

OAKVILLE-HAMILTON SECTION
ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WO DIST 4
HWY STR SITE

Drury Lane Pedestrian Overpass
C.N.R. & GO-ALRT, City of Burlington

DISTRIBUTION

Foundation Investigation Report
for
Drury Lane Pedestrian Overpass
C.N.R. & GO-ALRT, City of Burlington
District No. 4 (Burlington)

Introduction

This report contains the results of a foundation investigation carried out in the vicinity of existing Drury Lane Pedestrian Overpass Structure and C.N.R. tracks, during the period of 84 07 24 and 84 07 26. The fieldwork consisted of five sampled boreholes and were advanced either by 82 mm hollow stem augers or by BW casings using washboring and a tri-cone. The bedrock was drilled with BXL core barrel. The drilling machine was mounted on an all-terrain vehicle.

Site Description

The site is located along the C.N.R. tracks bordered by Orpha Street on the north side and by Drury Lane on the south side. Both Orpha St. and Drury Lane are terminated for vehicular traffic at the C.N.R. right-of-way. Pedestrians, however, can cross the tracks by means of an elevated walkway. The surrounding terrain is flat, built-up area. The buildings on the south side are mainly for commercial use, while the north side can be classified as residential area.

Physiographically the site is located in an area referred to as the South Slope.

Subsurface Conditions

General

The native subsoil at the proposed new structure location was found to consist of cohesive and granular till-like deposits (glacial in origin) followed by shale (weathered and sound) bedrock.

In addition, several underground utility lines which required some form of bedding and backfilling are present. Consequently, the subsurface materials, up to about 2 - 4.5 m in depth in these backfilled zones which were not intersected by any borings may be different from those described in this report.

The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A drawing which shows the boring locations and the soil strata is appended to this report. A description of the different strata encountered is given below.

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

Immediately below a relatively thin layer (25-150 mm) of asphalt, a till-like deposit was encountered at every borehole location. The thickness varies randomly from about 5.5 m to 6.8 m. Reference should be made to the Record of Borehole Sheets for boundary elevations at a particular location. The material in the deposit was found to consist of a heterogeneous mixture of gravel, sand, silt and clay. The overall deposit may be divided in two somewhat different zones. In the upper zone (in general above El. 96) the matrix is basically cohesive in nature - i.e., silty clay binding coarser particles. Atterberg Limit Tests carried out on samples obtained from this zone indicate that in general, the material is inorganic and of low plasticity. A plot of plasticity index versus liquid limit (Figure #1) shows the majority of the points to fall within the CL Region.

The corresponding natural moisture content in all the cases are below the plastic limit. Physical properties of the material in this zone as determined from laboratory tests are as follows:

	<u>Range</u>	<u>Average</u>
Natural Moisture Content (%)	8 - 14	11
Liquid Limit (%)	21 - 36	26
Plastic Limit (%)	14 - 18	15

The results of the grain-size distribution tests are shown on Figure #2.

Standard penetration tests carried out within the zones gave 'N' values to range from 13 to over 100 blows per 30 cm. The consistency of this upper zone varies from stiff to hard. The lower 'N' values in general were encountered in the vicinity of ground (pavement) surface.

The lower zone was found to be granular in nature. The natural moisture content ranges from 8% to 16%, the average being in the order of 9%.

The obtained grain-size distribution test results are shown in an envelope form on Figure #3.

Standard penetration tests 'N' values ranged from 72 to over 100 blows per 30 cm, but the great majority are over 100 blows per 30 cm penetration. Based on these values, this lower zone may be classified as being very dense. In order to obtain a more realistic picture about the 'denseness' of the material the Record of Borehole Sheets should be carefully examined. On these sheets the number of blows which were required for 'X' centimetre advancement (other than the standard 30 cm penetration) at a particular elevation are plotted.

It is also pointed out, that during the course of the field investigation, the hollow stem augers were unable to penetrate the subsoil below 3 to 4 m level. Washboring techniques in form of tri-cone bit drilling and BW casings were employed to advance the boreholes below these levels.

Shale Bedrock

The bedrock was encountered in all boreholes some 5.6 m to 6.9 m below pavement level at the following elevations:

B.H. #1	El. 92.6
B.H. #2	El. 93.0
B.H. #3	El. 93.4
B.H. #4	El. 93.7
B.H. #5	El. 94.5

The bedrock (shale) is of the Queenston Formation. The shale is predominantly red containing some (approximately 2% to 25%) siltstone layers. The upper portion of the bedrock is weathered to varying degrees and becomes more sound with depth. For details references should be made to the 'description rock core' sheet appended to this report. The core description was carried out by Mr. E.R. Magni, M.T.C. Geologist.

Groundwater Conditions

No stabilized groundwater conditions were established due to the following reasons:

- a) Relatively impermeable nature of the subsoil
- b) Short duration of fieldwork
- c) Below approximately El. 96⁺ the boreholes were advanced with the use of water

However, field exploration work done by others for the existing pedestrian bridge indicate that the groundwater level is located at approximate El. 96⁺ some 3-4 m below the pavement level. Seasonal fluctuations of the groundwater level may be expected.

Discussion and Recommendations

General

It is proposed to extend southerly the existing pedestrian bridge between Orpha Street and Drury Lane in the City of Burlington. This extension will involve the relocation of the existing south ramps by about 12 m and will provide space for the future GO-ALRT tracks.

The latest site plan (issued on 84 08 27) indicate the presence of an 24 in. (0.6 m) diameter sanitary sewer pipe at the new ramp location. According to available information, the invert of the pipe is about 4.6 m below the manhole covers and the side slopes of the excavated and backfilled sewer trench is about 60° to the horizontal.

Recommendations

In view of the encountered subsoil conditions and the presence of the underground utilities, it is recommended the footing (or footings) be supported on concrete caisson placed on the sound portion of the shale bedrock at or below El. 92.5.

For 1 m diameter concrete caissons the following design values are recommended:

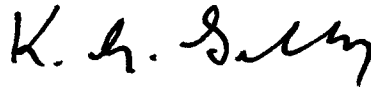
- Safe capacity: 5MN
- and for the purposes of the O.H.B.D.C.
 - Factored Capacity at U.L.S.: 7.5 MN
 - Capacity at S.L.S. Type II: 5.0 MN

Miscellaneous

The fieldwork for this investigation was supervised by Mr. D.L. Workman, Co-op Student. The equipment used was owned and operated by Dominion Soil Investigation Ltd. This report was written by Mr. P. Payer and reviewed by Mr. K.G. Selby.



