommendations are based on this information.

In summary, the subsurface conditions at the site consist of generally loose stratified sand and silt deposits extending to a depth of about 45 to 65 ft. below present grade, followed by a 5 to 12 ft. thick dense sand and gravel stratum and, finally, the Pre-Cambrian igneous bedrock below Elevation 594 to 585 ft. The sand and gravel stratum overlying the bedrock contains water under artesian pressure.

For the foundation treatment of the structure, three possible alternatives were considered:

1. Spread Footings
2. Friction Piles; and
3. End-Bearing Piles

6.1 Spread Footings

The very loose to loose sand and silt deposit encountered at the abutment and pier locations is not a suitable foundation stratum. Spread footings or timber cribs would have to be founded below the maximum

.../...

depth of scour which under flood water conditions could be well in excess of 10 ft. at this site.

At this level, the subsoil has a low bearing capacity and large deformations can be expected in the loose and compressible deposit even under light contact pressures. These conditions are not suitable for a multi-span structure and, therefore, in our opinion spread footing foundations are not feasible at this site.

6.2 Friction Piles

Consideration was given to the use of timber piles embedded in the loose to compact stratified sand and silt deposit. Such piles would develop their load carrying capacity from skin friction. In our analysis, we have assumed that the piles will be driven to Elevation 605 ft. and that the riverbed is scoured to Elevation 635 ft., that is about 10 ft. below the present level. Under these conditions, the estimated working capacity of 12-inch nominal diameter timber piles would be about 10 to 15 tons. Deeper penetration of the piles, to increase the carrying capacity, could not be considered as the pile tips would penetrate the water bearing sand stratum and the seepage caused by the artesian water along the piles would seriously reduce or completely destroy the skin friction. Because of the anticipated low load carrying capacity and the possibility that the river may be scoured to a greater depth and the possible danger represented by the artesian water bearing stratum, we do not advise the use of friction piles.

.../...

S

6.3 End-Bearing Piles

We recommend that the structure be placed on end-bearing piles driven to the surface of the bedrock. The surface of the igneous (granite) bedrock was encountered or inferred from refusal between Elevation 594.2 ft. in Borehole 3 and 585 ft. in Borehole 7. Further variations from these observed maximum and minimum values can also be expected.

Because of the anticipated variations in the tip elevation of the piles and the expected hard driving conditions through the boulders embedded in the sand and gravel deposit above the surface of the rock, steel tube or steel H-piles are the most suitable type of piles for this project. To protect the piles from damage on the boulders or overdriving on the rock, the tip of the piles should be reinforced with hardened steel tips.

*Should we use
heavy sections?
or any size
in particular?*

*or 12 BP 53
or 12 BP 74*

Piles driven to the surface of the bedrock will develop their full structural capacity and can be designed for a unit stress of 0.3 times the yield stress of the steel using the net cross-section of the pipe. The maximum stress in the pile, however, should not exceed 12,000 p.s.f. Unbalanced horizontal forces on the abutments and piers should be resisted by battered piles.

Care should be given not to overdrive the piles and the driving should be controlled by the Hiley Formula. To prevent the removal of excessive amounts of soil fines by artesian water seepage along the piles, it is recommended that a granular or synthetic filter mat be placed underneath the pile caps.

Unwatering requirements

.../...

6.4 Horizontal Earth Pressures on Abutments

The lateral earth pressure on the abutment can be assumed to be uniformly increasing with depth in accordance with the following equation:

$$p = K (\gamma \times d + q)$$

where p = unit horizontal pressure (p.s.f.)

γ = unit weight of soil = 135 p.c.f. for granular backfill

d = distance from top of wall to point of application of pressure (ft.)

K = coefficient of horizontal earth pressure = 0.5

q = unit surcharge load applied at the top of the wall due to traffic, structural load, etc. (p.s.f.)

Adequate drainage should be provided behind the abutments to prevent the accumulation of water and the build-up of hydrostatic pressure on the structure. The water should be collected in a perforated drainpipe and discharged into the river through a frost free outlet.

6.5 Approach Fills

The proposed vertical grade will range from Elevation 671 ft. at the mid-span of the bridge to about 673 ft. at about Station 285+40. The above proposed grade is up to 20 ft. above the present grade. We do not foresee stability problems for the proposed approach fills and, therefore, these can be constructed with 2 horizontal in 1 vertical side slopes and 1.75 horizontal in 1 vertical end slopes. The end .../...

the effect of the organic layer on the approach fill + settlements

slopes, however, should be adequately protected against scour and undermining by the river.

6.6 Scour Protection

The material encountered below the riverbed and in the east bank of the river is a cohesionless silty fine sand and is, therefore, highly susceptible for erosion and scour. It is estimated that erosion of the unprotected riverbed and banks would start at stream velocities in excess of 1.5 ft./sec. The presence of wood fragments to Elevation 634 to 627 ft. suggests the possible extent of the scour. Recommendations pertaining to this aspect, however, should be obtained from the hydrology section of the M.T.C.

In the case of spill-through type abutments, it is essential that the end slopes and the riverbed in front of the toe of the slope be adequately protected against erosion to prevent the undercutting of the slope and subsequent slope failures.

6.7 Personnel

The field work was under the supervision of Mr. N. McCall, Soil Technologist. The data was compiled by Mr. I. Rainu, P.Eng., who with Mr. Z. Ozden, P.Eng., worked on the analysis and the report. The report was reviewed by Mr. I.P. Lieszkowszky, P.Eng.

.../...



The boreholes were drilled with the drilling equipment of D.S.I.L. Drilling Inc.

DOMINION SOIL INVESTIGATION INC.

Z. Ozden, M.ASc., P.Eng.

I.P. Lieszkowszky, P.Eng.

/kmj

A P P E N D I X

APPENDIX 'A'

Ref. No. 78-6-20

PHOTOGRAPHS

Si



Figure 1
West Bank of River



Figure 2
West Bank of River
on Line of Crossing
Drilling Rig on Borehole 3



Figure 3
Looking East on \odot of Crossing
Drilling Rig on Borehole 9



Figure 4
East Bank of River
Drilling Rig on Borehole 6

ENCLOSURES

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 19-76-03 LOCATION Sta. 283+45 C ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE July 5, 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L	
663.1	GROUND LEVEL														
0.0	Firm to stiff. brown CLAY		1	SS	2										
			2	TW	--										
653.1	with occ. silty sand		3	SS	9										
10.0	Very loose to loose, grey SILT, dilatant, some clay		4	TW	--										
			5	SS	3										
			6	SS	2										
641.6			7	SS	7										
21.5	END OF BOREHOLE														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

W P 19-76-03 LOCATION Sta. 283+53 15' R.t. ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering and Diamond Drilling (MXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 27, 1978 CHECKED BY I.P.L.

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
662.4	GROUND LEVEL															GR SA SI CL
0.0	FILL															
659.9	2.5															
	Stiff, brown CLAY organic stained		1	SS	9											0 12 26 62
649.9			2	SS	11											
12.5			3	SS	8											0 2 83 15
			4	SS	3											
	Very loose to compact, grey SILT dilatant with occasional reddish brown Silty Clay layers		5	SS	3											0 12 83 5
			6	SS	7											
			7	SS	8											
			8	SS	8											
			9	SS	8											0 5 90 5
			10	SS	11											
622.4			11	SS	11											
40.0	Compact, brown Fine SAND with some fine gravel and clay		12	SS	9											
			13	SS	12											
607.4			14	SS	8											0 18 80 2
55.0	Compact, grey SILT		15	SS	63											0 18 82 0
602.4			16	SS	46											
60.0	Dense to very dense brown Silty Fine SAND		17	MC	100%											
595.7	Well graded SAND with occasional boulders		18	MC	83%											
589.4																augering wash boring
68.2	GRANITE BEDROCK															
590.2																
72.2	END OF BOREHOLE															

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

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

W P 19-76-03 LOCATION Sta. 283 + 99 C ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE July 7, 1978 CHECKED BY J.P.L.

