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GEOCRES No. 30M15-50

DIST. 7 REGION

W.P. No. 59-75-07

CONT. No. 82-03

W. O. No.

STR. SITE No. 21-162

HWY. No. 401

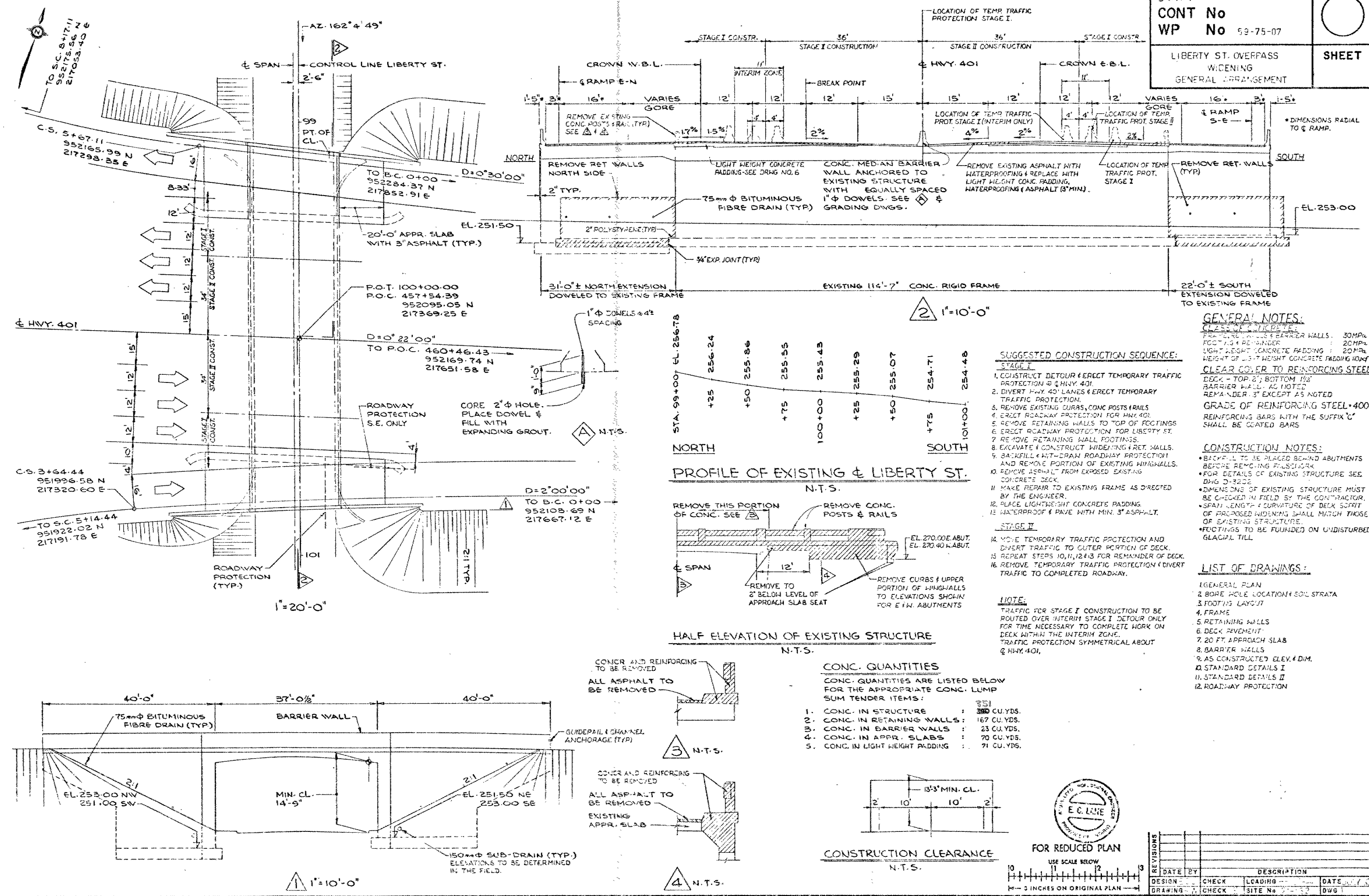
LOCATION Liberty Street Overpass

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:





Memorandum

WP 59-75-07

To: Mr. G. C. E. Burkhardt,
Head,
Structural Section,
Central Region.

From: Pav't. & Foundation Design Section,
Engineering Materials Office,
Room 315, Central Building.

Attention:

Date: 79 09 28

Our File Ref.

In Reply to

Subject:

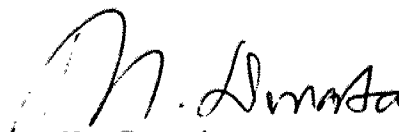
Re: Foundation Investigation
Proposed Widening of Liberty Street Overpass
King's Highway 401 - Town of Newcastle
W.P. 59-75-07; Site No. 21-162
District No. 7, Port Hope, Ontario

Our office retained the services of a Geotechnical Consultants, Dominion Soil Investigation Inc., to undertake the above mentioned project. They have recently submitted to us a foundation investigation report and our review suggests the following:

- 1) The new footing should be located at least one foot below the existing foundations, to avoid any disturbance caused by the construction of the existing foundations.
- 2) The new footing should be designed as an independent unit in order to minimize any detrimental effects on the existing foundations.

In general, the factual data and recommendation contained in this report are well presented and adequate for your requirements. If you require any further information, please contact this office.

MD/cy
Encl:


M. Devata,
Senior Foundation Engineer.

c.c. G. C. E. Burkhardt (3)
R. D. Gunter
I. V. Oliver
D. E. Thrasher (2)
C. Grebski
B. J. Giroux
R. Hore
R. Fitzgibbon)
J. Anderson) cover only
T. J. Kovich)

Files



DOMINION SOIL INVESTIGATION INC.

CONSULTING SOIL & FOUNDATION ENGINEERS

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

(416) 751-6565

30M15-50

GEOCRES No.

FOUNDATION INVESTIGATION
PROPOSED WIDENING OF LIBERTY STREET OVERPASS
KING'S HIGHWAY 401 - TOWN OF NEWCASTLE
W.P. 59-75-07; SITE NO. 21-162
DISTRICT NO. 7, PORT HOPE, ONTARIO

Ref. No. 79-5-6

September 1979



Prepared for:

Ministry of Transportation and Communications
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

DISTRIBUTION:

15 copies - Ministry of Transportation and Communications
2 copies - Dominion Soil Investigation Inc.