P. Payer, P. Eng.
Foundations Engineer



K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

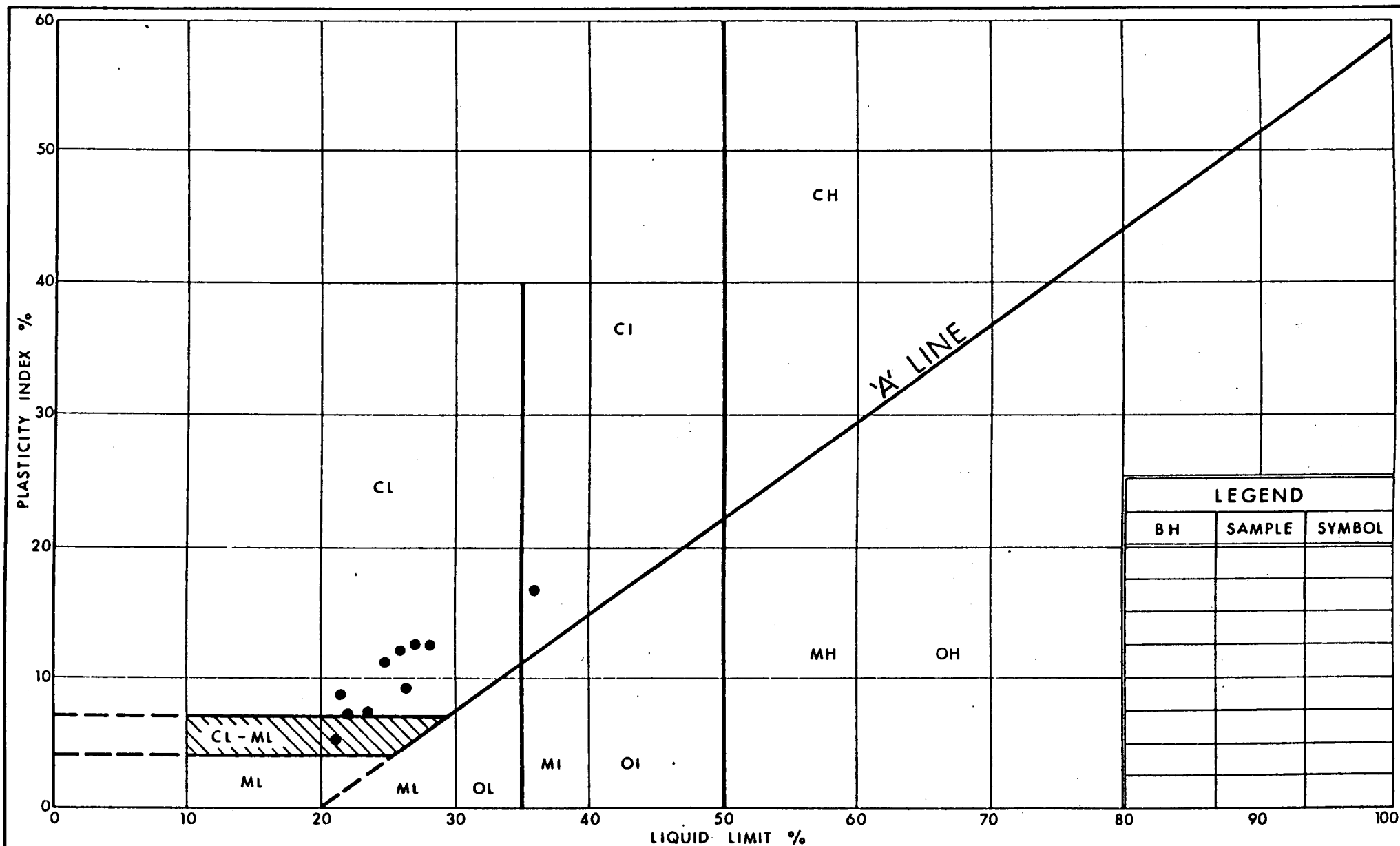
PHYSICAL PROPERTIES OF SOIL

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

DESCRIPTION OF ROCK CORE - W. 84-26026

OREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (M)	% CR*	% RQD*	DEPTH (M)	DESCRIPTION
1	6.86 - 9.74	72.2	71.3	6.86 - 7.60	Core loss assumed over this length; shale (Queenston), red, highly weathered
				7.60 - 9.74	Shale (Queenston), red, unweathered with widely spaced joints, contain- approx. 5% green siltstone in 25 - 50 mm layers
2	6.30 - 8.00	94.0	73.1	6.30 - 6.41	Core loss assumed over this length; shale (Queenston), red, highly weathered
				6.41 - 8.00	Shale (Queenston), red, unweathered with moderately spaced joints; con- taining approx. 10% green silty shale in 20 - 50 mm layers
3	5.69 - 7.35	92.3	49.2	5.69 - 6.45	Shale (Queenston), red, moderately weathered with very closely spaced joints
				6.45 - 7.35	Shale (Queenston), red, slightly weathered, becoming sound with depth with moderately spaced joints; containing approx. 2% green silty shale in a 25 mm layer
4	5.98 - 7.65	91.0	80.1	5.98 - 6.10	Core loss assumed over this length; shale (Queenston), red, highly weathered
				6.10 - 6.56	Shale (Queenston), red, moderately weathered with closely spaced joints; containing a 100 mm layer of green siltstone
				6.56 - 7.65	Shale (Queenston), red, slightly weathered with moderately spaced joints; containing two layers of green silty shale about 25 mm thick
5	5.64 - 7.17	100	90	5.64 - 7.17	Shale (Queenston), red, slightly weathered with moderately spaced joints; containing about 25% green siltstone or silty shale in 25 mm to 230 mm layers

* CR = CORE RECOVERY; RQD = ROCK QUALITY DESIGNATION



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PLASTICITY CHART
HETEROGENEOUS MIXTURE OF GRAVEL, SAND AND SILT
(GLACIAL TILL) UPPER ZONE

FIG No 1

WO 84-26026

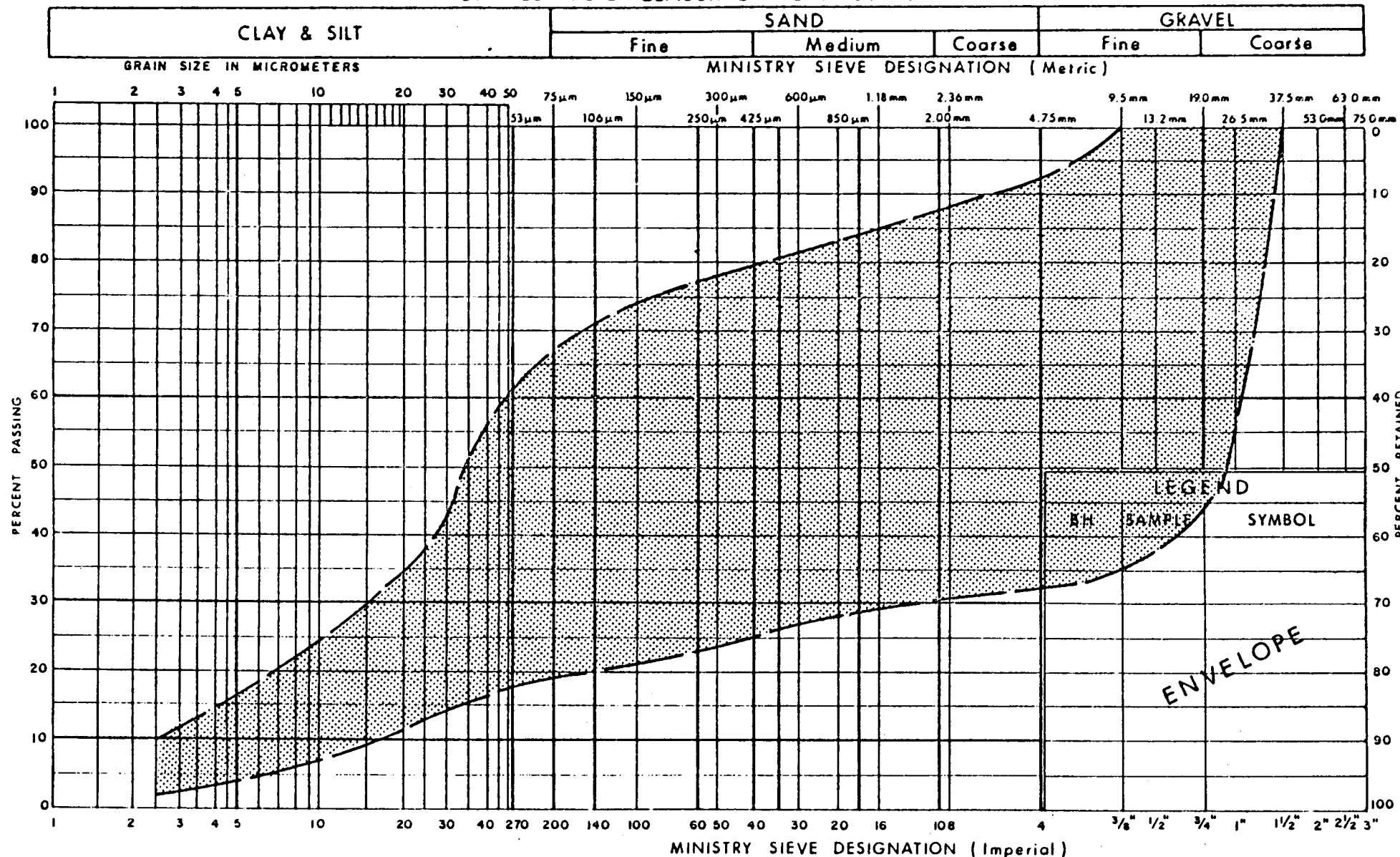
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GRAIN SIZE DISTRIBUTION HETEROGENEOUS MIXTURE OF GRAVEL, SAND AND SILT (GLACIAL TILL) UPPER ZONE