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
649.6	TOP OF RAFT DECK																GR SA SI CL
0.0	WATER																Artesian conditions observed below El. 600 ft. Measured head at El. 654.6 ft. Measured volume 2 gal./min.
645.7	RIVER BOTTOM																
3.9	Very loose SAND, well graded		1	SS	2		640										
636.6	with some wood chips																
13.0	Loose, grey Fine SAND, some silt and thin layers of Silty Clay		2	SS	5												
629.6							630										
20.0	Loose, grey SILT with fine sand seams		3	SS	7												
624.6																	
25.0	Loose to compact, grey Silty Very Fine SAND		4	SS	11		620										
			5	SS	5												
			6	SS	10												
609.6							610										
40.0	Compact, grey Sandy SILT, with some silty clay layers		7	SS	9												
604.1																	
45.5	Compact, grey		8	SS	25												Refusal @ 592.9'
600.6	Silty SAND																
49.0	Very dense, well graded SAND with fine gravel		9	SS	76		600										
592.9																	
56.7	END OF BOREHOLE																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

W P 19-76-03 LOCATION Sta. 284+15 C ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE July 7, 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
649.6	TOP OF RAFT DECK															GR SA SI CL
0.0	WATER															
645.6	RIVER BOTTOM															0 98 2 0
4.0	Loose, well graded SAND with fine gravel and some decayed wood		1	SS	PM											
			2	SS	7	640										
633.6			3	SS	8											
16.0	Loose to compact, grey SILT with occasional reddish/brown clay layers		4	SS	5	630										
623.1			5	SS	17											
26.5	END OF BOREHOLE															

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

W P 19-76-03 LOCATION Sta. 284+40 g ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE July 6, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER P 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			SHEAR STRENGTH									
649.6	TOP OF RAFT DECK							20	40	60	80	100					GR SA SI CL
0.0	WATER																
645.5	RIVER BOTTOM																
4.1	Loose, well graded SAND with some fine gravel		1	SS	4		640										2 90 8 0
	decayed wood		2	SS	7												
634.6			3	SS	4												3 72 25 0
15.0																	
	Very loose to loose, grey SANDY SILT, dilatant with occasional embedded wood to El. 627 Ft.		4	SS	6		630										
			5	SS	2												
			6	SS	9		620										
614.6			7	SS	14												
35.0	Compact brown to grey SILTY SAND						610										
609.6			8	SS	6												
40.0	Loose, grey SILT, trace Clay		9	SS	4												
604.6																	
45.0	Compact, grey fine SAND & SILT, with trace gravel		10	SS	29		600										
	coarse sand & fine gravel		11	SS	27												↑ augering
592.5																	
57.1	END OF BOREHOLE																Refusal at El. 592.5 Ft. Artesian conditions observed below El. 593 ft. Measured head @ El. 650.3 ft. Measured volume 3 gal./min.

+3, x5: Numbers refer to Sensitivity 20
15-20.5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Check notes
Engineer's 12

RECORD OF BOREHOLE No 7

W P 19-76-03 LOCATION Sta. 284+73 15' L.t. ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering and Diamond Drilling (NXL Size) COMPILED BY I.R.
DATUM Geodetic DATE June 27, 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			SHEAR STRENGTH								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
657.2	GROUND LEVEL															
0.0	Very loose, brown Silty Fine SAND, with some organics		1	SS	2										0 82 18 0	
647.2			2	SS	4											
10.0			3	SS	1											
643.7	Very loose Sandy PEAT		4	SS	1											
643.7			5	TW	--											
13.5	Loose, grey fine SAND with some wood inclusions		6	SS	8											
632.2			7	SS	6											0 92 8 0
25.0			8	SS	9											0 12 82 0
617.2	Compact, grey SILT, dilatant with occ. reddish brown silty clay layers		9	SS	12											
40.0			10	TW	--											
612.2			11	SS	19											
45.0	Compact, brown fine SAND Grey SANDY SILT compact very loose loose		12	SS	18										0 30 65 5	
592.2			13	SS	12											
65.0			14	SS	4											
585.0			15	SS	7											0 20 75 5
72.2			16	SS	55/6 "											W.S. = wash sample 2 80 18 0
578.4	Very dense, grey fine SAND		17	WS	--										↑ augering wash boring	
78.8			18	RC BXL	96%											
	GRANITE BEDROCK		19	RC BXL	100%											
	END OF BOREHOLE															

+3, x⁵ : Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8

W P 19-76-03 LOCATION Sta. 284+78 15' R.t. ORIGINATED BY N. McC.
 DIST 18 HWY 638 BOREHOLE TYPE Augering and Diamond Drilling (NXL Size) COMPILED BY I.R.
 DATUM Geodetic DATE June 28, 1978 CHECKED BY I.P.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					WATER CONTENT (%)
								SHEAR STRENGTH					
656.8	GROUND LEVEL											GR SA SI CL	
0.0 654.3	Dk.brown fine SAND												
2.5	Very loose Silty brown grey SAND		1	SS	2								
			2	SS	3								
			3	SS	<1								
			4	SS	<1								
644.3			5	SS	3								
12.5	4" sandy peat		6	SS	<1								
	2" sandy peat												
	very loose		7	SS	10								
	compact												
	Grey SAND		8	SS	11								
626.8			9	SS	11								
30.0	Light brown/grey Sandy SILT, dilatant		10	SS	10								
	compact		11	SS	8								
	loose		12	SS	3								
	very loose		13	SS	23								
	compact		14	SS	25								
	gravelly		15	SS	13								
	occ. cobbles		16	SS	14								
593.8			17	RC BXL	100%								
63.0	Compact coarse sand & fi. gravel, occ. boulders		18	RC BXL	100%								
589.3													
67.5	GRANITE BEDROCK												
582.7													
74.1	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 9

W P 19-76-03 LOCATION Sta. 284+88 G ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE June 26, 1978 CHECKED BY I.P.L.

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 10

W P 19-76-03 LOCATION Sta. 285+50 C ORIGINATED BY N. McC.
DIST 18 HWY 638 BOREHOLE TYPE Augering COMPILED BY I.R.
DATUM Geodetic DATE June 26, 1978 CHECKED BY I.P.L.