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1.0 INTRODUCTION

This report describes the results of a geotechnical investigation carried out at the site of the proposed widening of the existing Liberty Street overpass on Highway 401 in the Town of Newcastle. The investigation was requested by the Ministry of Transportation and Communications and authorization to carry out the work was received from the Pavement and Foundation Design Section of the Ministry.

The object of the investigation was to determine the subsoil and groundwater conditions at the site; to establish the engineering properties of the substrata; and to make recommendations for the foundation design and construction of the proposed bridge structure.

The investigation in the field was completed in May 1978 and consisted of the drilling of eight boreholes and the excavation of a test pit. The locations of the boreholes and the test pit are shown on Drawing No. 597507-A, and the subsurface conditions found in the boreholes and the test pit are presented on the Record of the Boreholes and in Appendix 'A'.

.../...

Si

2.0 DESCRIPTION OF THE SITE

The site is located in the Town of Newcastle at the intersection of Highway 401 and Liberty Street. The terrain in this area is generally flat and the embankment carrying Highway 401 rises 15 to 20 ft. above the surrounding area. Drainage to the area is provided by the Bowmanville and Soper Creeks located a short distance to the west and east respectively.

3.0 REGIONAL GEOLOGY

Geologically, the site is situated in the Lake Iroquois Plain, which is an area of low relief inundated during the Pleistocene by the waters of Lake Iroquois. The old abandoned shoreline of Lake Iroquois lies approximately 4 miles to the north.

The bedrock underlying the basin is of Ordovician age and consists of the Whitby formation which is a black calcareous shale unit with interbedded limestone bands. The bedrock surface is irregular and regional studies suggest that there are strong similarities between the existing surface topography and that of the bedrock surface.

The surficial deposits consist of sediments of Pleistocene and recent age. Glacio-lacustrine deposits south of the abandoned Lake Iroquois shoreline range from sand and gravel of a near shore and deltaic nature to off-shore sediments such as varved silt and clay. These were deposited on top of a ground moraine of generally coarse sandy texture.
.../...

The surface of the till is irregular and drumlinized and the surface of the drumlins are exposed in many places in this area. More recent deposits consisting of organic and alluvial soils are found in the valleys of the creeks.

4.0 SUBSOIL CONDITIONS

The eight exploratory boreholes and one test pit indicate reasonably uniform subsurface conditions. The stratigraphic sequence, as inferred from the borehole logs, is as follows:

- 1) Loose to compact mixed fill;
- 2) stiff silty clay (Boreholes 3, 7 and 8 only);
- 3) very dense silty sand till;
- 4) sound shale bedrock.

Details of the subsurface conditions are shown on the Record of Boreholes (Enclosures 1 to 8 inclusive) and also on the inferred soil profile and sections shown on Drawing No. 597507-A. The relevant index and engineering properties of the principal soil strata are described briefly below.

4.1 Fill

Fill was encountered in every borehole, ranging in thickness between 3 and 17.5 ft. The composition of the fill varies, but generally sand and silt particles predominate. The penetration indices or 'N'-values range from 2 to 27 blows per foot, with an average value of about 10 .../...

blows per foot. Based on this, the relative density of the fill is inferred to be loose to compact and generally in the compact range. The permeability of the fill is expected to be variable and to depend on the composition of the fill, but on the average it is estimated to be in the range of 10^{-3} to 10^{-5} cm/sec.

4.2 Silty Clay

A silty clay to clayey silt stratum was encountered in Boreholes 3, 7 and 8. It is believed to be of glacio-lacustrine origin laid down possibly by Lake Iroquois. The thickness of the silty clay ranges between 13 ft. in Borehole No. 3 and 4.5 ft. in Borehole No. 7. The penetration indices range between 10 and 22 blows per foot, indicating a generally stiff to very stiff consistency. The undrained shear strength of the clay is estimated to range between 2000 and 3000 psf. The permeability of this stratum is estimated to be low, generally less than 10^{-6} cm/sec.

4.3 Glacial Till

In each borehole, an approximately 10 ft. thick layer of basal till was encountered. The surface of the till lies between Elevations 255.7 ft. (Borehole No. 1) and 249.4 ft. (Borehole No. 6), with an average elevation of about 252 ft. The till has a coarse texture and is a well graded mixture of gravel, sand, silt and clay size particles. Embedded in the till are also frequent cobbles and boulders. Grading curves of representative samples of the till are shown on Enclosures 9, 10 and 11. Reference to these indicates that the till consists of 12 to 42% gravel, 35 to 55% sand, 17 to 25% silt and 5 to 10% clay size particles. The till exhibits some to considerable cohesion due to cementation. The .../...

Standard Penetration resistances were generally in excess of 100 blows per foot, indicating a very dense relative density. Due to the well graded and dense nature of the till and the cementation between the particles, the permeability of the till is estimated to be moderate to generally low in spite of the relatively high sand content. The coefficient of permeability is estimated to be generally less than 10^{-5} cm/sec.

4.4 Bedrock

The surface of the bedrock was encountered or inferred from refusal in the boreholes between Elevations 243.5 and 240.6 ft. The rock was cored at four locations and the recovered cores indicate that the rock is a dark grey coloured, highly calcareous shale with many limestone bands. The high percentage of core recovery and high R.Q.D.-values (78 to 100%) indicate a sound rock with good qualities. The rock is intact, showing signs of only insignificant amounts of weathering in the upper few inches of the rock. As the rock is relatively free of fractures, the mass permeability of the rock is estimated to be low.

4.5 Groundwater Conditions

The groundwater conditions in the boreholes were observed during drilling and the position of the water level was measured and recorded after the borehole was completed but before the rock was cored. During the drilling water was noticed only in Borehole No. 2 at a depth of 4 ft. in the fill. The other boreholes bored dry and remained dry for periods up to 7 hours after completing the drilling. These observations confirm the generally low permeability of the substrata. Standpipes were installed in Bore-
.../...

holes 2 and 6 and were protected from the influence of surface water by a bentonite clay seal. Observations carried out in these stand-pipes in September 1979 indicated water levels at Elevations 249.4 to 254.7 ft. From these results and visual and tactile examination of the soil samples, it is inferred that the permanent groundwater table may be near the surface of the silty sand till. It is expected, however, that a temporary perched water table may develop in the more pervious fill above the nearly impervious silty clay and till strata.



5.0 DISCUSSION OF THE RESULTS

The existing bridge, which was built around 1951, is a single span rigid frame reinforced concrete structure. It has a clear span of 37 ft., and the available design drawing (D.H.O. DWG. No. D-3202-2, March 1951) indicates that the existing foundations are at about Elevation 250.5 ft.