W P 84-26026

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF GRAVEL, SAND AND SILT
(GLACIAL TILL) LOWER ZONE

FIG No 3

W P 84-26026



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RECORD OF BOREHOLE No 1

METRIC

WO 84-26026 LOCATION Co-ords. N 4 800 228.5; E 280 091.0 ORIGINATED BY DLW
DIST 4 HWY GO-ALRT BOREHOLE TYPE Cont. Flight Auger (R.S.) & Wash Boring COMPILED BY DLW
DATUM Geodetic DATE 84 07 24 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						SHEAR STRENGTH	
99.5	Pavement Level*																GR SA SI CL		
0.0	Heterogeneous Mixture of gravel, sand, silt and clay		1	SS	13	8 cm	98										16 29 36 19		
			2	SS	53														
			3	SS	607														
			4	SS	107														
	Stiff to Hard																	8 23 46 23	
			5	SS	607	8 cm	96											40 34 23 3	
	Very Dense		6	SS	72														
	Glacial Till		7	SS	607	8 cm	94											67 13 16 4	
		8	SS	73															
92.6																			
6.9	Highly Weathered Shale		9	RC BXL	72% REC		92												
	UnWeathered Bedrock																		
89.9																			
9.6	End of Borehole																		
	* Asphalt Thickness 152 mm																		

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

WO 84-26026 LOCATION Co-ords. N 4 800 223.5; E 280 075.0 ORIGINATED BY DLW
DIST 4 HWY GO-ALRT BOREHOLE TYPE Cont. Flight Anger (H.S.) & Wash Boring COMPILED BY DLW
DATUM Geodetic DATE 84 07 25 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
99.4	Pavement Level*																
0.0	Heterogeneous Mixture of gravel, sand silt and clay		1	SS	23												12 21 44 23
			2	SS	17												
			3	SS	39												
	Very Stiff to Hard		4	SS	91												8 19 48 25
			5	SS	99												
			6	SS	120												12 48 35 5
	Very Dense Glacial Till		7	SS	60/	10 cm											
			8	SS	60/	8 cm											33 32 30 5
93.0			9	SS	60/	10 cm											
6.4	Shale Unweathered Bedrock		10	RC BXL	100% REC												
91.4																	
8.0	End of Borehole																
	* Asphalt Thickness 102 mm																

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



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RECORD OF BOREHOLE No 3

METRIC

WO 84-26026 LOCATION Co-ords. N 4 800 209.0; E 280 083.0 ORIGINATED BY DLW
DIST 4 HWY GO-ALRT BOREHOLE TYPE Cont. Flight Auger (H.S.) & Wash Boring COMPILED BY DLW
DATUM Geodetic DATE 84 07 25 CHECKED BY 10

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						WATER CONTENT (%)
99.1	Pavement Level*							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
0.0	Heterogeneous Mixture of gravel, sand, silt and clay Stiff to Hard ----- Very Dense Glacial Till		1	SS	13									17 24 35 24	
			2	SS	14										4 21 56 19
			3	SS	42										36 32 30 2
			4	SS	105										44 24 27 5
			5	SS	607	13 cm									
			6	SS	607	13 cm									
			7	SS	100										
93.4			8	SS	1207	10 cm									
5.7	Shale Moderately Bedrock Slightly		9	RC	95%										
91.8	Weathered			BXL	REC										
7.3	End of Borehole														
	* Asphalt Thickness 25 mm														

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 4

METRIC

WO 84-26026 LOCATION Co-ords. N 4 800 230.5; E 280 068.5 ORIGINATED BY DLW
DIST 4 HWY GO-ALRT BOREHOLE TYPE Cont. Flight Auger (H.S.) & Wash Boring COMPILED BY DLW
DATUM Geodetic DATE 84 07 26 CHECKED BY *DLW*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT	NUMBER	TYPE	VALUES		20	40	60	80	100	W _p	W	W _L		
99.7	Pavement Level*															
0.0	Heterogeneous Mixture of gravel, sand, silt and clay		1	SS	20											GR SA SI CL
			2	SS	17											43 39 (18)
			3	SS	43											
			4	SS	115/	22 cm										8 20 50 22
	Very Stiff to Hard		5	SS	105											
			6	SS	60/	15 cm										34 39 25 2
	Very Dense Glacial Till		7	SS	115/	28 cm										
93.7			8	SS	60/	13 cm										8 24 66 2
6.0	Shale Highly Weathered Moderately Slightly		9	RC EXL	91% REC											
92.0	Bedrock															
7.7	End of Borehole															
	* Asphalt Thickness 25 mm															

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

WO 84-26026 LOCATION Co-ords. N 4 800 261.0; E 280 026.0 ORIGINATED BY DLW
 DIST 4 HWY GO-ALRT BOREHOLE TYPE Cont. Flight Auger (H.S.) & Wash Boring COMPILED BY DLW
 DATUM Geodetic DATE 84 07 26 CHECKED BY DLW