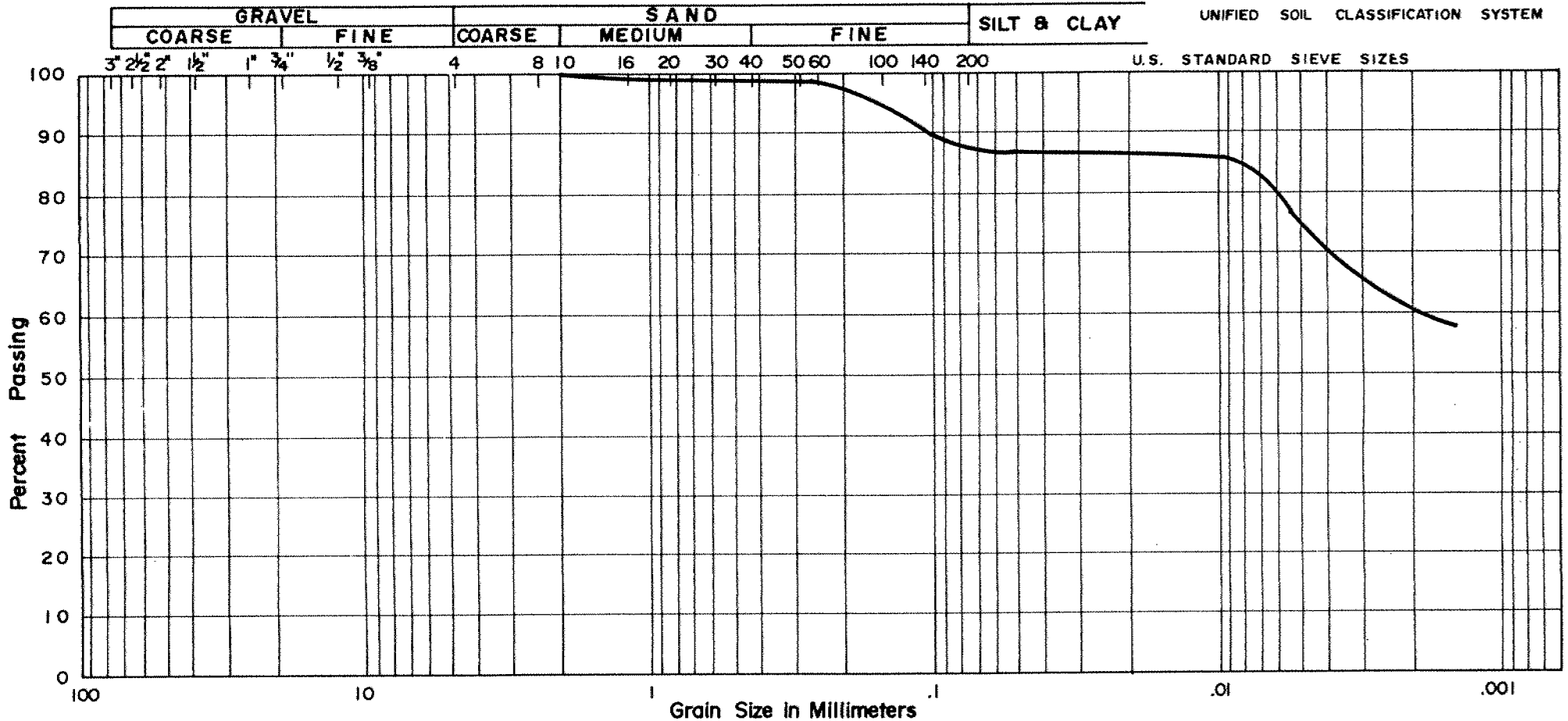
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
654.0	GROUND LEVEL																
0.0	Very loose, brown Sandy SILT, some Clay		1	SS	2		650										
649.0			2	TH	--		W.L. 649.5 ft.										
5.0	Very loose, fine SAND some decayed wood		3	SS	3												
646.5			4	TH	--												
7.5	Soft grey SILTY CLAY		5	SS	12												
644.0			6	SS	11												
10.0			7	SS	6												
	Loose to compact, grey SILT, dilatant						640										
632.0																	
22.0	END OF BOREHOLE																

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 78-6-20



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY:

LOCATION: HWY. 638 COEFFICIENT OF CURVATURE:

BOREHOLE №: 3

SAMPLE №: 2

DEPTH: 10'

ELEVATION: 652'

Classification of Sample and Group Symbol:

CLAY

CI

PLASTIC PROPERTIES

LIQUID LIMIT	% = 36
PLASTIC LIMIT	% = 22
PLASTICITY INDEX	% = 14
MOISTURE CONTENT	% = 27

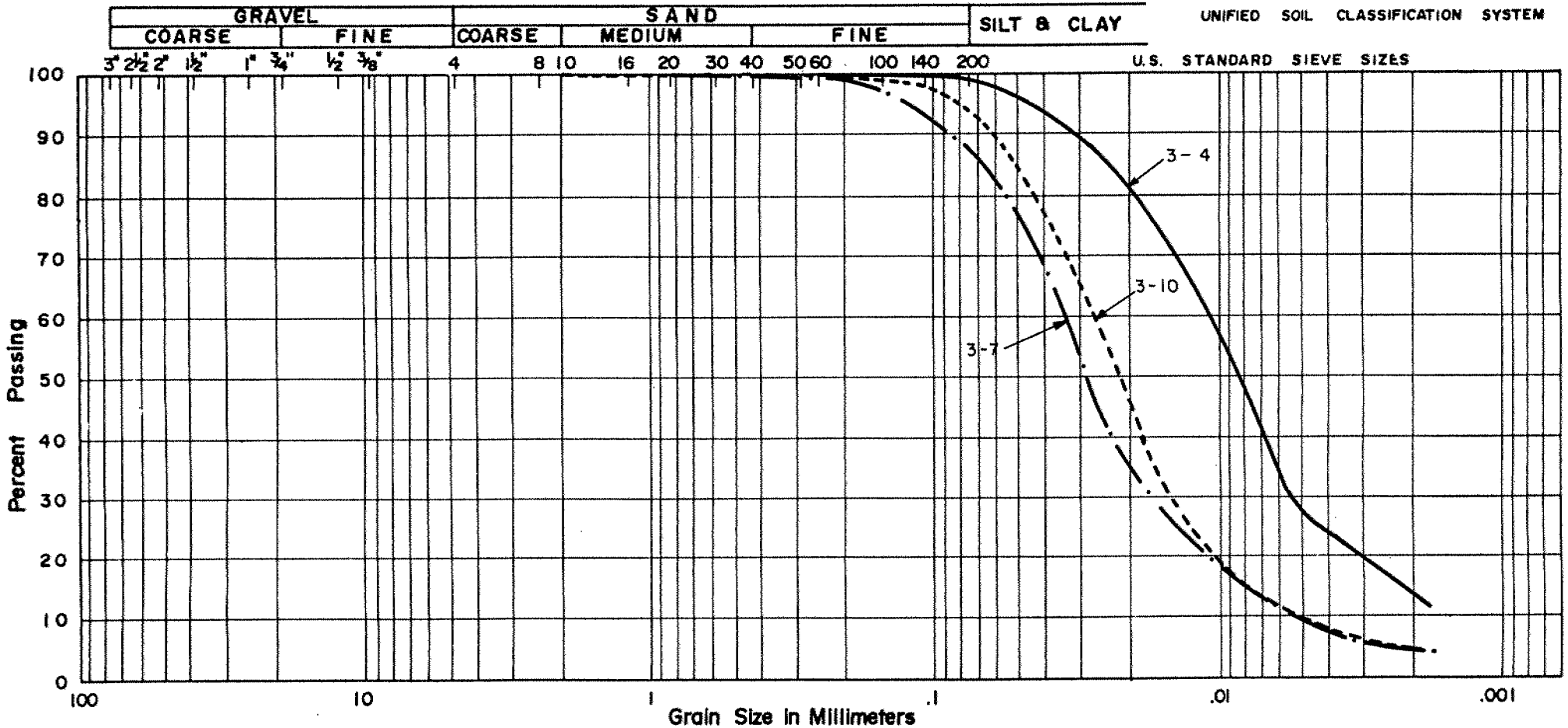
ENCLOSURE № 10

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 78-6-20

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY:

LOCATION: HWY. 638 COEFFICIENT OF CURVATURE:

BOREHOLE NO: 3 3 3

SAMPLE NO: 4 7 10

DEPTH: 15' 22.5' 35'

ELEVATION:

Classification of Sample and Group Symbol:

SILT
non plastic, dilatant ML

PLASTIC PROPERTIES

LIQUID LIMIT	% =	N / P
PLASTIC LIMIT	% =	
PLASTICITY INDEX	% =	
MOISTURE CONTENT	% =	20 - 28

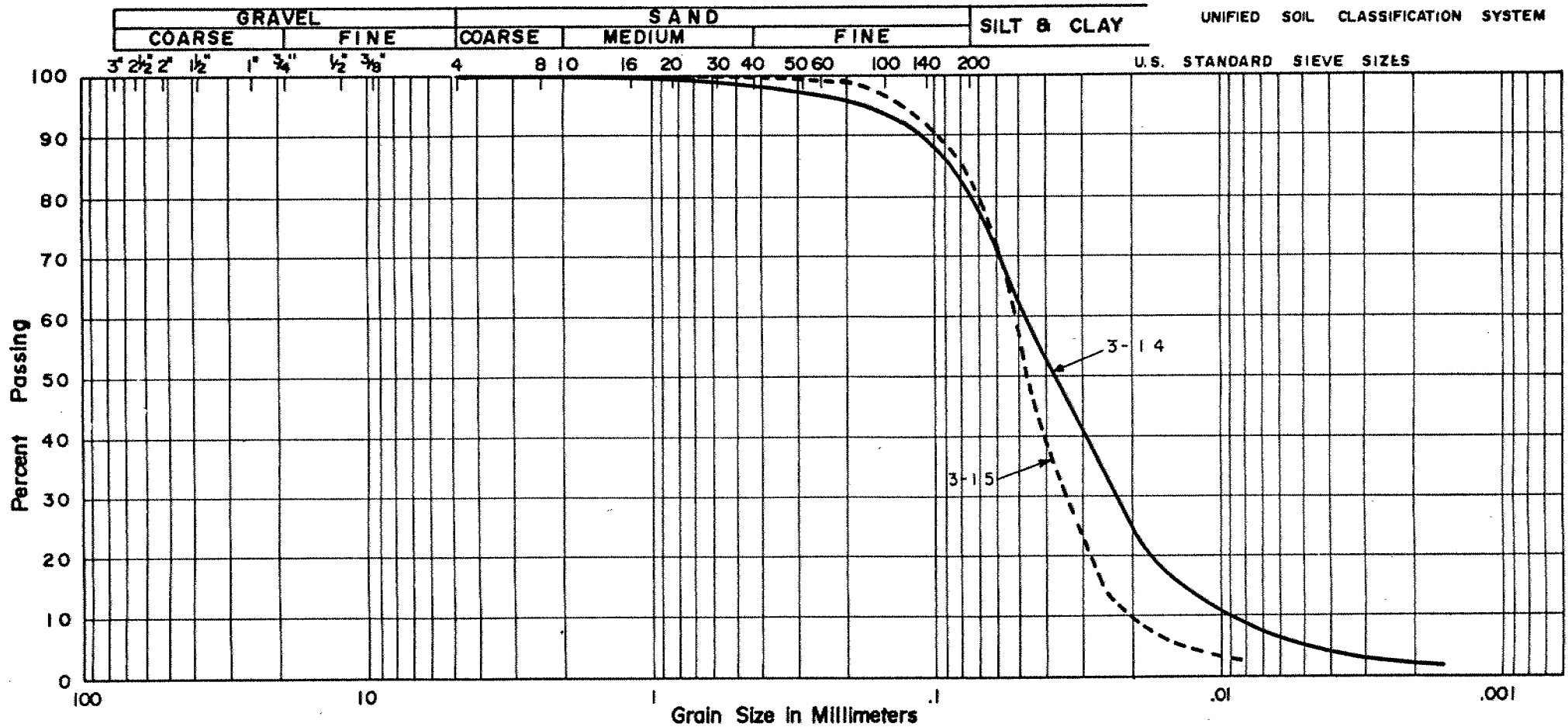
ENCLOSURE NO 11

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 78-6-20

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY:

LOCATION: HWY. 638

COEFFICIENT OF CURVATURE:

BOREHOLE №: 3 3

SAMPLE №: 14 15

DEPTH: 55' 60'

ELEVATION: 607' 602'

Classification of Sample and Group Symbol:

SILT
some sand

ML

PLASTIC PROPERTIES

LIQUID LIMIT % =

PLASTIC LIMIT % =

PLASTICITY INDEX % =

MOISTURE CONTENT % =

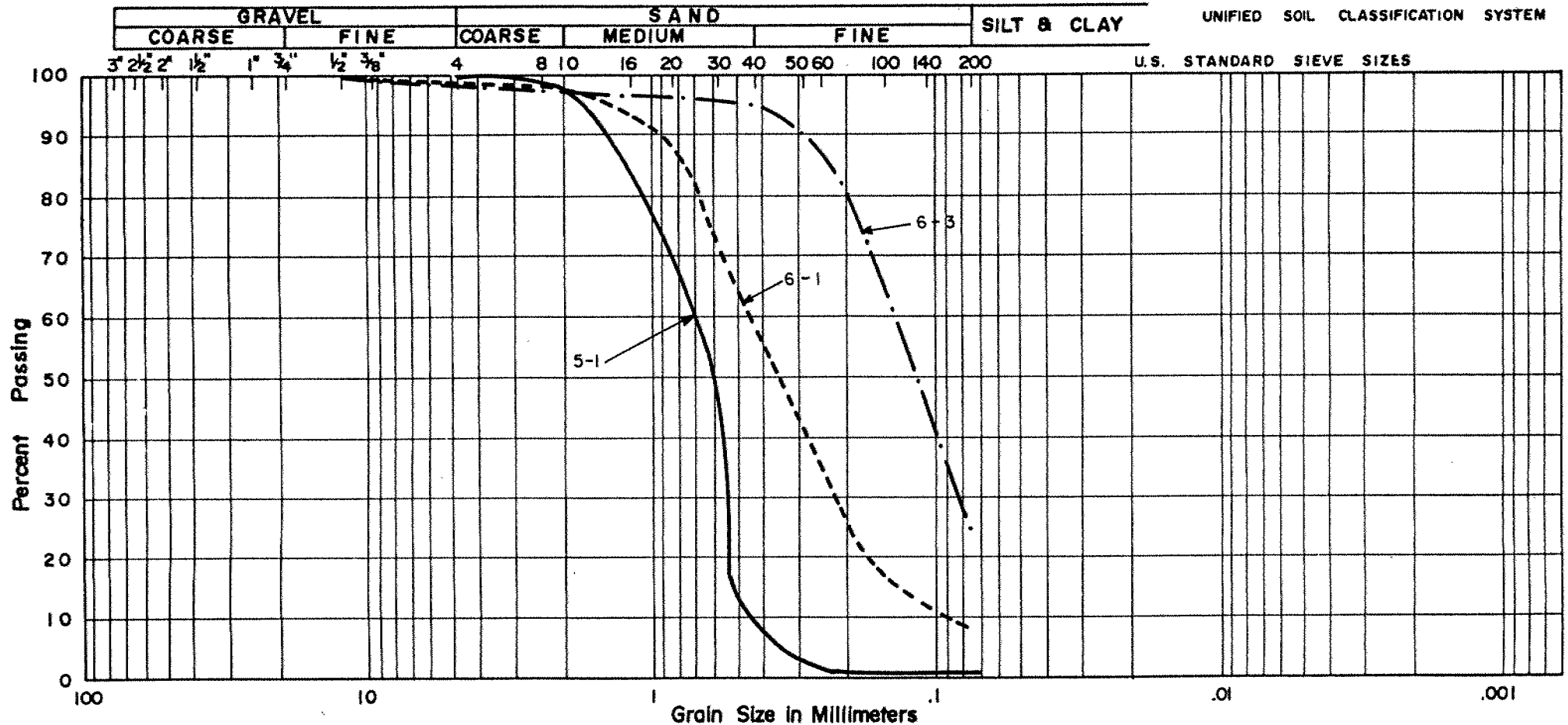
ENCLOSURE № 12

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No 78-6-20

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY: _____
 LOCATION: HWY. 638 COEFFICIENT OF CURVATURE: _____
 BOREHOLE No: 5 6 6
 SAMPLE No: 1 1 3
 DEPTH: 1' 1' 10'
 ELEVATION: 645' 645' 635'

Classification of Sample and Group Symbol:

Fine to medium SAND
trace to some Silt.