It is proposed to widen this structure both to the north and south to provide an additional width of about 30 ft. on each side. The widened structure will be similar in design to the existing bridge.

To verify whether the existing structure was founded as shown on the design drawing, a test pit was dug near the north-east corner of the existing abutment. The conditions found in the test pit are described in Appendix 'A'. Although the underside elevation of the footing could not be positively determined due to some wooden sheeting used possibly for the form work, the test pit confirmed that the footings project about 18-inches from the face of the abutment as shown on the design drawings. A reference to the boreholes located nearest to the existing abutments (Boreholes 2, 4, 5 and 6) indicate that the surface of a suitable bearing stratum lies between Elevations 252 and 249.4 ft. and, therefore, it is likely that locally the footings have been extended to a lower level than the elevation shown on the design drawings (250.5 ft.).

5.1 Foundation Design

It is recommended that the foundations of the widened structure be carried to the surface of the very dense silty sand till, which at the borehole .../...

locations lies between Elevations 252 to 249.4 ft. The safe bearing pressure for continuous strip footings founded on the very dense silty sand till is in excess of ^{5 t.s.f.} 10 k.s.f. We estimate that the pressure under the 4.5 ft. wide footing, as shown on the design drawings, is probably of the order of ^{2.5 t.s.f.} 5 kips per square foot and, therefore, the safety factor against a general shear failure of the soil will be well in excess of 3.

Assuming a uniformly distributed line load of about 23 k.l.f. on the foundations of the abutment, the maximum total settlement is estimated to be less than 1-inch. Differential settlements less than 1/2-inch are expected. All settlements will take place shortly after the load is applied.

5.2 Horizontal Earth Pressures

The abutments and wing walls should be designed to resist the horizontal earth pressure exerted by the approach embankments behind them. The earth pressure on the abutments can be assumed to be distributed in accordance with the following formula:

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

where p = unit horizontal earth pressure at depth "d" (p.s.f.)

K = coefficient of horizontal earth pressure
= 0.40 for granular backfill

γ = unit weight of soil = 135 p.c.f.

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

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

.../...

The backfill behind the abutment should be composed of free draining granular material and it should be well drained.

The coefficient of friction (μ) between the foundation and the glacial till can be taken to be 0.6. Additional resistance could be obtained from the passive resistance of the soil in front of the foundations. The coefficient of passive earth resistance (K_p) can be taken to be 4.0 if the vertical face of the footings is poured against the undisturbed till. The passive resistance in front of the footings within the frost penetration depth (approximately 4 ft.), or those contributed from backfill material, should be neglected. The design should incorporate a safety factor against horizontal sliding of not less than 1.5.

5.3 Approach Fill

There are no stability problems foreseen for the proposed widening of the approach fills. The approach embankment could be constructed in accordance with the current M.T.C. Specifications and Standards, using 2 horizontal in 1 vertical side slopes, and keying the new fills into the existing fills.

5.4 Construction

There are no major excavation or dewatering problems foreseen. Excavations to the surface of the till should not encounter difficulties or major obstacles. Excavations deeper than 4 ft. should be cut back to a stable angle of 45° or vertical cuts should be supported by braced skeleton or closed sheeting to comply with Safety Regulations.

.../...

The amount of water seepage into the excavation is expected to be small to moderate and is expected to be mainly due to perched water in the fill. Seepage through the till at the base of the excavation is expected to be small. It is expected that the excavations can be kept dry by gravity drainage and by pumping from temporary sumps established inside the excavation but outside the area of the footings. In any event, the excavation should be kept dry and free of water at all times.

It may be necessary to use a roadway protection scheme during construction of the footings in order to retain the existing approach fills.


6.0 STATEMENT OF LIMITATION

The Statement of Limitation, as quoted in Appendix 'D', is an integral part of this report.

DOMINION SOIL INVESTIGATION INC.


I. Rainu, P.Eng.




I.P. Lieszkowszky, P.Eng.
IPL:esp



A P P E N D I C E S

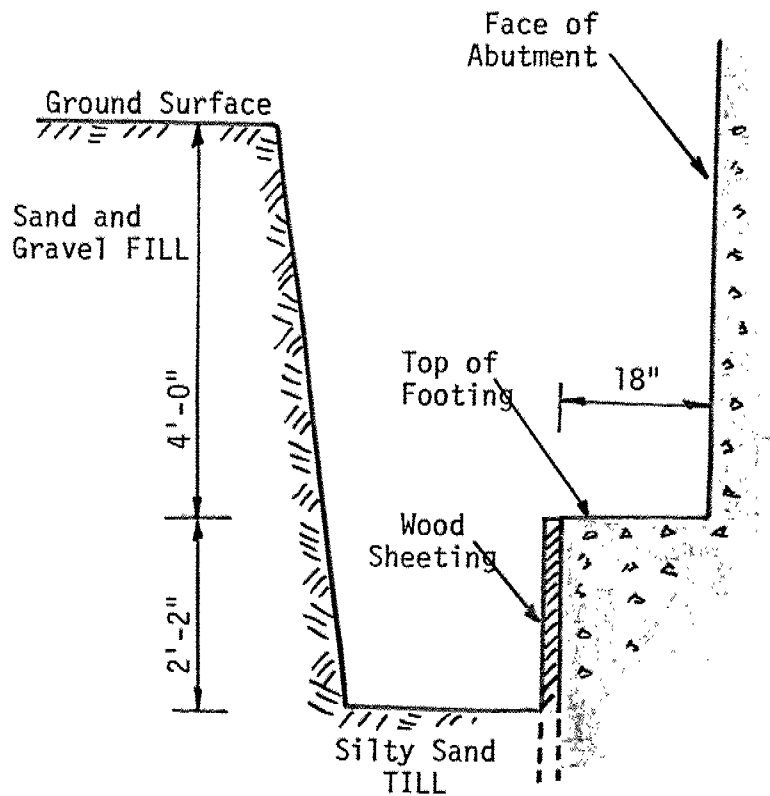
Ref. No. 79-5-6

APPENDIX 'A'
RECORD OF TEST PIT 1

W.P. 59-75-07
District 7, Hwy. 401
Liberty St. Overpass

Test Pit Location: 12 Ft. N. of N.E. Corner of Existing Abutment

Elevation: 257 \pm Ft.