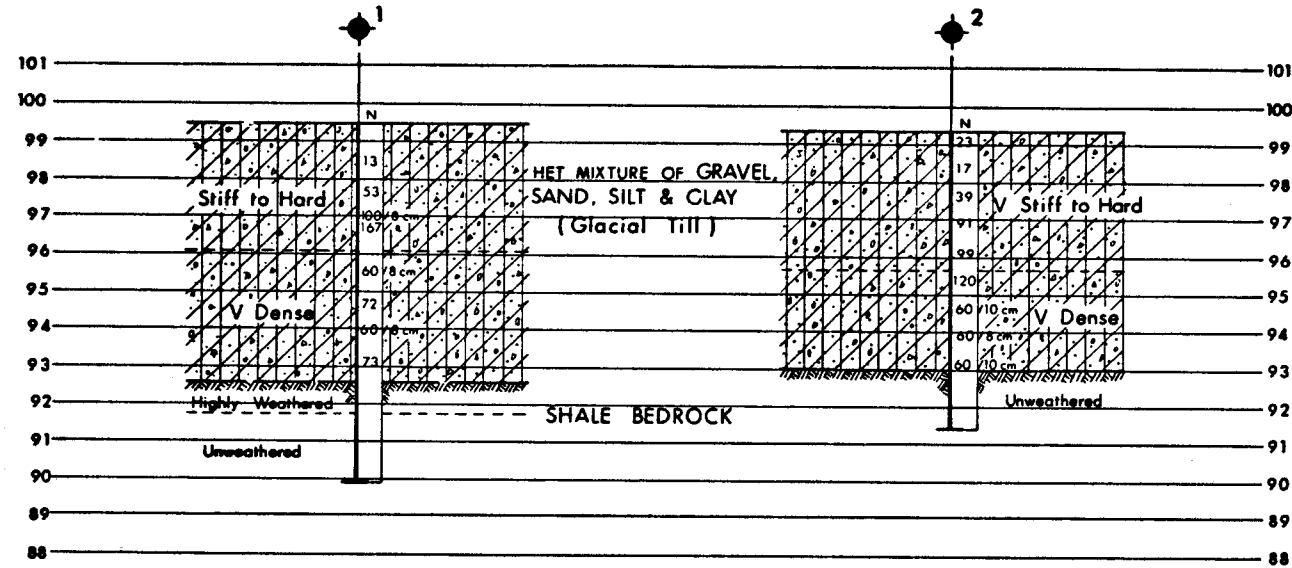
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
100.1	Pavement Level*												
0.0	Heterogeneous Mixture of gravel, sand, silt and clay		1	SS	15	100							29 39 24 8
			2	SS	18								
			3	SS	34								7 20 52 21
			4	SS	95								
	Stiff to Hard		5	SS	60/	10 cm							18 31 43 8
	Very Dense		6	SS	100								
	Glacial Till		7	SS	60/	10 cm							24 25 47 4
94.5			8	SS	60/	13 cm							42 27 27 4
5.6	Shale		9	RC	100%								
92.9	Slightly Weathered Bedrock			BXL	REC								
7.2	End of Borehole												
	* Asphalt Thickness 37 mm												

+3, x5: Numbers refer to
Sensitivity

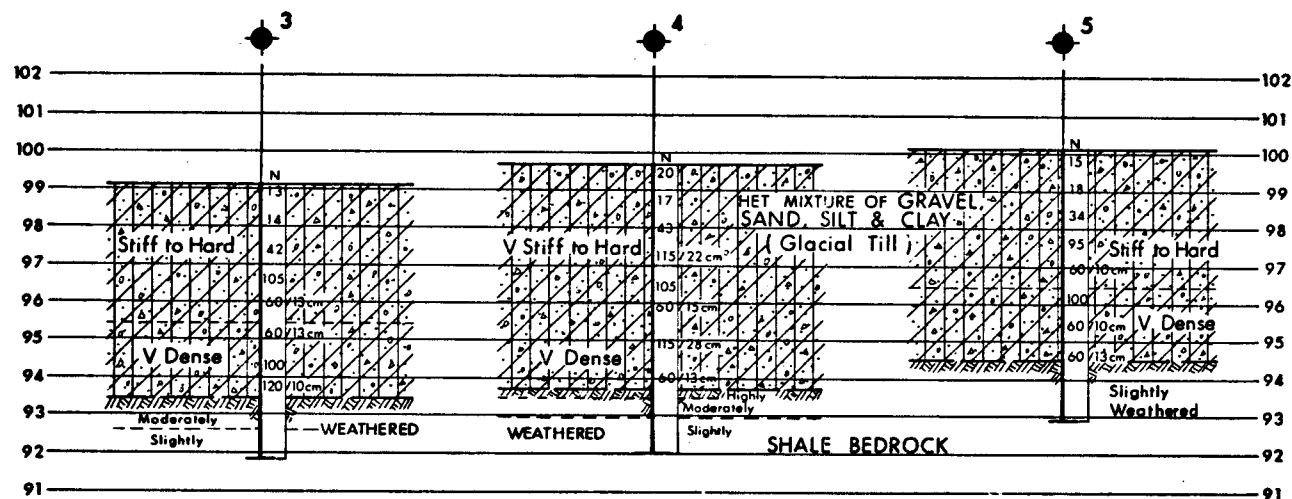
20
15
10
5 (%) STRAIN AT FAILURE

METRIC

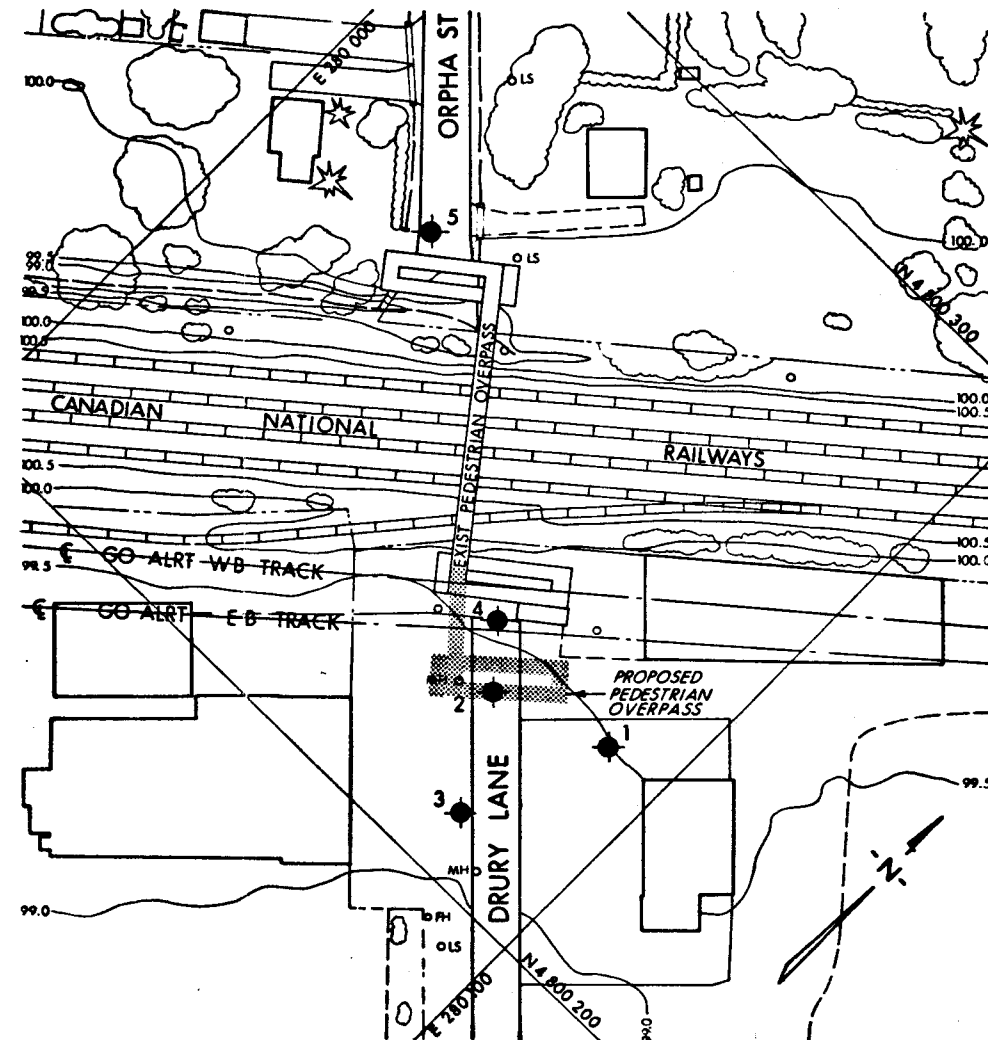
ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.