SP-SM

PLASTIC PROPERTIES

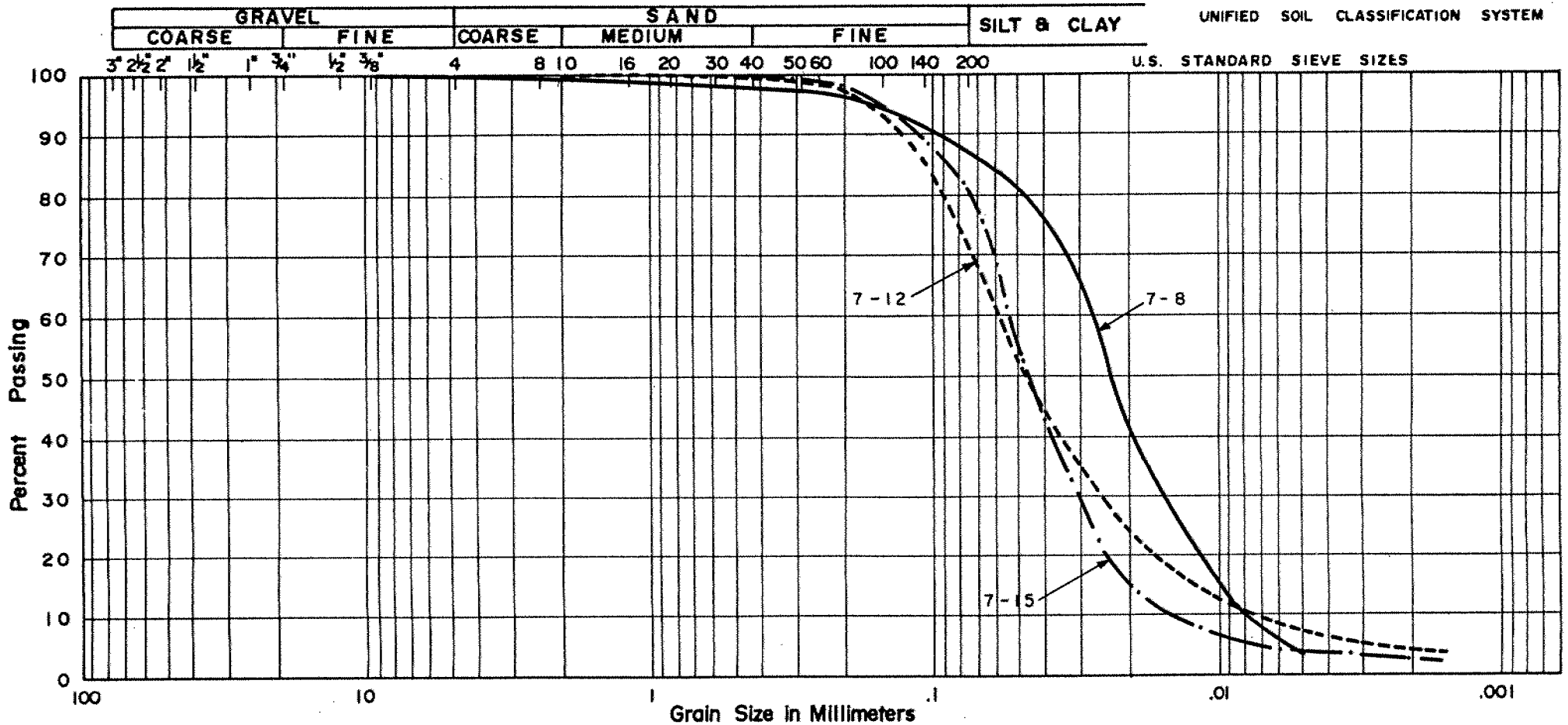
LIQUID LIMIT % = _____
 PLASTIC LIMIT % = _____
 PLASTICITY INDEX % = _____
 MOISTURE CONTENT % = _____

ENCLOSURE No 13

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N^o 78-6-20



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY:

LOCATION: HWY. 638 COEFFICIENT OF CURVATURE:

BOREHOLE N^o: 7 7 7

SAMPLE N^o: 8 12 15

DEPTH: 25' 45' 60'

ELEVATION: 632' 612' 597'

Classification of Sample and Group Symbol:

SILT
non plastic, some f. sand

ML

PLASTIC PROPERTIES

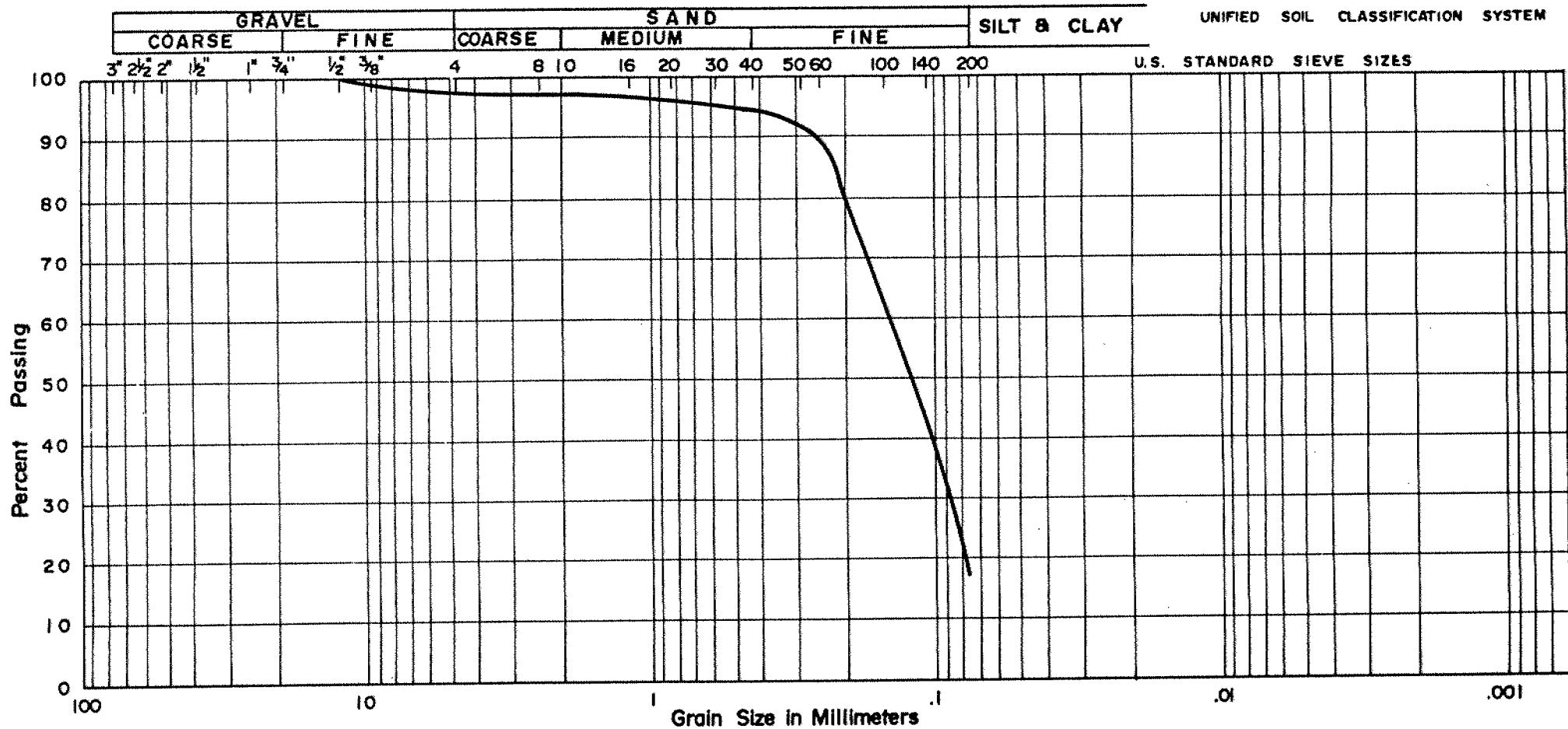
LIQUID LIMIT	% =
PLASTIC LIMIT	% =
PLASTICITY INDEX	% =
MOISTURE CONTENT	% =

ENCLOSURE N^o 15

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 78-6-20



PROJECT: THESSALON RIVER CROSSING. COEFFICIENT OF UNIFORMITY: _____
 LOCATION: HWY. 638 COEFFICIENT OF CURVATURE: _____
 BOREHOLE №: 7
 SAMPLE №: 16
 DEPTH: 65'
 ELEVATION: 592'

Classification of Sample and Group Symbol:

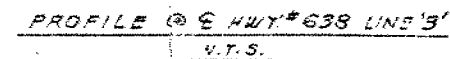
FINE SAND
some silt.