Note: Medium heavy water seepage at top of footing

CROSS - SECTION

APPENDIX 'B'

Field Work

The field work was carried out between May 14 and 23, 1979, and consisted of eight boreholes to depths ranging between 21 and 33 ft. The locations of the boreholes are shown on Drawing No. 597507-A. The boreholes were drilled with a BOA-8M machine mounted on an all terrain vehicle.

The sampling of the overburden was carried out at 2.5 and 5 ft. intervals. Samples were taken by the Standard Penetration test method. This method, which consists of driving a 2-inch outside diameter split spoon sampler into the undisturbed ground with 350 ft./lb. energy, provides representative soil samples from any level below the ground surface. The number of blows required to advance the sampler into the undisturbed ground are recorded as the Standard Penetration resistance or 'N'-values from which the relative density of the soil can be inferred. The relationship between penetration resistance and relative density is given in Appendix 'C'. The results of the borings and penetration tests are shown on the Record of Boreholes, presented as Enclosures 1 to 8 inclusive.

The boreholes were extended by augering to a depth where refusal was met. At four locations, the boreholes were further extended below this level by diamond drilling technique, using BXL size (2-3/8-inch diameter) coring equipment.

.../...



The field work was supervised by a soil technician who also determined the ground surface elevations at the borehole locations. The elevations of the boreholes were referred to the geodetic datum, using a nearby geodetic benchmark (No. 67-U-031) which is a tablet in the west concrete foundation wall of the Works Department garage at the east side of Liberty Street. The elevation of this benchmark is 256.000 ft.

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 and the natural moisture content was also determined. The laboratory test results are presented on the Record of Boreholes and the Grain Size Distribution Curves are plotted on Enclosures 9, 10 and 11.

APPENDIX 'C'

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

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

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC

TYPE OF SAMPLE

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

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

APPENDIX 'D'STATEMENT OF LIMITATION

The conclusions and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature which may be available for the area investigated. Soil and ground-water conditions between and beyond the boreholes may differ from those encountered at the borehole locations and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

We recommend that we be retained to ensure that all necessary stripping, subgrade preparation and compaction requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in the boreholes. In cases where this recommendation is not followed, the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.

This report is applicable only to the project described in the introduction, constructed substantially in accordance with details of alignment and elevations quoted in the text.