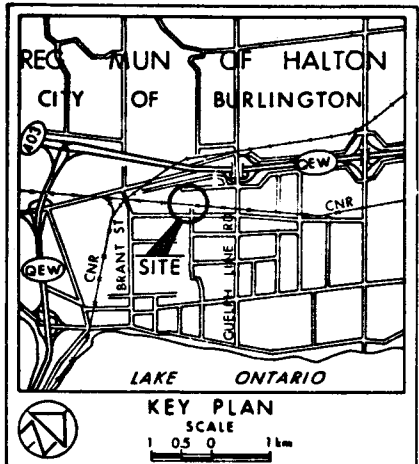
BORE HOLES 1 & 2



BORE HOLES 3, 4 & 5



PLAN



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	99.5	4 800 228.5	280 091.0
2	99.4	4 800 223.5	280 075.0
3	99.1	4 800 209.0	280 083.0
4	99.7	4 800 230.5	280 068.5
5	100.1	4 800 261.0	280 026.0


Geocres No 30M5-144

=NOTE=

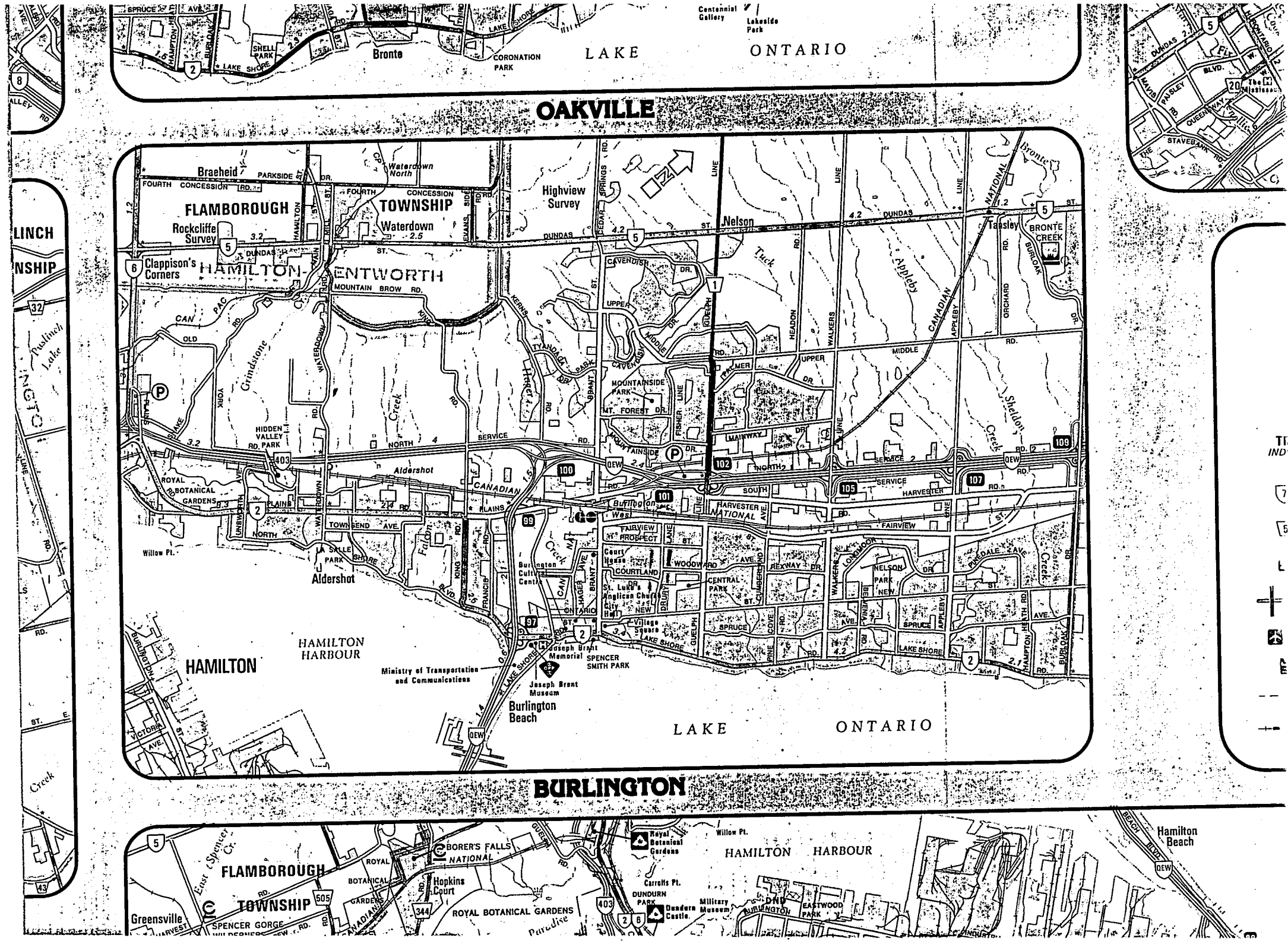
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

60-ALRT REF

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: SO 84 09 10 CHK'D BY: SCALE: FULL SIZE ONLY AS NOTED		DESIGNED BY: APPROVED BY: 		ENGINEERING MATERIALS OFFICE FOUNDATION DESIGN SECTION		GO-ALRT Ministry of Transportation and Communications OAKVILLE TO HAMILTON SECTION PROJECT MANAGER		CITY OF BURLINGTON HALTON REGION DRURY LANE PEDESTRIAN OVERPASS BOREHOLE LOCATIONS & SOIL STRATA				CONTRACT NO	DWG NO	REV	SHEET

PROJECT MANAGER



FOUNDATION INVESTIGATION
PROPOSED FOOTBRIDGE OVER
C.N.R. TRACKS AT DRURY LANE
BURLINGTON, ONTARIO

Prepared for:

THE CORPORATION OF THE TOWN OF BURLINGTON

WILLIAM TROW ASSOCIATES (HAMILTON) LTD.

Project: H1288

January 20, 1972

1870 Barton Street East

Hamilton, Ontario

Telephone: 547-6385

Direct Toronto Line: 368-6293

Project: H1288

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**William Trow
Associates**

Soil Mechanics
Consultants

W. A. Trow,
M.Sc., M.E.I.C., P.Eng.

K. Peaker,
Ph.D., M.E.I.C., P.Eng.



(Hamilton) Ltd.

C. D. Thompson, M.Sc., M.E.I.C., P.Eng.
Manager

January 20, 1972

The Corporation of the Town of Burlington
P.O. Box 5013
Burlington, Ontario

Attention: Mr. W. A. Trotter, P.Eng.

Foundation Investigation
Proposed Footbridge over C.N.R. Tracks at Drury Lane
Burlington, Ontario

Dear Sirs,

A foundation investigation was carried out at the above site as authorized by the Town of Burlington on January 6, 1972. A single span footbridge structure is proposed to link Orpha Street and Drury Lane. It will have a 23-1/2 foot clearance over the existing railway track and a clear span of approximately 120 feet.

The fieldwork was performed on January 17 and 19, 1972, by F. E. Johnston Drilling Company under the direction and supervision of the staff of William Trow Associates (Hamilton) Ltd. Two sampled boreholes were put down to 15 feet depth, and a total of 6 dynamic cone penetration tests were performed to determine the extent of fill or loose material. The borehole and dynamic cone test locations are shown on Drawing 1.