SM

PLASTIC PROPERTIES

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

ENCLOSURE № 16

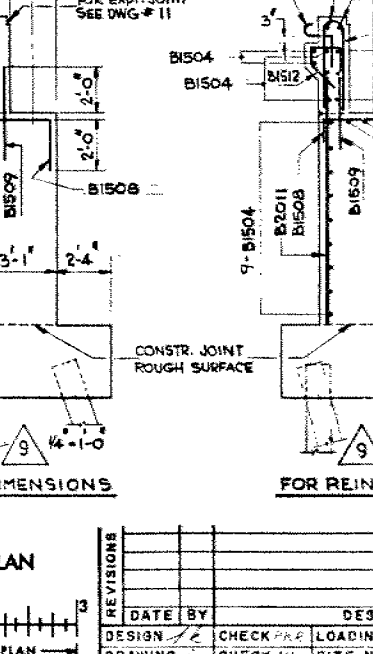
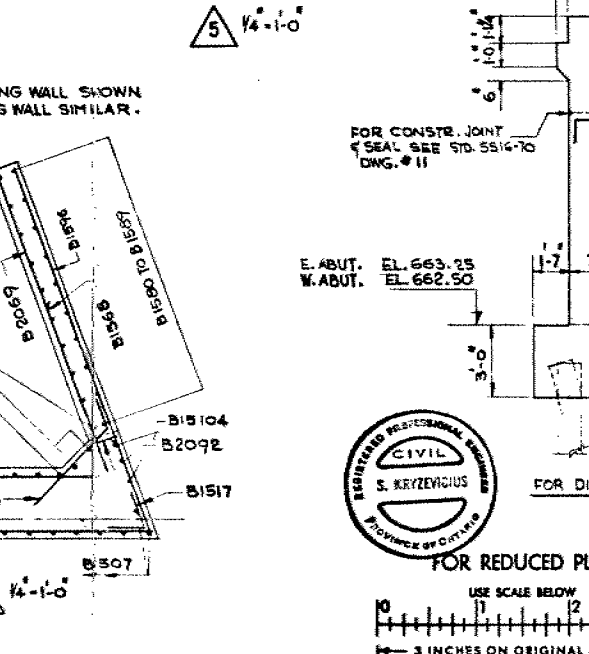
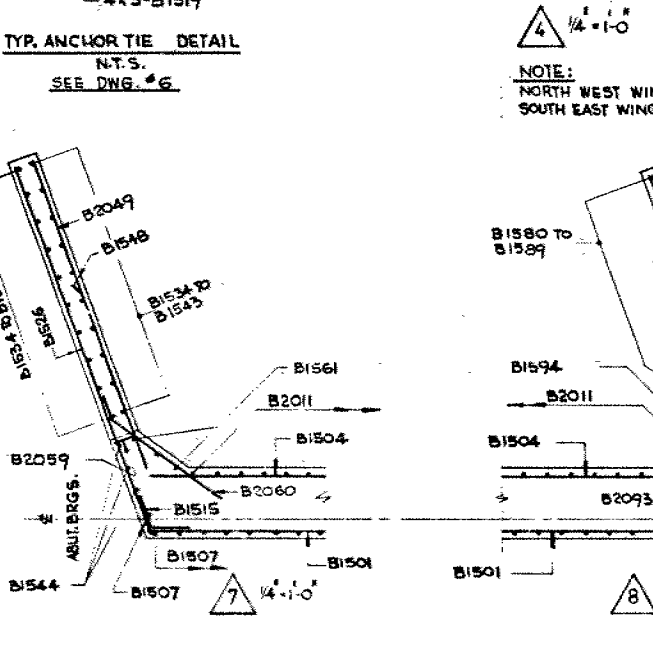
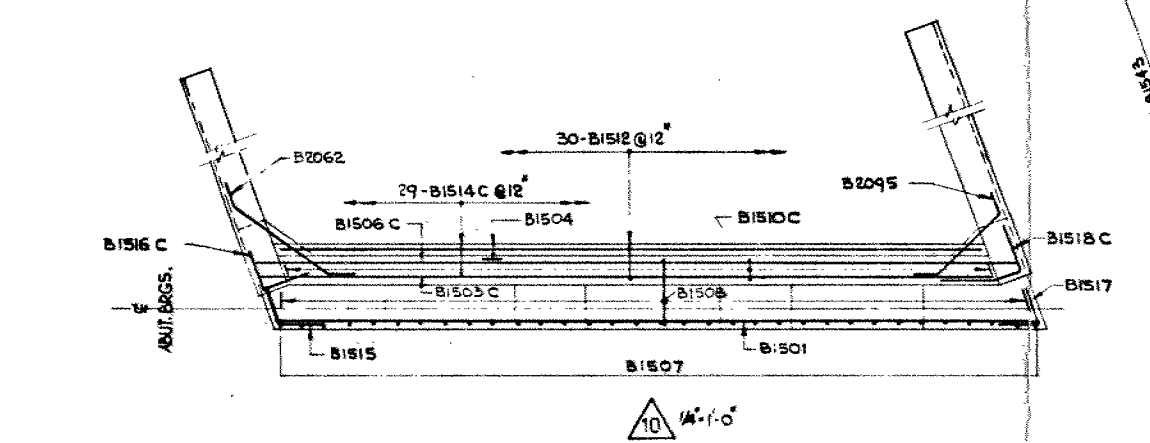
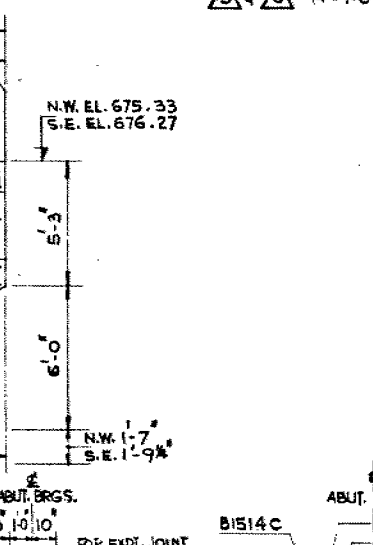
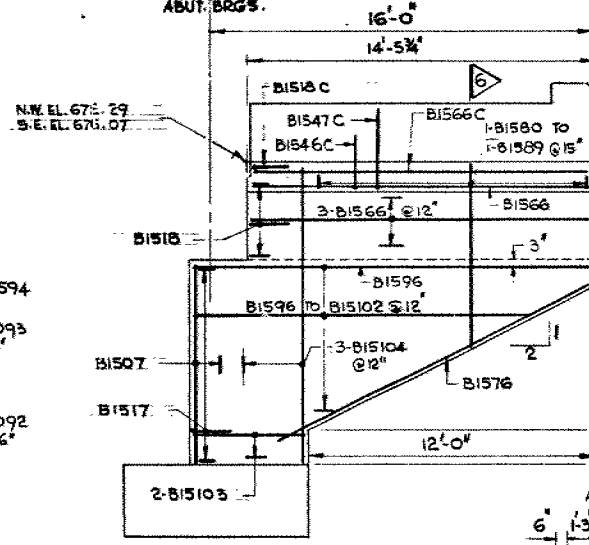
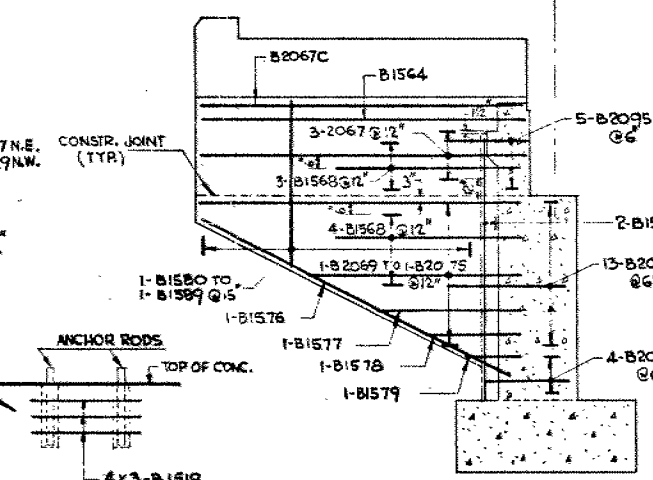
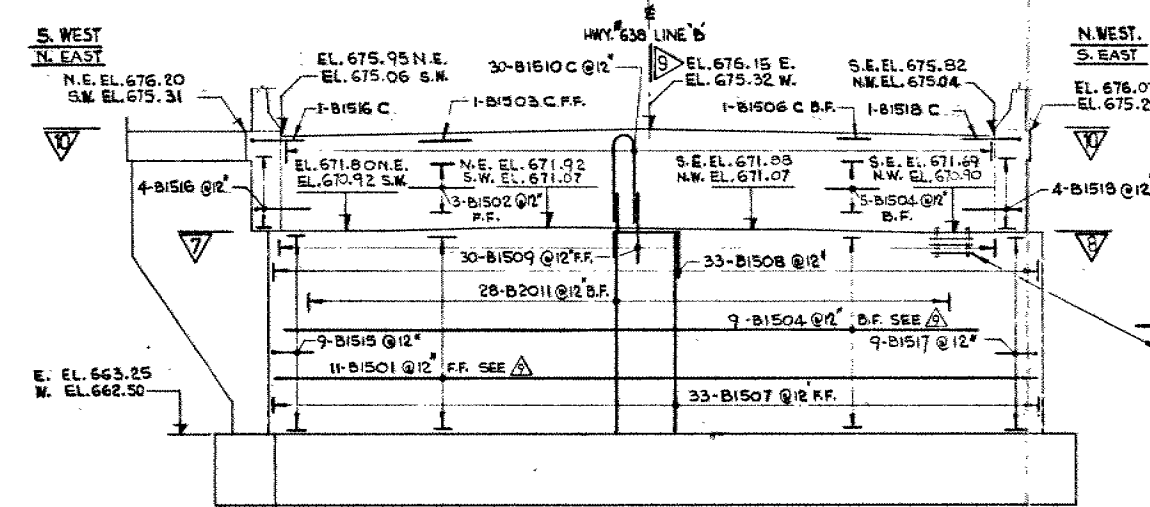
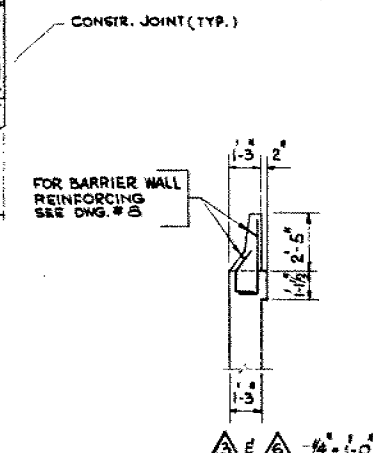
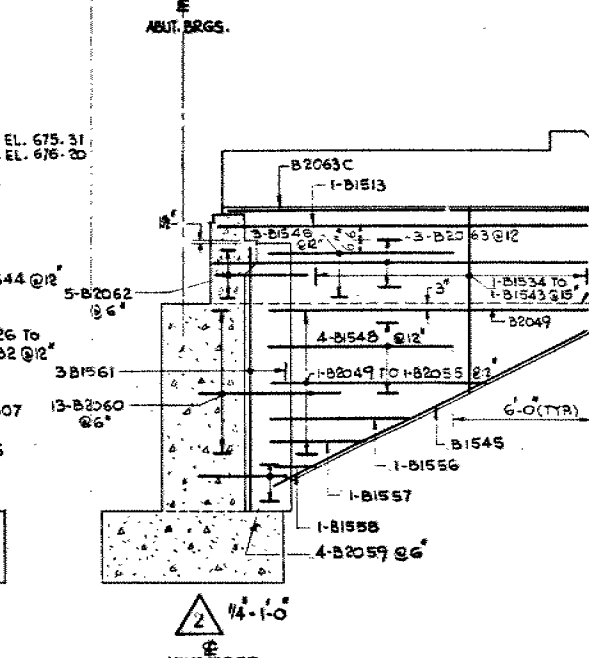
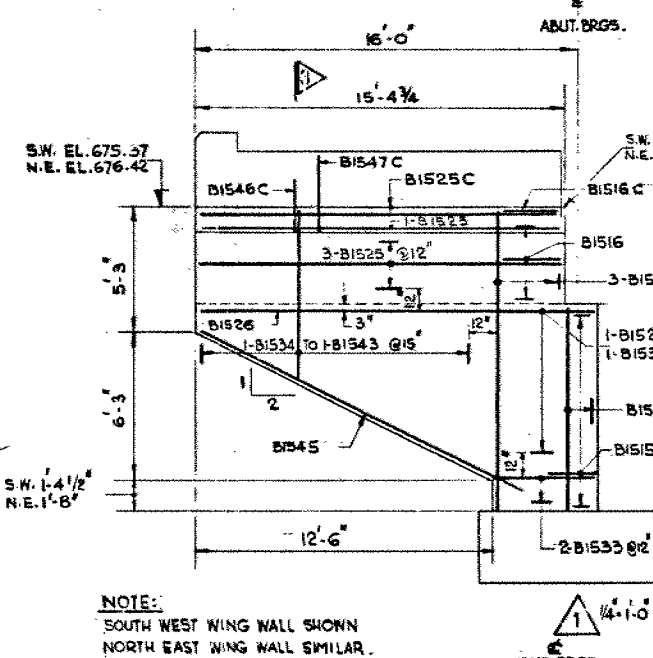
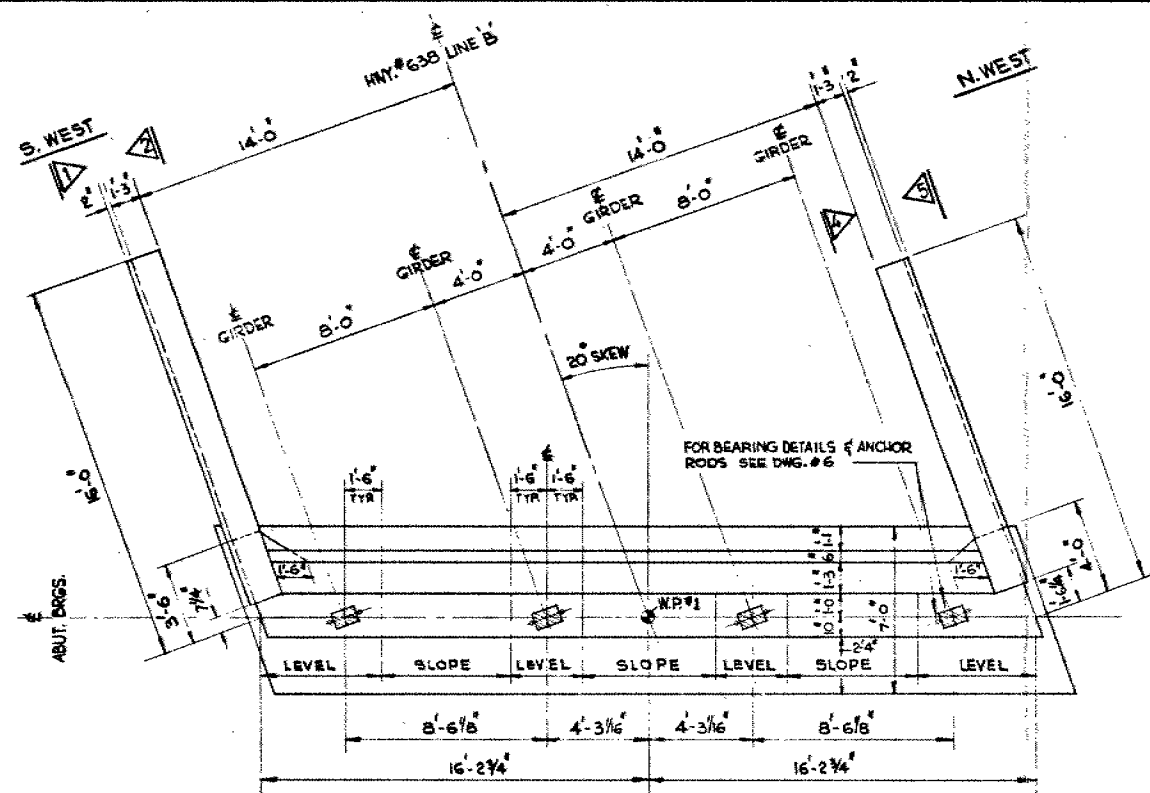