ENCLOSURES



CONT No
WP No 59-75-07

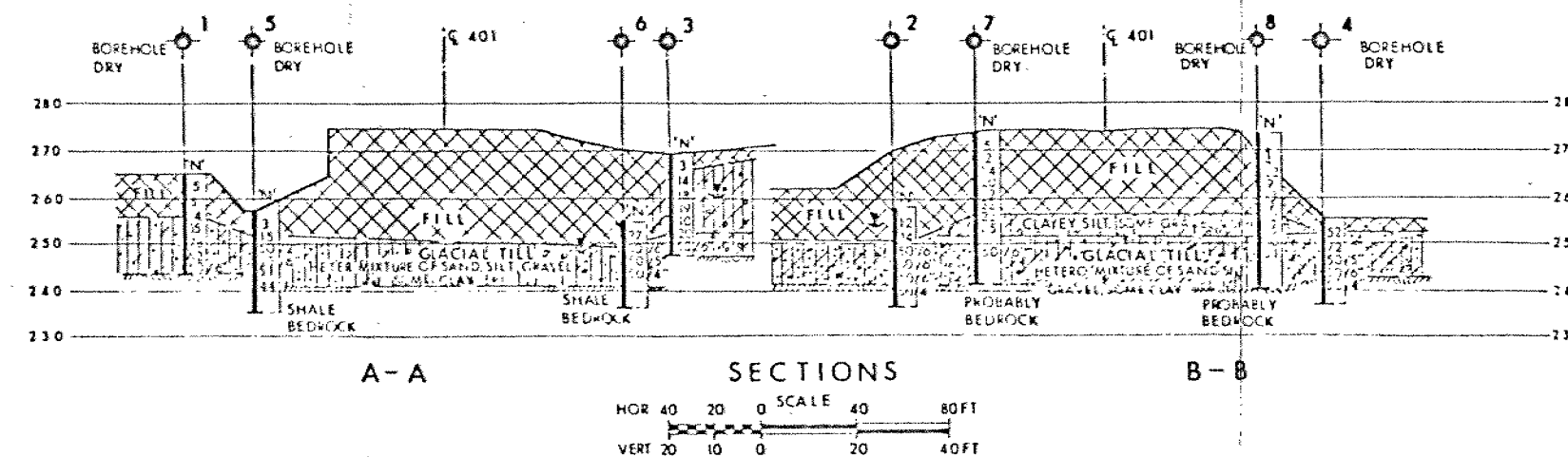
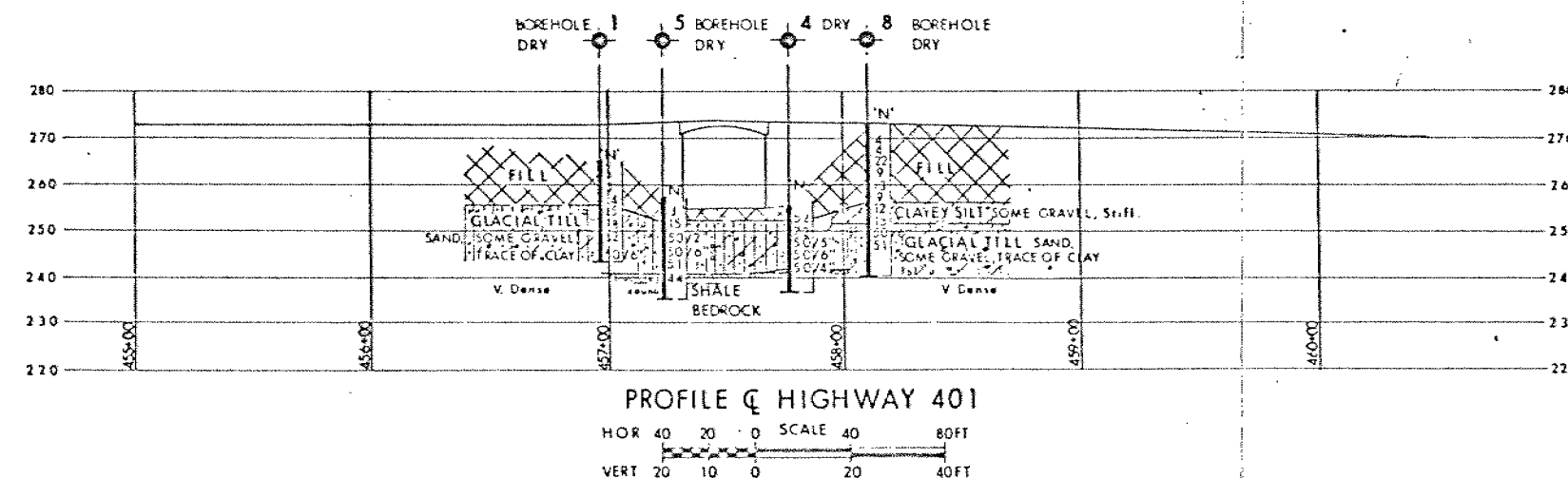
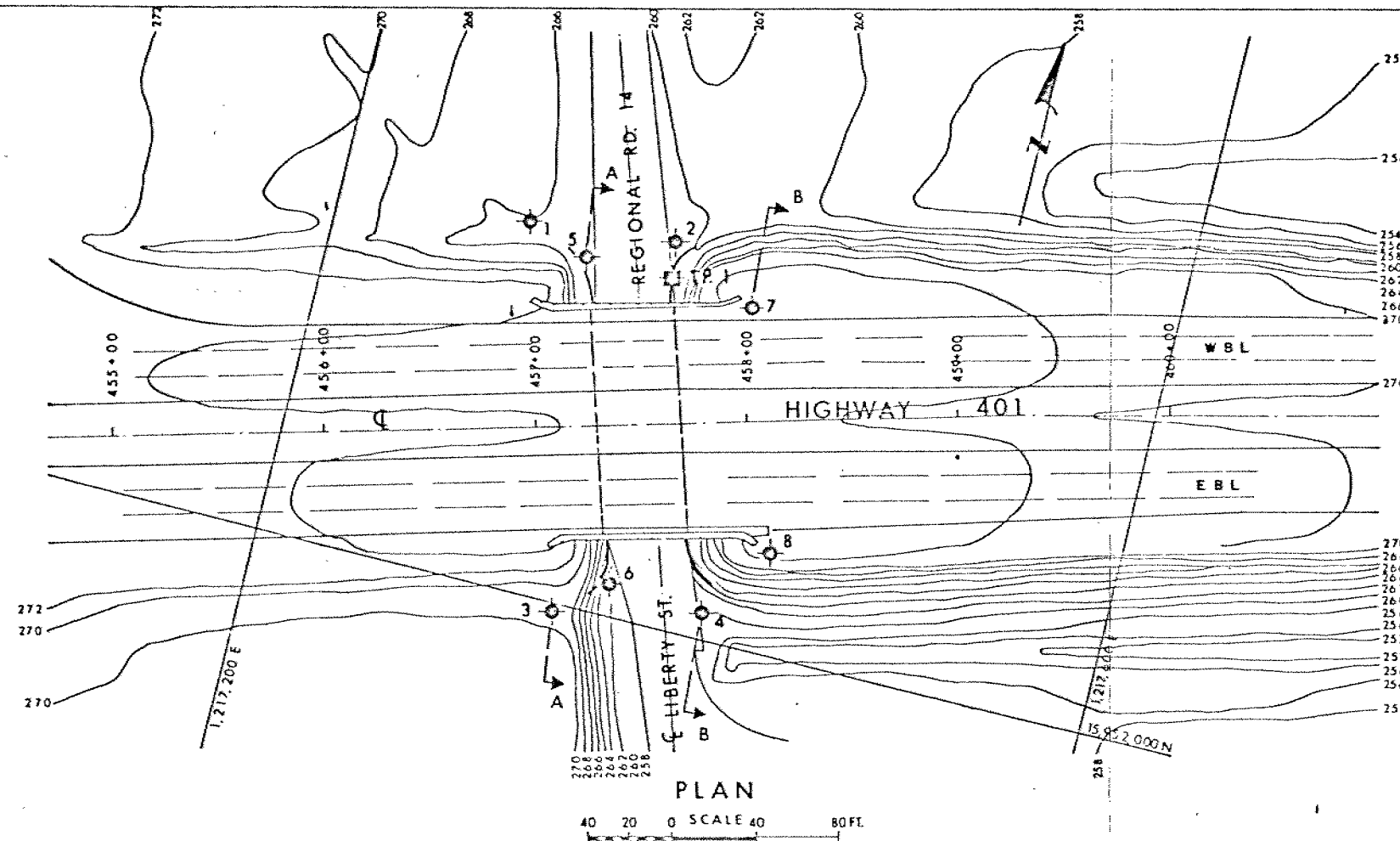
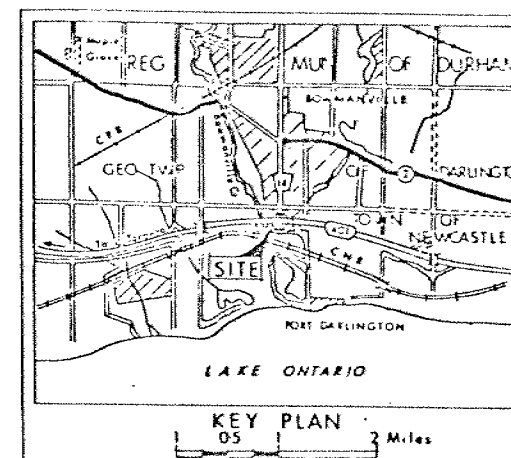


LIBERTY ST OVERPASS

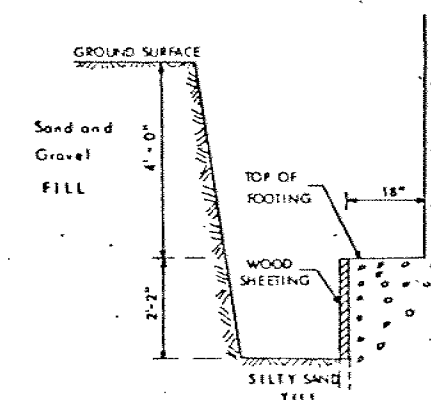
SHEET

BORE HOLE LOCATIONS & SOIL STRATA

DOMINION SOIL INVESTIGATION INC.



TEST PIT No. 1



CROSS SECTION



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ Wt at time of investigation May 1979
- ⊕ Test Pit

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	265.2	15,952,177	1,217,292
2	257.7	15,952,185	1,217,163
3	269.3	15,951,996	1,217,348
4	255.2	15,952,013	1,217,418
5	257.3	15,952,166	1,217,323
6	254.4	15,952,016	1,217,372
7	274.0	15,952,163	1,217,405
8	273.7	15,952,049	1,217,442

NOTE

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

30M15-50
GEOCRES No.