The borehole locations and groundsurface elevations were provided by the Town of Burlington. Borehole 1 could not be drilled at the stake due to the position of ditches preventing access. This borehole was therefore shifted 20 feet to the northeast as shown.

SITE AND SOIL CONDITIONS

The land in the vicinity of the proposed footbridge is generally flat lying near Elevation 329 feet. The Canadian National Railway tracks run on a 3 to 4 feet high embankment. Orpha Street and Drury Lane both terminate at the railway tracks. A drainage ditch runs across the end of Orpha Street parallel to the tracks.

The natural subsoil at this site consists of a silt till which is very dense except for the upper 4 to 5 feet which have been loosened by surficial weathering effects. It became apparent during the course of the investigation that a 24 inch diameter sewer main was tunnelled under the C.N.R. tracks at the proposed location of the footbridge. The sewer invert is 15 feet below the groundsurface at the manhole location. It would appear from the field data that the sewer trench excavations along Orpha Street and Drury Lane had side slopes at about 60 degrees to the horizontal or possibly steeper. Backfill in the sewer trench at the location of Borehole 1 is in a very loose state. The natural groundwater table appears to be located approximately 13 feet below the groundsurface near Elevation 316 feet.

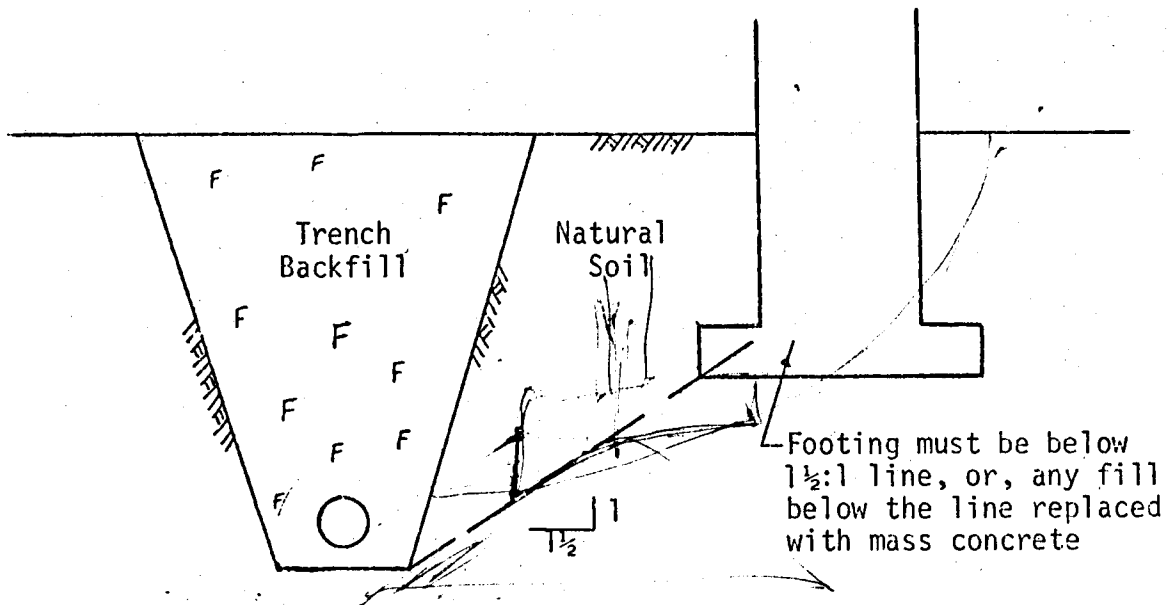
The soil conditions encountered at each borehole location are shown on the Borehole Logs, Drawings 2 to 7. Soil profiles are included on Drawing 1, showing the approximate areas affected by the sewer main installation.

DISCUSSION

The footbridge may be supported on spread footings established in the natural dense silt till below the 4 to 5 feet of surficially softened soils. A bearing pressure of 3 tsf may be used below Elevation 324 feet. A bearing pressure of 5 tsf may be used if footings are taken down to the very dense silt till below Elevations 319 to 322 feet. Settlements under the recommended bearing pressures will be less than 1/2 inch.

It is recommended that footing bases be inspected by a soils engineer to confirm that the footings are established below the surficially softened material in soil which is competent for the design bearing pressures.

In the vicinity of the existing sewer trenches, spread footings must be established in the natural soil at such a depth that they are below a line rising at $1\frac{1}{2}:1$ horizontal to vertical from the base of the trench backfill. This is illustrated in Sketch 1. If this condition cannot be fulfilled, the backfill in trenches below the $1\frac{1}{2}:1$ line must be replaced by mass concrete. The entire sewer pipe may be encased in suitability reinforced concrete if it is required to construct the footings over the sewer trench.



SKETCH 1 - LOCATION OF FOOTINGS IN VICINITY OF EXISTING SEWER TRENCH

Excavations to the founding level should be straightforward. The soils are relatively impervious and any flow of surficial water into the excavations may be dealt with by the usual construction methods, i.e., ditches and sumps.

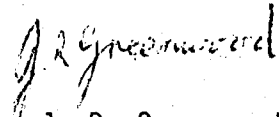
The natural on-site soil may be used as backfill in footing excavations. However, the material is not free-draining and is therefore unsuitable as backfill behind retaining structures. If the proposed design requires the retaining of soil fill, free-draining granular backfill must be used and a pipe drain installed to prevent the build up of hydrostatic pressures behind the retaining wall.

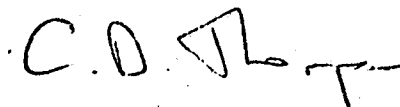
Project: H1288

5. 

We trust this report is satisfactory to your purposes.
Please do not hesitate to contact this office if we may be of further assistance to you.

Yours very truly,
WILLIAM TROW ASSOCIATES (HAMILTON) LTD.


J. R. Greenwood, P. Eng.


C. D. Thompson, P. Eng.






JRG/ml
Encl.





Dist: Town of Burlington (4)