USE SCALE BELOW

0 1 2 3

3 INCHES ON ORIGINAL PLAN

REVISIONS				
DATE	BY	DESCRIPTION		
DESIGN	1	CHECK	1	LOADING
DRAWING	1	CHECK	1	SITE No. 100-100
				DATE
				DWS



FOR REDUCED PLAN
USE SCALE BELOW
3 INCHES ON ORIGINAL PLAN

REVISIONS	DATE	BY	DESCRIPTION
1			DESIGN
2			CHECK
3			DRAWING

Mr. E. Van Beilen
Head, Northern & NW Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 04 10


Re: Thessalon River Bridge
W.P. 19-76-03, Site 38S-123
Hwy. 638, District 18, Sault Ste. Marie

We have reviewed the following final bridge plans, general layout and abutment footings and piers for the above mentioned structures and have noted the following revisions.

1. abutment piles have been increased in section to 12HP74
2. east abutment footing elevations have been lowered by 0.75 feet

In consideration of the heavy pile section required and the probable depth to bedrock, the following theoretical pile length below cut-off at pier locations should be adopted.

<u>Location</u>	<u>Type</u>	<u>No. Req'd</u>	<u>Pile Length</u>	<u>Remarks</u>
West Pier	HP12X102	4	59'-0"	Driving Shoe
East Pier	HP12X102	4	62'-0"	Driving Shoe


T. Kazmierowski
Project Engineer

TK/gs

Files ✓

Mr. E. Van Beilen
Head, Northern & NW Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

78 12 07

Mr. A. Radkowski

Re: Thessalon River Bridge
W.P. 19-76-03, Site 38S-123
Hwy. 638, District 18, Sault Ste. Marie

Further to your memorandum of 78 11 22, we have reviewed the preliminary bridge plan drawing (38S-123-P1). Our comments are as follows.

Due to the presence of boulders in the overburden, difficult pile driving conditions can be anticipated. In view of this, heavy pile sections such as 12 BP74 (or heavier) should be used. Further, the tip of the piles should be reinforced with hardened steel tips. These comments were also contained in our memorandum of 78 09 07.

B. Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/MD/gs

cc: W.A. Stewart
W.W. Kulmatickas
Files



Memorandum

To: Mr. W.W. Kulmatickas
Head, Structural Section
Northwestern Region
Thunder Bay

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Attention:

Date: 78 09 07

Our File Ref.

In Reply to

Subject: Re: Foundation Investigation For
Thessalon River Bridge on Hwy. 638 (Line B)
W.P. 19-76-03, Site 38S-123
District 18, Sault Ste. Marie

At the request of the Soil Mechanics Section, Engineering Materials Office, of the Ministry, Geotechnical Consultants Dominion Soil Investigation Inc. has carried out a foundation investigation with the purpose of determining the subsurface conditions at the site of the above mentioned structure. Due to the urgency of this project preliminary geotechnical recommendations were submitted to your office in a memorandum dated 78 08 14. The final report on this project was issued by the Consultant on 78 09 06 to this office. We have reviewed this report and submit the following comments:

1. The structure should be placed on end-bearing steel 'H' piles driven to the surface of the bedrock. Due to the presence of boulders embedded in the sand and gravel deposit immediately above the surface of the bedrock, hard driving conditions can be expected. In view of this, heavy pile sections (e.g. 12BP74) should be used and the tip of the piles should be reinforced with hardened steel tips. Pile driving should not be controlled by the Hiley formula.
2. It is recommended that a granular filter (e.g. Granular 'A') or synthetic filter mat be placed underneath the pile caps to prevent the removal of fines by artesian water seepage along the piles.
3. Horizontal earth pressures on abutments suggested in the report should be used for design purposes.
4. In our opinion the forward slopes for the proposed 28 foot high fills in the longitudinal direction should not be steeper than 2:1. In addition, the end slopes should be adequately protected with rip-rap against scour and undermining by the river. The rip-rap should extend at least 1 foot above the high high water level of the river.

cont'd.....

We believe that the aforementioned comments, together with the factual data and recommendations contained in the enclosed foundation report prepared by the Geotechnical Consultant, will be adequate for your requirements. Should you require any further information please contact our office.

M. Devata
M. Devata
Supervising Engineer

MD/gs

Enclosure

cc: C.M. Smith
D.A. Jarvis (2)
W.A. Stewart (2)

E. Van Beilen
G.A. Wrong
B.J. Giroux
R.S. Pillar
J.D. Harris
R. Hore

N. Maluzinsky)
J. Anderson) memo only
G. Sloan)

Files ✓