REF No E-5457-1 APR 1979

DATE 5-11-1979
DRAWN BY CHECKED BY
SITE 21-162
DWG 597507-A

GEOC. No 30M15-50



RECORD OF BOREHOLE No 1

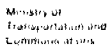
W P 59-75-07 LOCATION Co-ords 15, 592, 177 N; 1, 217, 292 E. ORIGINATED BY N.McC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGERING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 14, 1979 CHECKED BY I.P.L.

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)			
265.2	GROUND SURFACE														
0.0	4" TOPSOIL		1	SS	5										
	FILL - Sandy Silt		2	SS	5										
	Loose, brown		3	SS	14										
255.7	some topsoil		4	SS	15										
9.5	compact		5	SS	78										
	v. dense		6	SS	62										
	GLACIAL TILL: heteroge-														
	neous mixture of sand,														
	silt, gravel, boulders														
243.5	some clay, cemented		7	SS	50/6"										
21.7	END OF BOREHOLE														
	Refusal probably on														
	bedrock														

+3, x5: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

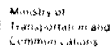


W P 59-75-07 LOCATION Co-ords 75, 592, 185 N.; 1, 217, 163 E. ORIGINATED BY N.McC
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER, BXL ROCK CORE COMPILED BY I.P.L.
DATUM GEODETTIC DATE MAY 14, 1979 CHECKED BY I.P.L.

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					
257.7	GROUND SURFACE												GR SA SI CL
0.0	FILL, mixture of sand, gravel, silt, some cobbles. Compact. Brown		1	SS	12								
250.2			2	SS	14								
7.5	GLACIAL TILL: heterogeneous mixture of sand, silt, gravel, some clay very dense, grey		3	SS	50/6								25,45,20,10
			4	SS	50/6								12,53,25,10
			5	SS	50/6								
241.2			6	SS	50/6								
16.5	Sound Shale BEDROCK highly calcareous grey		7	RC	100%								R.Q.D.=100%
236.2													
21.5	END OF BOREHOLE												DATE W.L. May 14 253.2 Sept. 10 254.7

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

W P 59-75-07 LOCATION Co-ords 15, 951, 996 N.; 1, 217, 348 E. ORIGINATED BY N.McC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGERING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 15, 1979 CHECKED BY I.P.L.

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 4

W P 59-75-07 LOCATION Co-ords 15, 592, 013 N.; 1, 217, 418 E. ORIGINATED BY N.McC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGERING; BXL ROCK CORING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 15, 1979 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					
255.2	GROUND SURFACE																GR SA SI CL
0.0	FILL - Sandy Silt																
252.2	brown		1	SS	52		250						o				42,35,17,6
3.0	GLACIAL TILL: heteroge- neous mixture of sand, silt, gravel, some clay		2	SS	72								o				25,45,25,5
	very dense, grey, cemented		3	SS	50/	5"							o				25,45,25,5
242.5			4	SS	50/	6"							o				
12.7	Shale BED- weathered ROCK, highly sound calcareous		5	SS	50/	4"											
236.8	w. limestone bands, grey		6	R.C. BXL	78%		240										R.Q.D.=78%
18.4	END OF BOREHOLE																

+3, x5: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5

W P 59-75-07 LOCATION Co-ords 15, 952, 166 N.; 1, 217, 323 E. ORIGINATED BY N.MCC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGERING, BXL ROCK CORING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 16, 1979 CHECKED BY I.P.L.

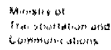
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
257.3	GROUND SURFACE															
0.0	5" Topsoil		1	SS	3											
251.8	FILL - mixture of clay, silt,sand,loose,brown		2	SS	15											
5.5	GLACIAL TILL: heteroge- neous mixture of boulder sand,silt,gravel, some clay,very dense, grey limestone fragments		3	SS	50/2											
			4	SS	50/2											
			5	SS	51											
240.8			6	SS	44											
16.5	Shale BEDROCK fractured calcareous, with sound		7	RC	100											
235.5	limestone bands, grey		8	BXL	100%											R.Q.D.=100%
21.8	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 6

W P 59-75-07 LOCATION Co-ords 15, 952, 016 N.; 1, 217, 372 E. ORIGINATED BY N.McC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER, BXL ROCK CORING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 23, 1979 CHECKED BY I.P.L.

[illegible]

+3, x5: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 7

W P 59-75-07 LOCATION Co-ords 15, 952, 163 N.; 1, 217, 405 E. ORIGINATED BY N.M.C.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER/ERING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 17, 1979 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					
274.0	GROUND SURFACE																
0.0	FILL - mixture of sand, gravel, clayey silt, limestone fragments v. loose to compact brown		1	SS	5		270										
			2	SS	2												
			3	SS	14												
			4	SS	20												
			5	SS	12		260										
			6	SS	22												
256.5			7	SS	22												
17.5	Clayey SILT, some sand v. stiff, grey		8	SS	15												
252.0																	
22.0	GLACIAL TILL: heteroge- neous mixture of sand, silt, gravel, some clay		9	SS	50/ 6"		250										
241.7	boulders																
32.3	END OF BOREHOLE Refusal probably on bedrock																

+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 59-75-07 LOCATION Co-ords 15, 952, 049 N.; 1, 217, 442 E. ORIGINATED BY N.McC.
DIST 7 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGERING COMPILED BY I.P.L.
DATUM GEODETIC DATE MAY 17, 1979 CHECKED BY I.P.L.