BOREHOLE LOG

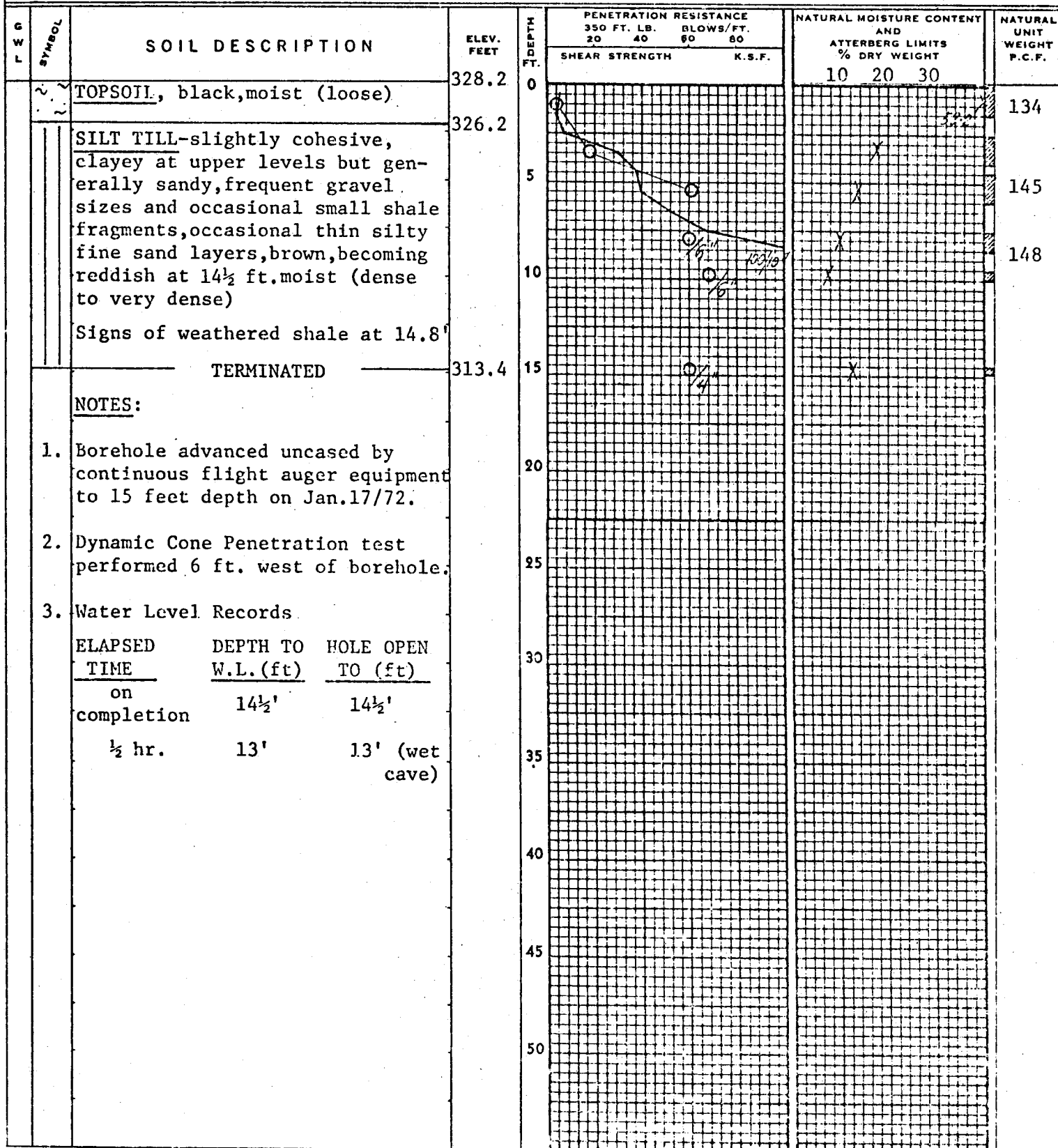
PROJECT No. H1288BOREHOLE No. 1 (Orpha Street)DRAWING No. 2

PROJECT Pedestrian Bridge Over
C.N.R. Tracks
 LOCATION Drury Lane
Burlington, Ontario

2" O.D. SPLIT TUBE 
 2" I.D. SHELBY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

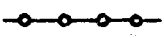
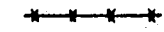
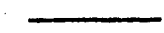






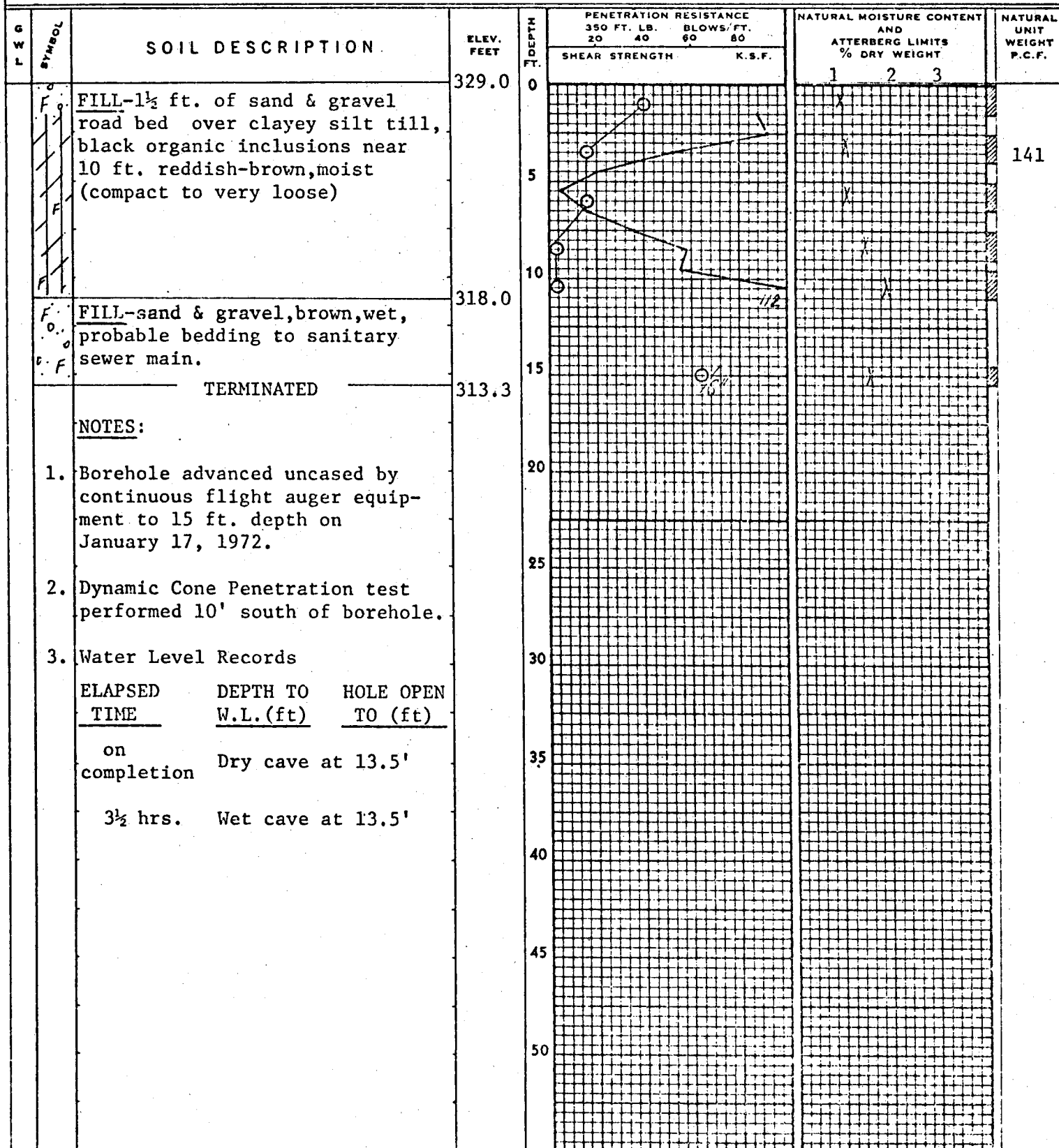
HOLE LOCATION AND DATUM SEE DRAWING NO. 1



BOREHOLE LOG

PROJECT No. H1288BOREHOLE No. 2 (Drury Lane)DRAWING No. 3PROJECT Pedestrian Bridge Over
C.N.R. TracksLOCATION Drury LaneBurlington, Ontario

HOLE LOCATION AND DATUM SEE DRAWING No. 1

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
2" DIA. CONE 
PUSHED 
VANE TEST AND SENSITIVITY (S)  P
+ SNATURAL MOISTURE  X
PLASTIC AND LIQUID LIMIT 
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
% STRAIN AT FAILURE  15
10