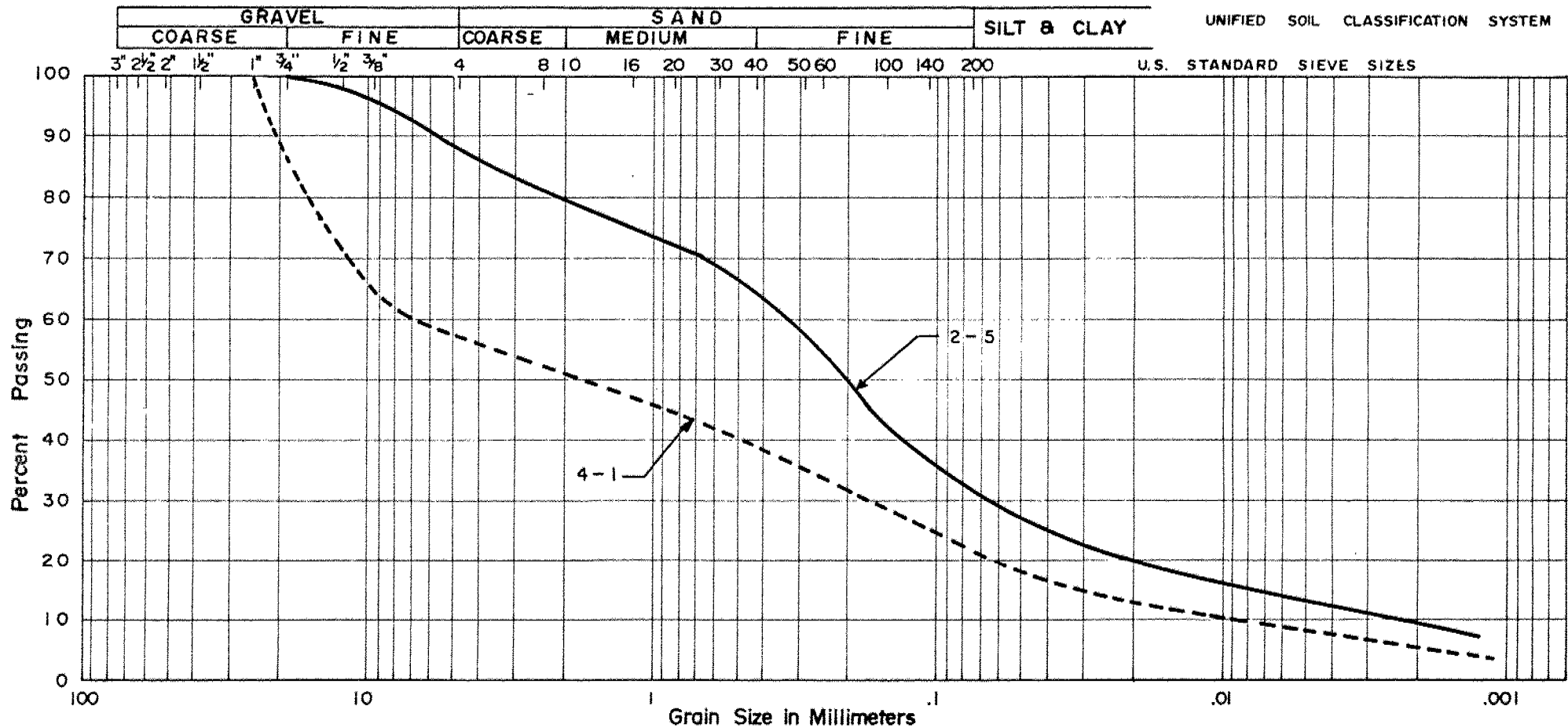
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
273.7	GROUND SURFACE																
0.0	FILL - mixture of sand, gravel, clayey silt, v. loose to compact, brown		1	SS	4		270										
			2	SS	4												
			3	SS	22												
			4	SS	9												
			5	SS	13		260										
256.7	wet		6	SS	9												
17.0	Clayey Silt, some gravel, stiff, grey-brown		7	SS	12												
251.7			8	SS	15												
22.0	GLACIAL TILL: heterogeneous mixture of sand, silt, gravel, some clay v. dense, cemented, grey boulders		9	SS	507	6"	250										
			10	SS	51												
240.6																	
33.1	END OF BOREHOLE Refusal probably on bedrock																

OFFICE REPORT ON SOIL EXPLORATION

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE No 79-5-6



PROJECT: LIBERTY BRIDGE
 LOCATION: BOWMANVILLE, ONT.
 BOREHOLE No: 2 4
 SAMPLE No: 5 1
 DEPTH: 13.4 3.5
 ELEVATION:

COEFFICIENT OF UNIFORMITY:
 COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY SAND
 with gravel; tr. clay.

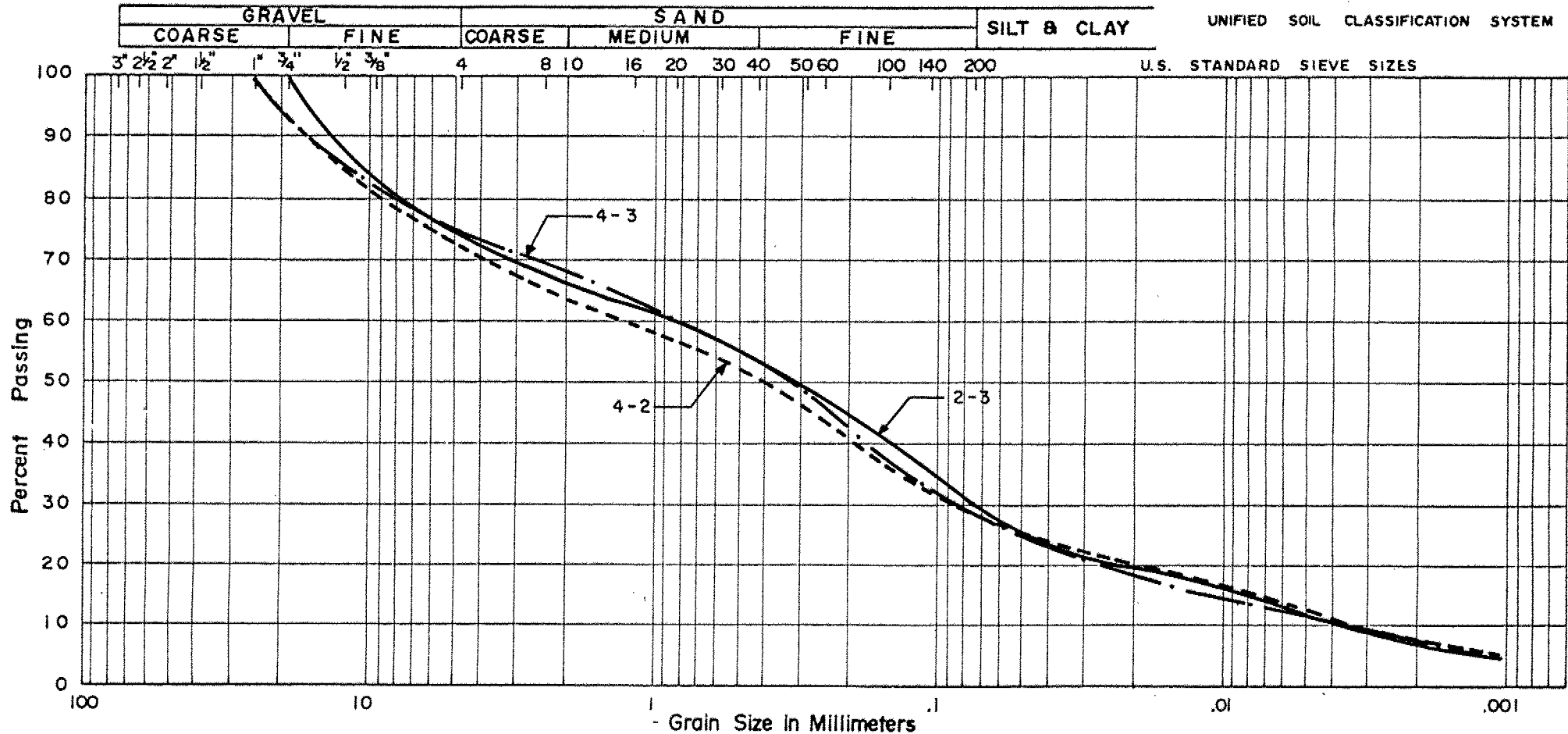
PLASTIC PROPERTIES

LIQUID LIMIT % =
 PLASTIC LIMIT % =
 PLASTICITY INDEX % =
 MOISTURE CONTENT % = 5.4 - 5.5

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE № 79-5-6



PROJECT: LIBERTY BRIDGE
 LOCATION: BOWMANVILLE, ONT.
 BOREHOLE №: 2 4 4
 SAMPLE №: 3 2 3
 DEPTH: 8 6 8
 ELEVATION:

COEFFICIENT OF UNIFORMITY :
 COEFFICIENT OF CURVATURE :

Classification of Sample and Group Symbol:

SILTY SAND TILL
 some gravel, tr. clay.

PLASTIC PROPERTIES

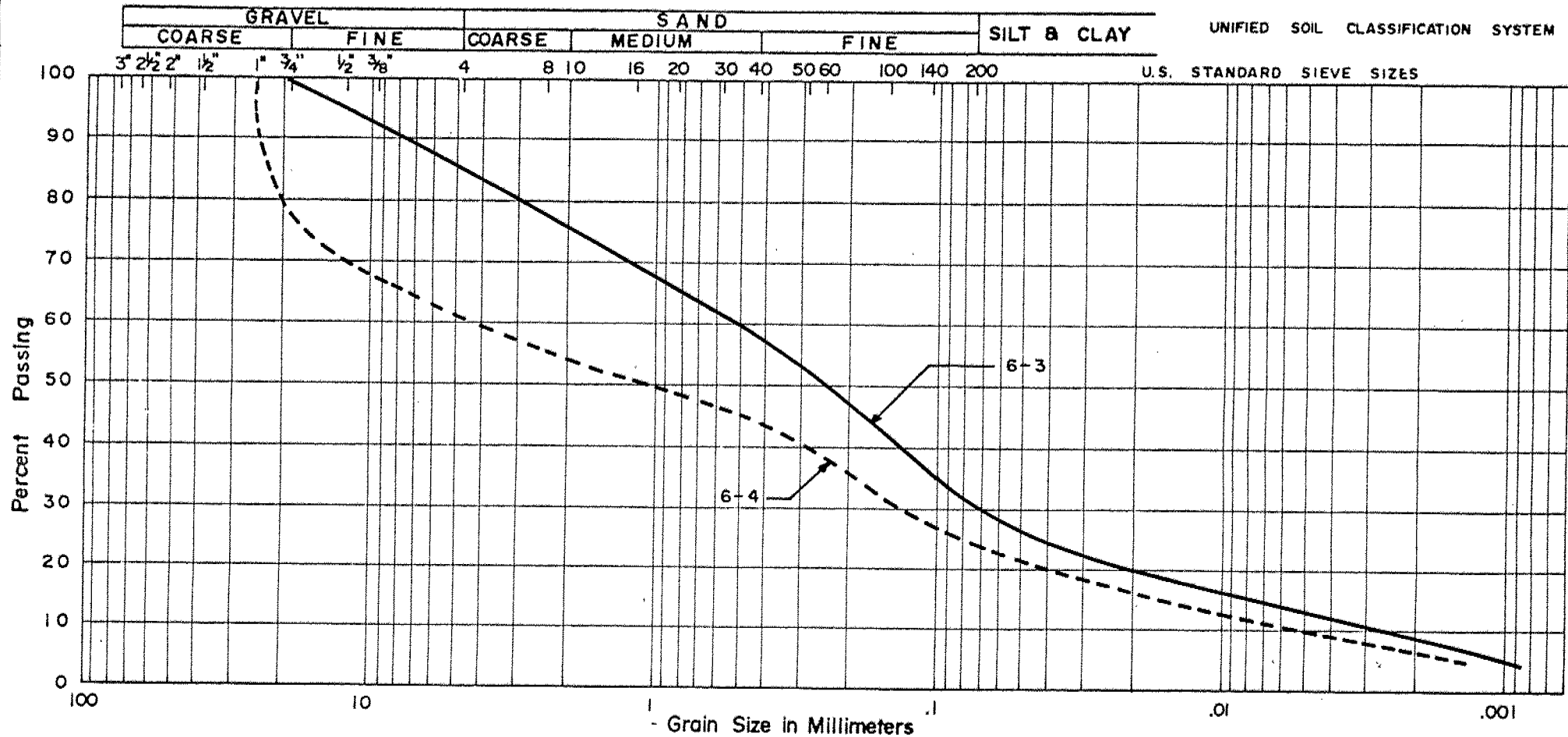
LIQUID LIMIT	% =
PLASTIC LIMIT	% =
PLASTICITY INDEX	% =
MOISTURE CONTENT	% = 4.8 - 5.3

ENCLOSURE № 10

DOMINION SOIL INVESTIGATION INC.

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 79-5-6



PROJECT: LIBERTY BRIDGE
 LOCATION: BOWMANVILLE, ONT.
 BOREHOLE NO: 6 6
 SAMPLE NO: 3 4
 DEPTH: 8 10
 ELEVATION:

COEFFICIENT OF UNIFORMITY:
 COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY SAND TILL
 with some gravel.

PLASTIC PROPERTIES

LIQUID LIMIT % =
 PLASTIC LIMIT % =
 PLASTICITY INDEX % =
 MOISTURE CONTENT % = 5.1 - 4.5

ENCLOSURE NO 11