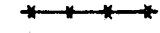

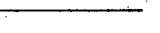

BOREHOLE LOG



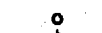
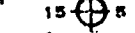
PROJECT No. H1288

CONE A

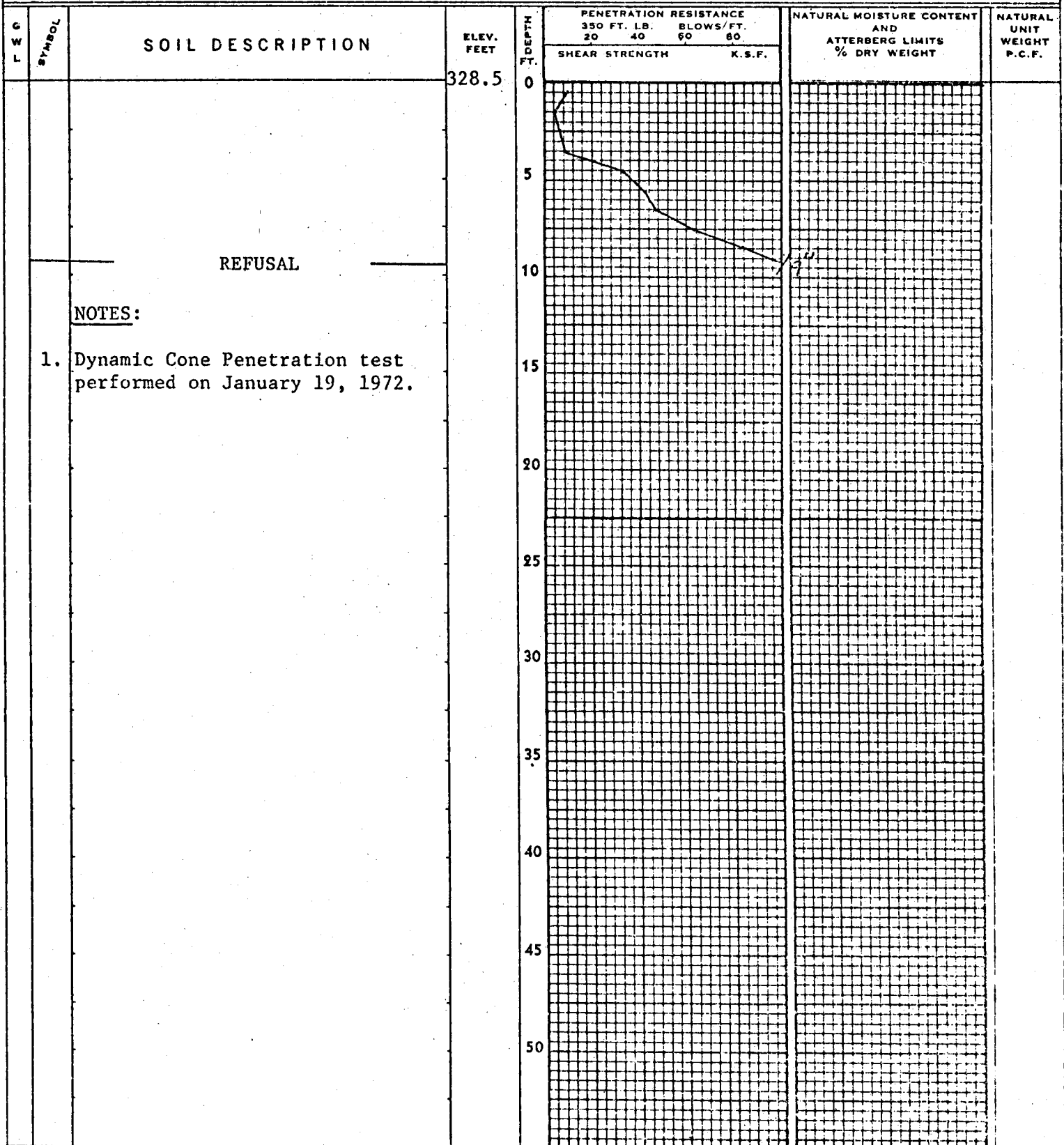
DRAWING No. 4

PROJECT Pedestrian Bridge Over
C.N.R. Tracks
LOCATION Drury Lane
Burlington, Ontario

2" O.D. SPLIT TUBE 
2" I.D. SHELBY TUBE 
2" DIA. CONE 
PUSHED 
VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
PLASTIC AND LIQUID LIMIT 
UNDRAINED TRIAXIAL AT
OVERBURDEN PRESSURE 
% STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING NO. 1



BOREHOLE LOG

PROJECT No. H1288

CONE B

DRAWING No. 5PROJECT Pedestrian Bridge Over
C.N.R. TracksLOCATION Drury LaneBurlington, Ontario

HOLE LOCATION AND DATUM SEE DRAWING NO. 1

2" O.D. SPLIT TUBE 2" I.D. SHELBY TUBE 2" DIA. CONE PUSHED  PVANE TEST AND SENSITIVITY (S)  + SNATURAL MOISTURE  XPLASTIC AND LIQUID LIMIT UNDRAINED TRIAXIAL AT
OVERBURDEN PRESSURE  15 5
% STRAIN AT FAILURE  10

G W L	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	PENETRATION RESISTANCE 350 FT. LB. BLOWS/FT. 20 40 60 80		NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	NATURAL UNIT WEIGHT P.C.F.
					SHEAR STRENGTH K.S.F.			
			329.0	0				
				5				
				10				
		REFUSAL						
		NOTES:						
		1. Dynamic Cone Penetration test performed on January 19, 1972.						






BOREHOLE LOG





PROJECT No. H1288

CONE C

DRAWING No. 5

PROJECT Pedestrian Bridge Over
C.N.R. Tracks
 LOCATION Drury Lane
Burlington, Ontario

2" O.D. SPLIT TUBE 
 2" I.D. SHELBY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING No. 1

G W L	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	PENETRATION RESISTANCE		NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	NATURAL UNIT WEIGHT P.C.F.
					350 FT. LB. 20 40 60 80	BLOWS/FT. 60 80		
			329.5	0				
				5				
				10				
		REFUSAL		15				
				20				
				25				
				30				
				35				
				40				
				45				
				50				

NOTES:

1. Dynamic Cone Penetration test performed on January 19, 1972.






BOREHOLE LOG





PROJECT No. H1288

CONE D

DRAWING No. 7

PROJECT Pedestrian Bridge Over
C.N.R. Tracks
 LOCATION Drury Lane
Burlington, Ontario

2" O.D. SPLIT TUBE 
 2" I.D. SHELBY TUBE 
 2" DIA. CONE 
 PUSHED 
 VANE TEST AND SENSITIVITY (S) 

NATURAL MOISTURE 
 PLASTIC AND LIQUID LIMIT 
 UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 
 % STRAIN AT FAILURE 

HOLE LOCATION AND DATUM SEE DRAWING NO. 1

G L W	SYMBOL	SOIL DESCRIPTION	ELEV. FEET <u>328.5</u>	DEPTH FEET	PENETRATION RESISTANCE		NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	NATURAL UNIT WEIGHT P.C.F.
					350 FT. LB. 20	BLOWS/FT. 40 60 80		
					SHEAR STRENGTH K.S.F.			
			328.5	0				
				5				
				10				
				15				
				20				
				25				
				30				
				35				
				40				
				45				
				50				
		REFUSAL						
		NOTES:						
		1. Dynamic Cone Penetration test performed on January 19, 1972.						